ROE Environmental Consulting

WASTEWATER TREATMENT SYSTEM OPERATION

2024 Post-Discharge Monitoring Annual Report

City of Port Alberni

DATE: APRIL 10, 2025
VERSION: FINAL

Prepared for:
City of Port Alberni
4850 Argyle Street
Port Alberni, BC
V9Y 1V8

Prepared by:
Roe Environmental Inc.
106 – 185 Forester Street
North Vancouver, BC
V7H 0A6
(604) 987-5588

EXECUTIVE SUMMARY

Roe Environmental Inc. (Roe), Associated Engineering (AE) and the City of Port Alberni (CPA) completed a post-discharge receiving environment monitoring program (REMP) for the CPA's Wastewater Treatment Facility (WWTF) comprised of four quarterly sampling events and five rounds of sampling within a 30-day period. This sampling was completed as a requirement of Operational Certificate (OC) 110576 which was issued to the CPA on March 7, 2022 and permits the CPA to discharge effluent to the Somass River estuary via outfall and diffuser from the WWTF. Under the OC, the CPA is required to complete a post-discharge monitoring program which incorporates sampling of the final ("end-of-pipe") treated effluent, monitoring of the receiving environment at and beyond the Initial Dilution Zone (IDZ), and monitoring to assess potential effects of seepage from the treatment lagoons. Roe was retained to provide this Post-Discharge Monitoring Annual Report which is a requirement of the OC and summarizes sampling activities conducted by Roe, AE and the CPA in 2024.

In the marine quarterly and 5-in-30 sampling, receiving environment water quality generally met the applicable guidelines and demonstrated that WWTF effluent was not having a negative impact at or beyond the IDZ. Where water quality results were found to be in exceedance of applicable water quality guidelines, the exceedances were determined to be the result of existing marine and estuarine conditions and not the result of the WWTF effluent discharge.

For quarterly groundwater, tidal channel, and piezometer sampling, applicable water quality guidelines were generally met. The WWTF effluent was shown to not have a negative impact on the environment immediately surrounding the WWTF.

Regarding the CPA's final effluent monitoring program, the following parameters did not meet the sampling frequency requirements of the OC: CBOD5, NH3-N (ammonia as nitrogen), pH, TP (total phosphate), and PO4-P (orthophosphate). Two exceedances of the OC limits occurred during the CPA's final effluent monitoring program: CBOD5 and fecal coliforms. Roe recommends that the sampling frequencies required by the OC be revised to better address the intermittent discharge of the WWTF.

Roe completed the annual vegetation survey in July 2024 based on the methods proposed by AE (2021). Due to a significant increase in the presence of invasive plants, the results of the vegetation survey were inconclusive. Roe also sampled marine sediment and benthic invertebrates with the assistance of Biologica Consulting in September 2024. Results generally aligned with those from previous years.

CONTENTS

1 INTRODUCTION AND BACKGROUND

1.1 Introduction

Roe was retained by the City of Port Alberni (CPA) to develop this 2024 Post-Discharge Monitoring Annual Report required under Operational Certificate 110576 (the "Operational Certificate") issued by the Province of BC. The Operational Certificate permits effluent discharge from the CPA's upgraded municipal wastewater treatment facility (WWTF; the "Site") to the Somass River estuary via outfall and diffuser.

This 2024 Annual Report is guided by the requirements of Section 4.5 of the Operational Certificate (**Appendix A**). The Operational Certificate was issued on March 7, 2022, following development of the CPA's new sewage treatment lagoon which was constructed to provide increased capacity and support the objectives of the CPA's Liquid Waste Management Plan (LWMP) prepared by Associated Engineering (AE) in 2020.

This report sets out to:

- Characterize the receiving environment near the treatment facility and determine whether areas outside of the WWTF outfall Initial Dilution Zone (IDZ) are compliant with water quality guidelines for the protection of aquatic life.
- Characterize the water quality conditions in the groundwater, tidal channels, and piezometers adjacent to the new sewage treatment lagoon.
- Summarize the results of vegetation, sediment, and benthic invertebrate assessment and sampling.
- Summarize and provide a comparison of the final effluent monitoring program results.
- Provide a comparison of the 2024 data to previous year's results (pre- and post-operational) to identify trends and potential on-going issues.
- Provide conclusions and recommendations for the operation of the WWTF and future assessment and sampling programs.

1.2 2024 Sampling and Reporting

In 2024, AE, the CPA, and Roe completed the annual post-discharge monitoring (the "Program") based on the requirements of the Operational Certificate and AE's (2021) *Wastewater Treatment System Upgrades Pre-Discharge and Operational Receiving Environment Monitoring Program* (the "Sampling Plan"). The Program consisted of two components: monitoring of marine and groundwater environments (the 'Receiving Environment Monitoring Program' [REMP]) completed by AE and Roe, and the final effluent monitoring program completed by the CPA.

REMP

The REMP portion of the Program in 2024 included one quarterly sampling event conducted by AE on April 23-24, 2024 (1st Quarter), followed by the three remaining 2024 quarterly sampling events which were conducted by Roe; June 26th - July 3rd, 2024 (2nd Quarter), September 3 - 30th, 2024 (3rd Quarter), and December 17-18th, 2024 (4th Quarter). Note the 3rd Quarter sampling spans from September 3 to 30 due to the inclusion of a five-sample event in 30-day program completed to satisfy Sampling Plan requirements.

Quarterly sampling events consisted of marine water quality sampling in the receiving environment at all sites (A, B, C, D, E, F, H, I, and Z), as well as seepage sampling from four groundwater monitoring wells

(MW21-1, MW21-2, MW21-3A, MW21-3B), one piezometer (P1), and three tidal channels adjacent to the treatment lagoon (T1, T2, T3). See **Figure 1** for the location of the sampling sites.

In accordance with the Sampling Plan, the September sampling event represents the most sensitive period, and consists of five (5) weekly samples within thirty (30) days to allow for comparison of results to guidelines that have an averaging requirement.

The final components of the REMP portion of the Sampling Plan include sampling for sediment quality and benthic invertebrates, and annual vegetation surveys. Vegetation sampling occurred on July 31, 2024. Sediment quality and benthic invertebrate sampling occurred on September 23rd and 24th, 2024.

Final Effluent Monitoring Program

As per the Sampling Plan, the CPA is required to sample the final effluent (treated effluent) for all parameters specified by the BC Municipal Wastewater Regulation (MWR) and the Canada Wastewater Systems Effluent Regulation (WSER). In addition to the required provincial and federal parameters, in 2021 the Ministry of Environment and Climate Change (ENV) requested the CPA also test for total metals in the final effluent for three years. It was stated that the value of sampling for total metals would be assessed annually and in detail after three years to determine the need for its continuation.

In 2024, all final effluent samples were collected from the new treatment lagoon by CPA staff according to the required sampling schedule (for a complete list of the required parameters and schedule, see Table 2-1 under Section 2.1.1 of AE's (2021) Sampling Plan). This 2024 report will summarize the results of the final effluent monitoring program completed by the CPA, and compare the results to previous years.

1.3 Comparison to Previous Years Data and Discussion

A comparison to AE's 2014 to 2020 results (the "Pre-discharge Sampling Program") and their 2022 and 2023 results will be provided in this 2024 report. This report will also summarize the results of the final effluent monitoring program completed by the CPA in 2024 to results from previous years.

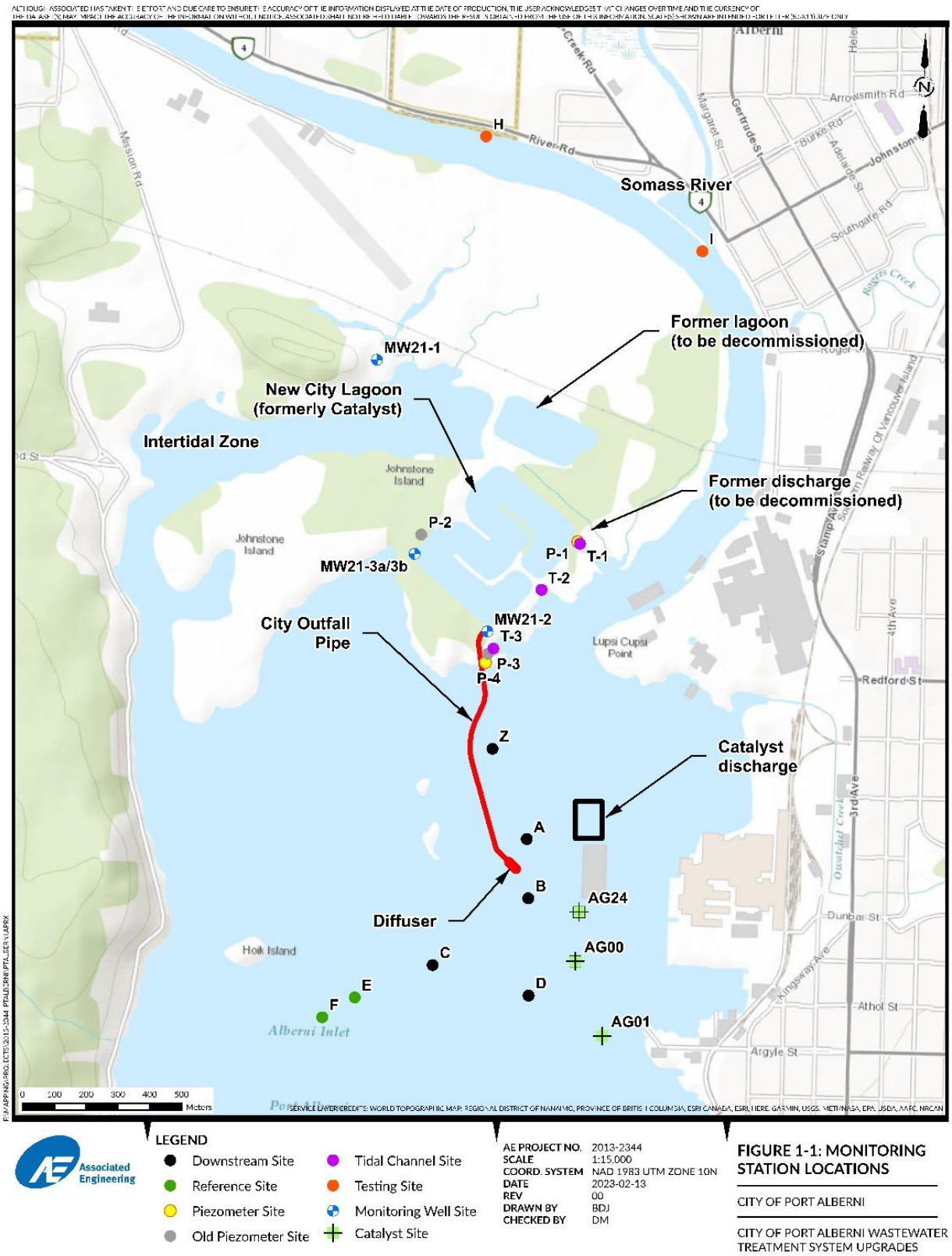


Figure 1: Sampling site locations (Map Source: AE 2023).

2 METHODS

The sampling was conducted in accordance with requirements described in the Sampling Plan (AE, 2021), as well as guidance from the most recent edition of the BC Field Sampling Manual (Province of BC, 2013) and the Marine Monitoring Guidance (BC ENV 2019).

For the purposes of this 2024 annual report, the sampling methods will be summarized separately in the following sections: Marine Receiving Environment Sampling, Groundwater and Tidal Channel Sampling, Sediment and Benthic Invertebrate Sampling, Vegetation Survey, Sample Handling and Analysis, and Comparison to Guidelines.

2.1 Marine Receiving Environment Sampling

The 2024 post-discharge marine sampling events were scheduled to align with low tide to capture the worst-case environmental conditions, due to the reduced influence of tidal dilution on the effluent discharge at the WWTF diffuser site. However, this was not always possible due to practical considerations such as daylight hours and weather conditions.

All sampling sites were accessed by boat other than site H, which was accessed via the Hupačasath First Nation wharf by foot. Prior to sampling at each site, the location was confirmed using a GPS device and the boat was anchored in position.

Sampling consisted of:

- In-situ depth profile measurements taken with a YSI ProDSS multiparameter meter. Parameters included dissolved oxygen (DO), salinity, and water temperature, and were recorded at depth intervals of 0.5m to determine the vertical location of the halocline.
- Collection of laboratory water samples with a Van Dorn grab sampler.
- 200mm limnological Secchi disk was used at the sites to provide an indication of water clarity by lowering it through the water column and recording the depth at which the black quadrants of the disk could not be differentiated from the white quadrants.
- Collection of two water samples (three at Site D): one sample from within the halocline and the second from below the halocline. The sample bottles from ALS Canada Ltd. (ALS) were filled from the spigot of the Van Dorn grab sampler.

Shallow, within halocline sample IDs end with a 1 (e.g. A1, B1, C1, etc.) and deeper, below halocline sample IDs end with a 2 (e.g. A2, B2, C2, etc.). Sample IDs at site D are as follows; D1 (shallow, surface), D2 (shallow, within halocline), D3 (deeper, below halocline).

Table 1 presents the physical and chemical parameters which were prescribed within the Sampling Plan and analyzed during the sampling events.

All laboratory samples were shipped to and processed by ALS Environmental in Burnaby, BC.

Table 1. Parameters analyzed during sampling of the receiving environment.

Receiving Environment	
pH	Total Kjeldahl Nitrogen (TKN)
Total Suspended Solids (TSS)	Total Phosphorus
Biochemical Oxygen Demand	Ortho-Phosphate
Hardness (as CaCO3)	Dissolved Chloride

Ammonia-N	Total metals (including mercury)
Nitrate-N	Enterococcus sp.
Nitrite-N	

2.2 Groundwater and Tidal Channel Sampling

The 2024 post-discharge groundwater and tidal channel sampling events were scheduled to align with low tide, when possible, to capture worst-case environmental conditions. Water samples were collected from four groundwater monitoring wells, a piezometer, and three tidal channels during quarterly sampling events in the vicinity of the new treatment lagoon. All sampling sites were accessed by foot.

Tidal channel samples were collected with a Van Dorn grab sampler and sample bottles were filled using the spigot on the sampler immediately following collection. An in-situ measurement was taken with a YSI ProDSS multiparameter meter at each tidal channel site.

Low-flow groundwater sampling was conducted at the monitoring wells as a method with low disturbance to the water column. The wells were purged with a peristaltic pump set to a low flow rate, to remove stagnant and/or turbid water from the well prior to sampling. In-situ water quality parameters were recorded during purging and sample bottles were filled once the parameters were observed to stabilize. Purging and sampling were completed without groundwater drawdown at all wells.

The piezometer was purged with a peristaltic pump until dry, and then sample bottles were filled using the same method as for the groundwater wells.

Table 2 presents the physical and chemical parameters which were prescribed within the Sampling Plan for the groundwater and tidal channels, and analyzed during the sampling events. All laboratory samples were processed by ALS Environmental in Burnaby, BC.

Table 2. Parameters analyzed during sampling of the groundwater, tidal channel, and piezometer.

Tidal Channel, Groundwater, and Piezometer Sampling	
pH	Nitrite-N
Total Suspended Solids (TSS)	Total Kjeldahl Nitrogen (TKN)
Total Dissolved Solids (TDS)	Total Phosphorus
Biochemical Oxygen Demand	Ortho-Phosphate
Hardness (as CaCO3)	Dissolved Chloride
Ammonia-N	Dissolved metals (including mercury)
Nitrate-N	Enterococcus sp.

2.3 Sediment and Benthic Invertebrates Sampling

Sediment Sampling Methods

Sediment samples were collected from a boat using a standard Ponar grab sampler at sites A, B, C, D, E, and F on September 23rd and 24th, 2024. Three grab samples were collected using the grab sampler from within 10 m of each other, totaling three replicates per site. Sediment samples were collected from the top 2 cm of each of the three grab samples and combined into a composite sample with a total volume of approximately 30 mL. This process was repeated for each site. The sampling materials were washed with acetone between sites.

Table 3 presents the physical and chemical parameters which were analyzed during the 2024 sediment sampling event on September 23rd and 24th, 2024. All laboratory samples were processed by ALS Environmental in Burnaby, BC.

Table 3. Parameters analyzed during sediment sampling in September 2024.

Sediment Sampling	
Chlorinated Phenols	Total Organic Carbon
Total Nitrogen	Total Kjeldahl Nitrogen (TKN)
Particle Size Distribution	Anions (Nitrate and Nitrite)

Benthic Invertebrate Sampling Methods

Benthic invertebrate samples were collected at the same time as the sediment sampling. A subconsultant, Biologica Environmental Services Ltd. (Biologica), assisted with sediment collection and then processed the invertebrate samples at the dock in Port Alberni. Benthic invertebrate analysis was completed by Biologica at their laboratory in Victoria. Benthic invertebrate methods were as follows:

- Sediment samples were delivered to a Biologica technician at the dock in separate covered plastic totes.
- A Biologica technician used a portable washing table and water pump to sieve the contents of each plastic tote through 1 mm mesh to remove fine sediments.
- The resulting sample from each tote, including any debris, was placed in one or more labelled jars (depending on the size of the sample) and preserved in 10% buffered formalin.
- The samples were delivered to Biologica's laboratory in Victoria for taxonomic identification to the lowest practicable level (i.e., Genus-species).

Biologica's processing, sorting, identification, and enumeration methods are presented in **Appendix B**.

2.4 Vegetation Survey

Vegetation sampling was conducted using the methods included within AE (2024b) and AE (2021). Vegetation inventory, percent cover, and dominant species were surveyed within vegetation plots which were randomly located within 36 Zone of Influence (ZOI) and Reference sites.

2.5 Sample Handling and Analysis

Water and sediment samples were collected using laboratory supplied, clean containers and were filtered and preserved in accordance with laboratory requirements and following the guidelines in the most recent edition of the BC Field Sampling Manual (Province of BC, 2013).

For samples that required field filtering, new syringes and filters were used for each sample. Materials used to collect water and sediment samples were cleaned to prevent cross-contamination.

Sample bottles were labeled and stored in a cooler that was maintained at a temperature of 10°C or less during transport to ALS Laboratory in Burnaby via floatplane from Nanaimo. ALS analyzed the water and sediment samples for the physical and chemical parameters prescribed by AE (in April 2024) and Roe (June/July, September, December 2024), using methods with detection limits meeting or exceeding values required to compare the results to applicable provincial and/or federal guidelines.

2.6 Comparison to Guidelines

Marine receiving environment samples were analyzed for the parameters listed in Table 1 and compared against applicable water quality guidelines, including the BC Ambient Water Quality Guidelines for the Protection of Aquatic Life (BCWQG; BC ENV 2024, BC ENV 2024a), and the Guidelines for Canadian Recreational Water Quality (Health Canada 2024). Although the BC Phosphorus Management in Vancouver Island Streams guideline (MOE, 2014) was previously used for comparison in past annual/quarterly reports, this guideline is applicable to freshwater streams and will no longer be used for comparison within the estuarine/marine environment.

Groundwater and tidal channel samples were analyzed for the parameters listed in Table 2 and compared against applicable water quality guidelines. **Tidal channel samples** were compared to the BCWQG, and **groundwater samples** (monitoring wells and piezometer) were compared to BC Contaminated Sites Regulation (BC CSR) Schedule 3.2: Generic Numerical Water Standards for aquatic life. According to the BC CSR Technical Guidance 15 memo (BC ENV 2017), the Schedule 3.2 standards apply to groundwater and surface water that may discharge into an aquatic receiving environment when the sampling sites are located beyond 10 m inland from the high-water mark (HWM). If concentrations of the groundwater samples do not meet BC CSR Schedule 3.2 standards, but are still below BCWQGs, the concentrations of the samples would be considered protective of the aquatic receiving environment (BC ENV 2017). The groundwater and tidal channel samples were also compared to the Guidelines for Canadian Recreational Water Quality.

Some parameters under the BCWQGs have an averaging approach; a Long Term Chronic guideline which requires a minimum of 5 samples to average and compare. The **5-in-30 sampling events** provide data that allow for this approach. Individual sampling results from **5-in-30 events** will not be considered exceeding even if they fluctuate above and below the long-term chronic guideline, provided that the individual results do not exceed the short-term acute guideline and that the mean result calculated from the averaging period meets the long-term chronic guideline (BC ENV 2024).

In addition to providing data that allows for the averaging approach needed to compare some parameters against long-term chronic BCWQGs, the **5-in-30 sampling events** also allow for the calculation of the **geometric mean concentrations of *E. coli* and enterococci**. The updated Guidelines for Canadian Recreational Water Quality provide a Beach Action Value (BAV) for *E. coli* and enterococci which is applied to individual sample results (single or composite) and are used for making day-to-day or short-term decisions, while the geometric mean value of the sample results is used for analyzing long-term trends. The BAV for enterococci aligns with the previous, 2012 Health Canada value (referred to as the "single sample maximum value" in previous reports), and the BAV for *E. coli* is more conservative than the previous, 2012 Health Canada single sample maximum value. Geometric mean calculations that "include samples collected over numerous months (or seasons) can help determine whether the water quality is changing or remaining stable", and "the greater number of samples included in the calculation of the geometric mean, the more reflective it will be of the water quality" (Health Canada 2024). Based on this guidance and for the purpose of maintaining consistency with previous reports, the geometric mean concentration for *E. coli* and enterococci will be calculated using the 5-in-30 sampling event results and compared to the Health Canada geometric mean value. For all other sampling events, *E. coli* and enterococci results will be compared to Health Canada's BAV (single sample) values.

$$\textbf{Geometric Mean} = (X_1 * X_2 * X_3 * X_4 * X_5)^{(1/n)}$$

Sediment quality guidelines in BC consist of the BC Working Water Quality Guidelines (BC ENV 2021), Schedule 3.4 of the BC CSR, and the Canadian Council of Ministers of the Environment (CCME) guidelines.

For the parameters analyzed during the 2024 Sampling Program, no applicable guidelines are available for comparison.

3 2024 SAMPLING PROGRAM RESULTS

3.1 Marine Receiving Environment Quarterly Results

The following sections summarize the 2024 quarterly marine sampling results. Parameters that were observed to exceed applicable guidelines in 2024 are summarized below in tables to show all the individual sampling results from each quarter and sample site, as well as graphs, which display the average concentrations for each sample site throughout the year of monitoring.

In addition to parameters that exceed guidelines, additional parameters are described below which were observed to be meeting applicable guidelines and have been included because they are either indicator parameters for effluent monitoring and/or the results were considered to be significant to comparison/trend discussion.

Roe conducted quarterly receiving environment sampling in June/July 2024 (Quarter 2; Q2), September 2024 (Quarter 3; Q3), and December 2024 (Quarter 4; Q4). The results from AE's April 2024 sampling event are listed under Quarter 1 (Q1) of each table. It is noted that all results and guideline limit values are in mg/L unless otherwise stated.

3.1.1 pH

Throughout the quarterly sampling events in 2024, seven measurements were less than the lower pH limit of the BC Approved Water Quality Guidelines (BCWQG) for Marine Aquatic Life, which is 7.0 to 8.7 in marine water (**Table 4**). However, when compared to the acceptable range of 6.5 to 9.0 for the BCWQG Freshwater Aquatic Life guideline, only two measurements were less than 6.5. Field measured pH was less than the lower pH guideline limit of 7.0 at sites C1, C2, H1, H2, and Z1, and lower than 6.5 at H1 (Figure 2). In 2024 the pH at all sites during quarterly marine sampling ranged from 6.31 to 8.18, with an average of 7.53 pH. The third quarter (Q3), in September, had the highest average pH, and Q4, December, had the lowest average pH.

Table 4. Field Measured pH During Quarterly Marine Receiving Environment Sampling in 2024.

pH (Field Measured)				
Sample Site	2024 Quarterly Sampling Events			
	Q1	Q2	Q3	Q4
A1	7.43	7.49	7.87	7.44
A2	7.76	7.50	7.94	7.45
B1	7.57	7.57	8.01	7.51
B2	7.67	7.42	7.77	7.44
C1	7.75	7.89	7.83	**6.61**
C2	7.57	7.79	7.62	**6.74**
D1	7.78	8.02	7.99	7.34
D2	7.61	7.69	7.96	7.36
D3	7.39	n.s.	7.34	7.41
E1	7.68	7.69	7.86	7.27

E2	7.59	7.61	7.61	7.24
F1	7.63	7.41	7.93	7.25
F2	7.57	7.54	7.56	7.30
H1	**6.31**	**6.49**	7.76	**6.63**
H2	n.s.	n.s.	7.89	**6.85**
I1	8.07	7.61	7.74	8.18
I2	n.s.	7.57	7.89	7.80
Z1	**6.73**	7.52	7.62	7.42
Z2	7.24	7.47	7.77	7.41
n.s. – Not sampled due to tidal conditions and water level.				

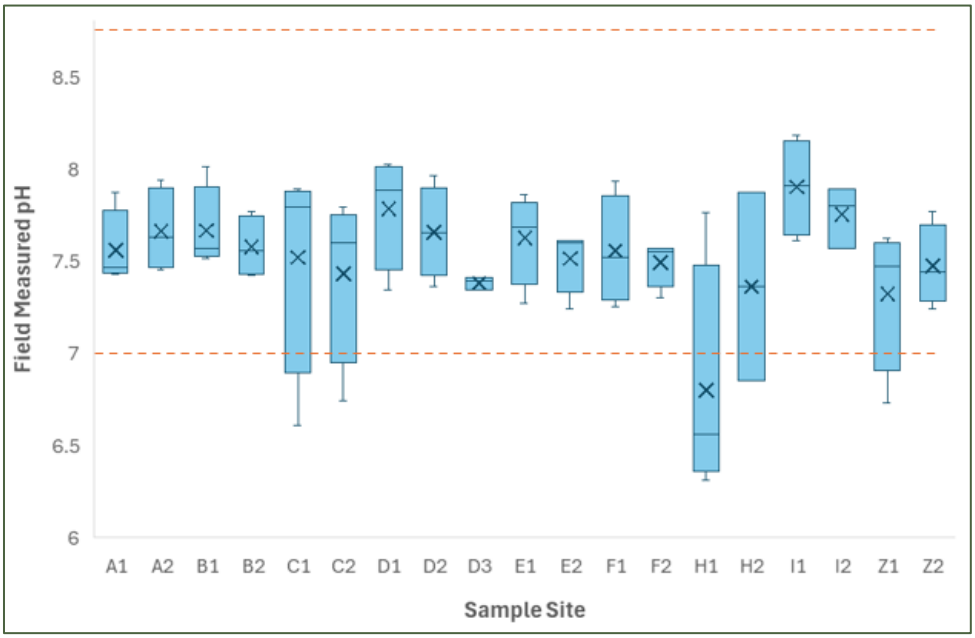


Figure 2: Average Field Measured pH During Quarterly Marine Receiving Environment Sampling in 2024.
Dashed lines represent BCWQG lower and upper limits for pH.

3.1.2 Dissolved Oxygen

In 2024, the dissolved oxygen at all sites during quarterly marine sampling ranged from 1.46 mg/L to 15.78 mg/L, with an average of 9.04 mg/L. The lowest average dissolved oxygen was observed in Q3, September, and the highest average dissolved oxygen was observed in Q4, December.

Three measurements were less than the BCWQG instantaneous minimum guideline for dissolved oxygen (5 mg/L; **Table 5**). Field measured dissolved oxygen was less than the minimum guideline at site D3, the deepest sample depth in the Program, and at F2, one of the two reference sites (**Figure 3**). These measurements align with previous findings (AE, 2022; AE, 2024) and are considered to be representative of existing estuarine/marine environment conditions. The low dissolved oxygen at sites D3 and F2 is not considered to be related to impacts from the WWTF effluent.

Table 5. Field Measured Dissolved Oxygen During Quarterly Marine Receiving Environment Sampling in 2024.

Dissolved Oxygen (mg/L; Field Measured)				
Sample Site	**2024 Quarterly Sampling Events**			
	Q1	**Q2**	**Q3**	**Q4**
A1	11.17	8.77	8.26	11.45
A2	9.86	8.72	8.35	9.96
B1	10.17	8.93	8.98	11.45
B2	8.87	8.61	6.94	8.17
C1	10.45	8.61	7.63	12.28
C2	7.71	7.60	5.40	11.12
D1	10.01	8.58	8.99	11.77
D2	7.23	6.14	8.38	8.60
D3	**4.41**	n.s.	**1.46**	8.98
E1	10.22	8.85	7.80	12.11
E2	7.01	8.41	5.02	8.70
F1	9.87	6.22	8.33	11.5
F2	7.30	7.02	**4.80**	7.02
H1	11.11	9.19	8.34	12.99
H2	n.s.	n.s.	8.00	13.18
I1	11.96	9.13	10.17	13.14
I2	n.s.	9.12	15.78	13.16
Z1	10.73	8.81	7.49	11.76
Z2	8.95	8.66	7.41	7.52

n.s. – Not sampled due to tidal conditions and water level.

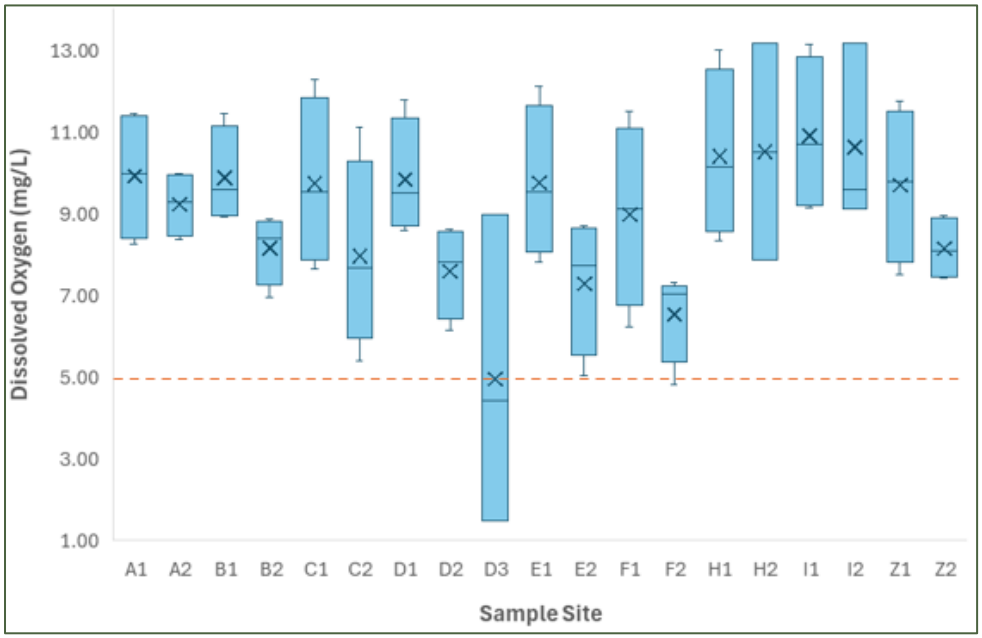


Figure 3: Average Field Measured Dissolved Oxygen During Quarterly Marine Receiving Environment Sampling in 2024. *Dashed line represents BCWQG minimum guideline for Dissolved Oxygen.*

3.1.3 Ammonia

Ammonia (as N) is considered to be toxic to fish, and its toxicity varies depending on other variables such as water temperature, salinity, and pH. The BCWQG for total ammonia therefore also varies depending on these variables and there is no single guideline value for marine water, however, the most conservative guideline value is 0.1 mg/L. Instead, there are multiple BCWQG guideline limits for total ammonia based on the varying values of salinity, pH, and temperature for a given sample.

Throughout the quarterly sampling events in 2024, there were no exceedances of the BCWQG guidelines for total ammonia once adjusted for pH, salinity, and temperature. In Q2, total ammonia concentrations at sample sites B1 (0.187 mg/L) and B2 (0.200 mg/L) were greater than the most conservative BCWQG guideline value (0.1 mg/L), however, once adjusted for pH, salinity, and temperature, the actual guideline limit for those samples was 2.4 mg/L. In Q4, the total ammonia concentration at sample site C2 (0.120 mg/L) was greater than the most conservative BCWQG (0.1 mg/L), but the actual, adjusted guideline for the sample was 20 mg/L. Therefore, there were no exceedances of total ammonia.

In 2024 the concentration of total ammonia at all sites during quarterly marine sampling ranged from <0.005 mg/L to 0.200 mg/L, with an average of 0.023 mg/L. The lowest average total ammonia concentrations were observed in Q1, April, and the highest average total ammonia was observed in Q4, December.

Table 6. Total Ammonia Concentrations During Quarterly Marine Receiving Environment Sampling in 2024.

Total Ammonia as N (mg/L)				
Sample Site	2024 Quarterly Sampling Events			
	Q1	Q2	Q3	Q4
A1	0.0080	0.0055	<0.0050	0.0358
A2	0.0089	0.0082	0.0083	0.0223
B1	0.0068	0.187	<0.0050	0.0287
B2	0.0064	0.200	0.0132	0.0317
C1	0.0079	0.0129	<0.0050	0.0178
C2	0.0095	<0.0050	0.0231	0.120
D1	<0.0050	0.0088	<0.0050	0.0489
D2	0.0072	0.0162	<0.0050	0.0263
D3	0.0226	n.s.	0.0518	0.0207
E1	0.0066	<0.0050	0.0063	0.0215
E2	0.0102	0.0154	0.0505	0.0297
F1	0.0073	0.0052	0.0135	0.0489
F2	0.0079	0.0185	0.0432	0.0270
H1	<0.0050	<0.0050	n.s.	n.s.
H2	n.s.	<0.0050	n.s.	n.s.
I1	<0.0050	<0.0050	0.0068	<0.0050
I2	n.s.	<0.0050	0.0076	0.0344
Z1	<0.0050	0.0102	0.0177	0.0636
Z2	0.0070	0.0088	0.0297	0.0339
n.s. – Not sampled due to tidal conditions and water level.				

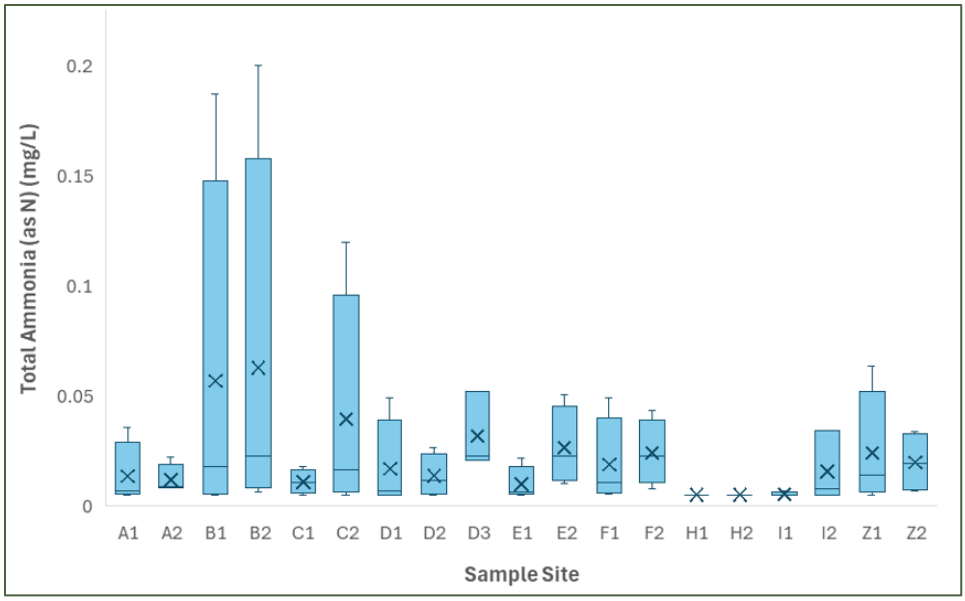


Figure 4: Average Total Ammonia During Quarterly Marine Receiving Environment Sampling in 2024.

3.1.4 Total Phosphorus

Total phosphorus concentrations in 2024 ranged from <0.0040 mg/L to 0.0697 mg/L, with an average of 0.027 mg/L. The lowest average total phosphorus concentration was observed in April, Q1, outside of the growing season (May – September), and the highest average total phosphorus was observed in December, Q4, also outside of the growing season. Total phosphorus concentrations were higher in the below halocline samples (e.g. A2, B2, C2, etc.) than the within halocline samples (e.g. A1, B1, C1, etc.; **Table 7; Figure 5**).

In the absence of BC Approved or Working Water Quality Guidelines for total phosphorus, the BC Ministry of Environment Phosphorus Management in Vancouver Island Streams (MOE, 2014) growing season objectives were previously used to provide comparison to total phosphorus concentrations (AE, 2022). However, since the entire REMP program occurs in the estuarine and marine environment, Roe concludes that this guideline does not apply, and moreover, there are no applicable provincial or federal water quality guidelines for total phosphorus within the estuarine or marine environment. Additionally, when compared to the previous guideline, elevated levels were seen in both downstream and reference sites. Reference sites are considered to be a sufficient distance away from the outfall that they should not be significantly influenced by WWTF effluent.

Table 7. Total Phosphorus Concentrations During Quarterly Marine Receiving Environment Sampling in 2024.

Total Phosphorus (mg/L)				
Sample Site	2024 Quarterly Sampling Events			
	Q1	Q2	Q3	Q4
A1	0.0067	0.0336	0.0221	0.0279
A2	0.0098	0.0404	0.0256	0.0560
B1	0.0128	0.0596	0.0227	0.0179
B2	0.0193	0.0652	0.0340	0.0375
C1	0.0085	0.0306	0.0265	0.0107

C2	0.0164	0.0304	0.0394	0.0461
D1	0.0082	0.0433	0.0256	0.0241
D2	0.0395	0.0444	0.0208	0.0508
D3	0.0602	n.s.	0.0697	0.0482
E1	0.0099	0.0188	0.0229	0.0130
E2	0.0325	0.0354	0.0570	0.0492
F1	0.0105	0.0171	0.0223	0.0252
F2	0.0274	0.0326	0.0514	0.0388
H1	<0.0040	0.0037	n.s.	n.s.
H2	n.s.	0.0041	n.s.	n.s.
I1	<0.0040	0.0040	0.0059	<0.0040
I2	n.s.	0.0044	0.0098	0.0307
Z1	0.0043	0.0079	0.0297	0.0284
Z2	0.0103	0.0181	0.0306	0.0412
n.s. – Not sampled due to tidal conditions and water level.				

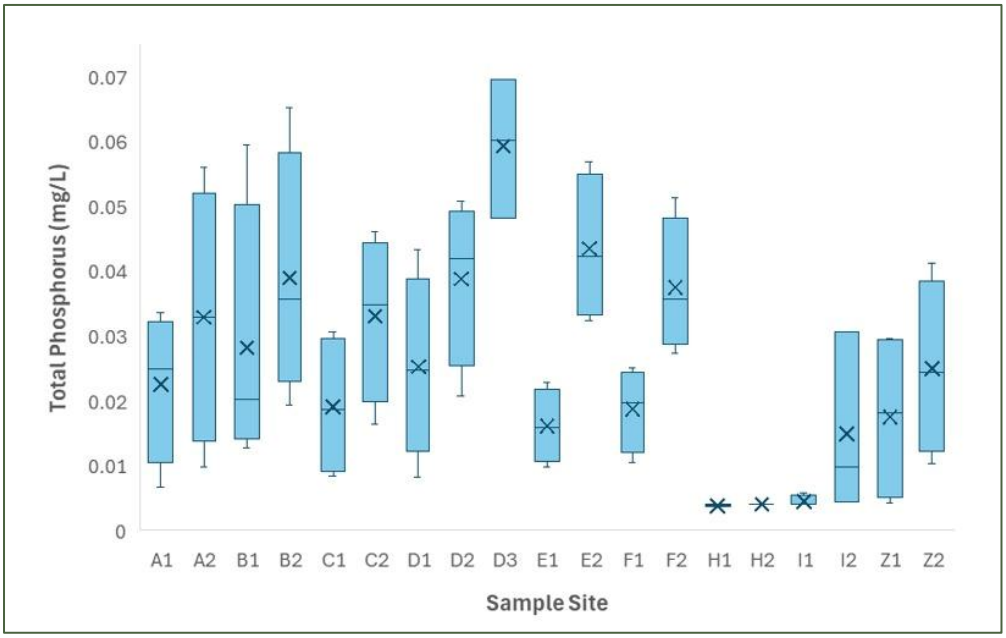


Figure 5: Average Total Phosphorus During Quarterly Marine Receiving Environment Sampling in 2024.

3.1.5 Boron

Total boron concentrations in 2024 ranged from <0.010 mg/L to 4.61 mg/L, with an average of 1.73 mg/L (**Table 8; Figure 6**). The lowest average total boron concentration was observed in Q2, June, and the highest average total boron was observed in Q3, September. Total boron concentrations were higher in the below halocline samples than the within halocline samples (Figure 6).

The BCWQG Long Term Chronic (LTC) Marine Aquatic Life guideline for total boron is 1.2 mg/L (no Short Term Acute guideline is available). Past reports have determined that elevated boron levels in the marine environment likely reflect natural conditions (AE 2022; AE, 2024). Boron in seawater can typically be around 4-5 mg/L, and it is also present in volcanic deposits and released through weathering and erosion (CCME, 2009). Furthermore in 2024, elevated boron concentrations were found at reference sites E and F during all sampling events except for Q2. This finding aligns with those of AE (2022; 2024). Roe

concludes that the elevated boron concentrations are representative of natural marine/estuarine conditions and not related to impacts from the WWTF effluent.

Table 8. Total Boron Concentrations During Quarterly Marine Receiving Environment Sampling in 2024.

Total Boron (mg/L)				
Sample Site	2024 Quarterly Sampling Events			
	Q1	Q2	Q3	Q4
A1	0.48	0.313	2.54	0.96
A2	1.12	0.343	2.76	3.32
B1	1.37	0.317	2.64	0.68
B2	2.80	0.449	3.29	2.17
C1	1.37	1.43	2.70	0.46
C2	2.42	0.341	3.35	2.18
D1	1.40	4.22	2.07	1.18
D2	3.71	4.58	2.45	3.02
D3	4.61	n.s.	3.85	3.05
E1	1.71	0.304	2.48	0.62
E2	3.36	1.07	3.77	2.93
F1	1.47	0.298	2.74	1.34
F2	3.13	1.19	3.64	2.19
H1	<0.30	<0.010	n.s.	n.s.
H2	n.s.	<0.010	n.s.	n.s.
I1	<0.03	<0.010	0.33	<0.10
I2	n.s.	0.012	0.91	1.73
Z1	0.30	0.271	1.63	1.26
Z2	0.81	0.340	2.88	2.45
n.s. – Not sampled due to tidal conditions and water level.				

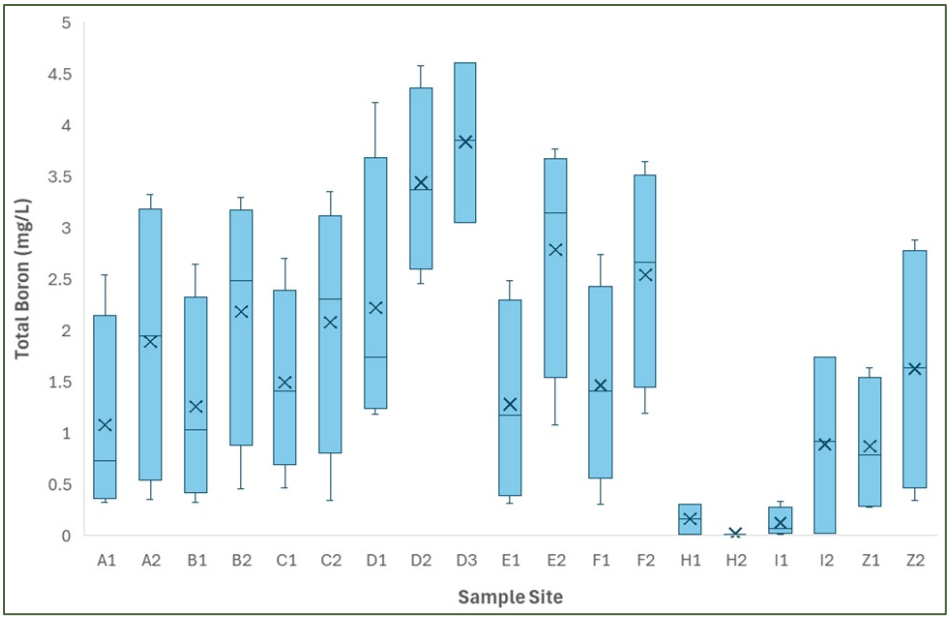


Figure 6: Average Total Boron During Quarterly Marine Receiving Environment Sampling in 2024.

3.1.6 Copper

In Q4, the concentration of total copper at station D3 (0.0063 mg/L) exceeded the Short Term Acute (STA) Marine Aquatic Life guideline (0.003 mg/L) for total copper (**Table 9; Figure 7**). For all other samples, copper concentrations were reported below guidelines or below the laboratory detection limits. For 26 samples, the laboratory adjusted the detection limit for required dilution which caused the detection limit to be greater than the BCWQG STA guideline limit. **Table 9** shows all sample locations exceeding the guideline, but this is due to entering the detection limits as the plotted values. Roe is working with the laboratory to determine methods to prevent the raised detection limits and this identified issue with copper reporting. Accurate spatial and temporal trends could not be determined due to the multiple samples with raised detection limits.

AE (2021b) noted that the local geology in the Somass watershed is documented to contain mineral deposits including copper, lead, and zinc and that naturally occurring copper may originate from local geology and be present in the Somass River. If the copper is coming from the river, it would be concentrated in the upper portion of the water column (i.e., above/within the halocline) and also could be higher during the freshet. More data will be required to determine seasonal or spatial variations in copper concentrations.

Table 9. Total Copper Concentrations During Quarterly Marine Receiving Environment Sampling in 2024.

Copper (mg/L)				
Sample Site	**2024 Quarterly Sampling Events**			
	Q1	**Q2**	**Q3**	**Q4**
A1	0.00050	<0.00100	<0.00050	<0.0050[1]
A2	<0.00050	<0.00250[1]	<0.00050	<0.0050[1]
B1	<0.00050	<0.00250[1]	<0.00050	<0.0050[1]
B2	<0.00050	<0.00250[1]	<0.00050	<0.0050[1]
C1	<0.00050	<0.00500[1]	<0.00050	<0.0050[1]
C2	<0.00050	<0.00250[1]	<0.00050	<0.0050[1]
D1	<0.00050	<0.0250[1]	0.00062	<0.0050[1]
D2	<0.00050	<0.0250[1]	<0.00050	<0.0050[1]
D3	<0.00050	n.s.	<0.00050	**0.0063**
E1	<0.00050	<0.00100	<0.00050	<0.0050[1]
E2	<0.00050	<0.00500[1]	<0.00050	<0.0050[1]
F1	<0.00050	<0.00100	<0.00050	<0.0050[1]
F2	<0.00050	<0.00500[1]	<0.00050	<0.0050[1]
H1	<0.00050	<0.00050	n.s.	n.s.
H2	n.s	<0.00050	n.s.	n.s.
I1	<0.00050	<0.00050	<0.00050	<0.0050[1]
I2	n.s	0.00050	<0.00050	<0.0050[1]
Z1	<0.00050	<0.00100	0.00058	<0.0050[1]
Z2	<0.00050	<0.00250[1]	<0.00050	<0.0050[1]

[1] – Limit of detection was raised by laboratory and is greater than the guideline limit.
n.s. – Not sampled due to tidal conditions and water level.

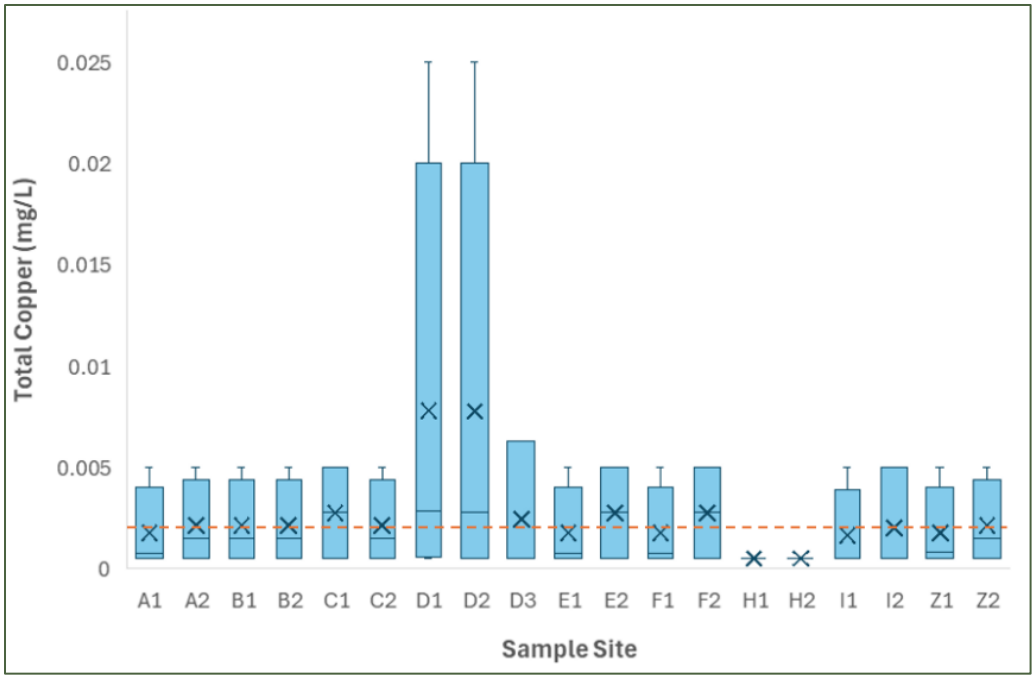


Figure 7: Average Total Copper During Quarterly Marine Receiving Environment Sampling in 2024. Copper concentrations are shown to be exceeding the BCWQG STA guideline of 0.03 mg/L. *Dashed line represents BCWQG Long Term Chronic maximum concentration value for Copper (0.002 mg/L).*

3.1.7 Lead

Throughout the quarterly sampling events in 2024, no measurements were confirmed to be exceeding the BCWQG LTC guideline (80% of values less than or equal to 0.002 mg/L) or STA guideline (0.14 mg/L) for total lead. It is noted that when there are both LTC and STA guidelines listed in the BCWQG for a given parameter, the STA guideline is considered to be the applicable guideline when there are less than 5 samples, which is the case for all quarterly results.

Total lead concentrations were less than the guideline limits or less than the limit of detection for all the samples. However, 2 of the samples (D1, D2 in Q2) detection limits were raised by the laboratory to <0.00250 mg/L, greater than the LTC guideline (0.002 mg/L). These 2 samples are plotted in Figure 8 as equal to their limit of detection, which is why they *appear* to exceed the LTC guideline. These samples are not considered to be exceeding BCWQG because they do not exceed the STA guideline (0.14 mg/L).

Additionally, total lead concentrations were less than the BCWQG LTC guideline at all sample sites during the entire month of September 5-in-30, which is the most environmentally sensitive period (see Section 3.2.7). Accurate spatial and temporal trends could not be determined due to majority of the samples being less than laboratory detection limits. See Figure 8 for general trends between the sample sites, with less than detection limit values as reported in Table 10 plotted as equal to the detection limit.

Table 10. Total Lead Concentrations During Quarterly Marine Receiving Environment Sampling in 2024.

Total Lead (mg/L)				
Sample Site	2024 Quarterly Sampling Events			
	Q1	Q2	Q3	Q4
A1	<0.00010	<0.000100	<0.00010	<0.0020

A2	<0.00010	0.000584	<0.00010	<0.0020
B1	0.00010	<0.000250	<0.00010	<0.0020
B2	<0.00010	<0.000250	<0.00010	<0.0020
C1	<0.00010	<0.000500	<0.00010	<0.0020
C2	<0.00010	<0.000250	<0.00010	<0.0020
D1	<0.00010	<0.00250[1]	<0.00010	<0.0020
D2	<0.00010	<0.00250[1]	<0.00010	<0.0020
D3	<0.00010	n.s.	<0.00010	<0.0020
E1	<0.00010	<0.000100	<0.00010	<0.0020
E2	<0.00010	<0.000500	<0.00010	<0.0020
F1	<0.00010	<0.000100	<0.00010	<0.0020
F2	<0.00010	<0.000500	<0.00010	<0.0020
H1	0.00024	0.000072	n.s.	n.s.
H2	n.s.	<0.000050	n.s.	n.s.
I1	<0.00010	<0.000050	0.00012	<0.0020
I2	n.s.	0.000346	<0.00010	<0.0020
Z1	<0.00010	<0.000100	<0.00010	<0.0020
Z2	<0.00010	<0.000250	<0.00010	<0.0020

[1] – Limit of detection was raised by laboratory and is greater than the guideline limit.
n.s. – Not sampled due to tidal conditions and water level.

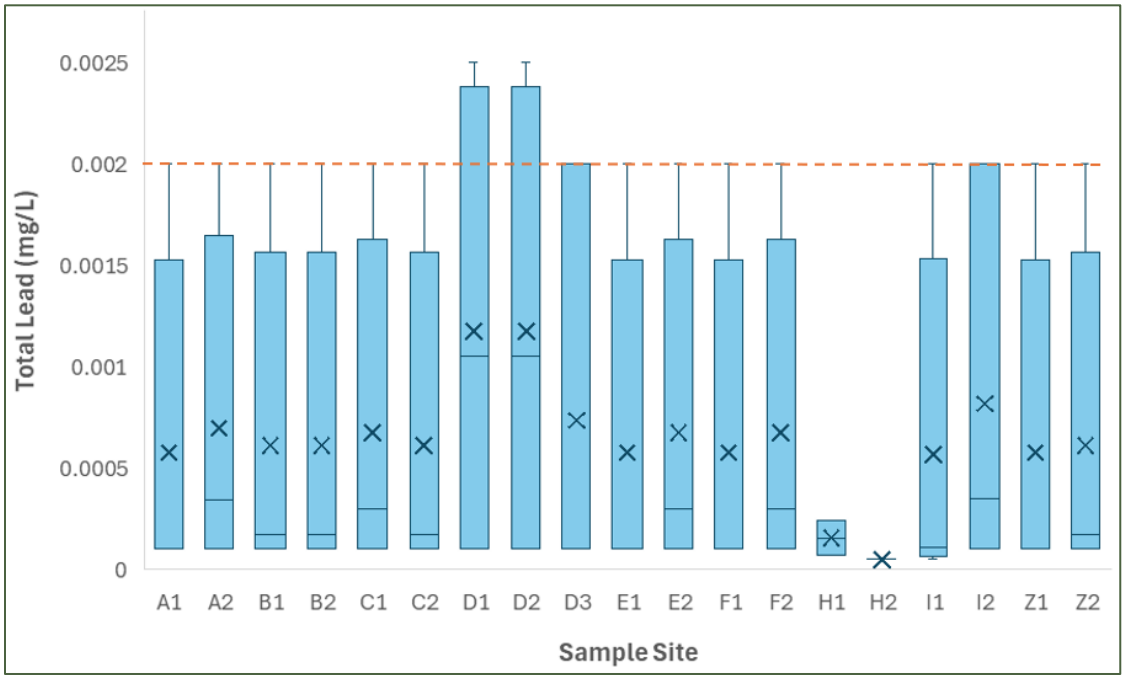


Figure 8: Average Total Lead During Quarterly Marine Receiving Environment Sampling in 2024.
Dashed line represents BCWQG Long Term Chronic maximum concentration value for Total Lead (0.002 mg/L).

3.1.8 Enterococcus

Enterococcus concentrations in 2024 ranged from <1 CFU/100 mL to 270 CFU/100 mL, with an average of 40 CFU/100 mL. The lowest average enterococcus was observed in Q1, April, and the highest in Q4, December. Enterococcus concentrations were generally higher in the within halocline samples (e.g. C1,

E1, F1) as compared to below halocline samples (e.g. C2, E2, F2) with some exceptions (A2, Z2).

There were 11 measurements that exceeded the Health Canada Beach Action Value (BAV) for enterococcus (less than or equal to 70 CFU/100 mL). Values exceeding the BAV were observed mostly in December (Q4) at sample sites A1, A2, C1, E1, H1, H2, I1, I2, Z1, and Z2, and at sample site I2 in September (**Table 11; Figure 9**).

Roe has determined that the elevated enterococcus results cannot be solely attributed to WWTF effluent discharge; see Section 6.1 for discussion.

Table 11. Enterococcus Concentrations During Quarterly Marine Receiving Environment Sampling in 2024.

Enterococcus (CFU/100mL)				
Sample Site	2024 Quarterly Sampling Events			
	Q1	Q2	Q3	Q4
A1	5	27	27	**110**
A2	12	14	18	**270**
B1	3	46	5	60
B2	3	44	2	60
C1	7	9	15	**110**
C2	1	2	1	20
D1	10	13	41	60
D2	3	42	2	40
D3	9	n.s.	1	60
E1	5	18	17	**130**
E2	2	5	18	10
F1	3	41	13	20
F2	<1	24	10	20
H1	10	19	30	**150**
H2	n.s.	67	18	**100**
I1	1	62	50	**90**
I2	n.s.	29	**110**	**130**
Z1	6	43	>60	**160**
Z2	6	44	>60	**190**

n.s. – Not sampled due to tidal conditions and water level.

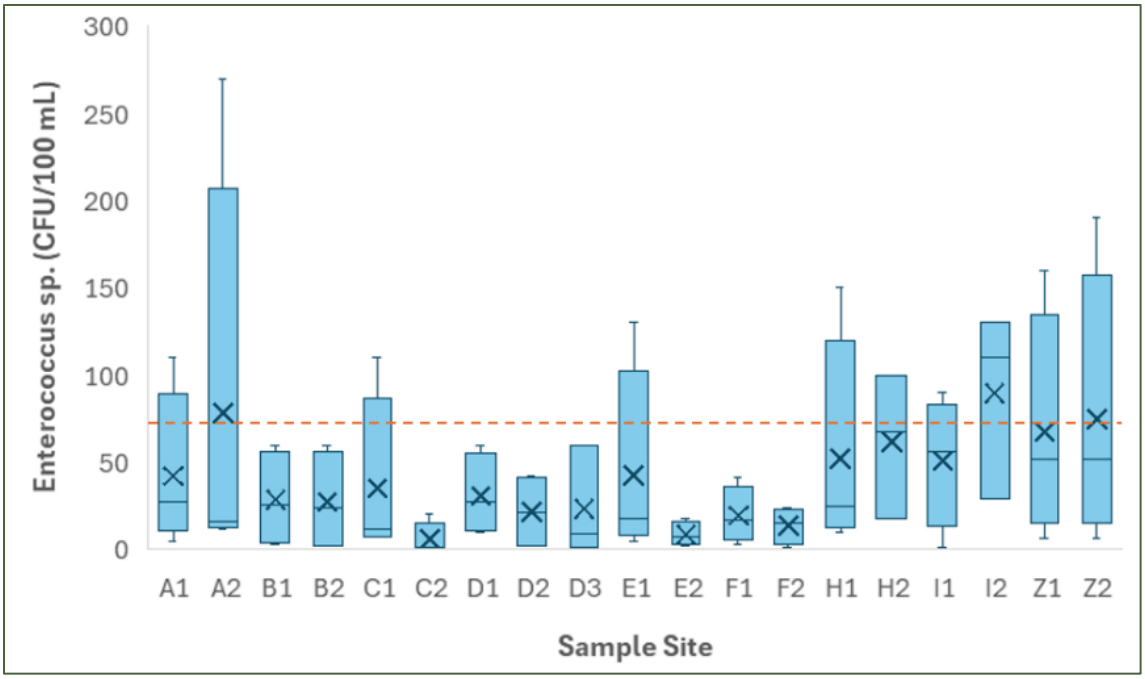


Figure 9: Average Enterococcus During Quarterly Marine Receiving Environment Sampling in 2024.
Dashed line represents Health Canada BAV (single sample maximum) for enterococcus (70 CFU/100 mL).

3.1.9 Total Selenium

It is noted that there was a single exceedance of total selenium on December 17th, 2024 at site C2; 0.0022 mg/L. The BCWQG LTC guideline for total selenium is 0.002 mg/L, therefore it exceeded the guideline by 0.0002 mg/L. This result does not appear to be attributed to WWTF effluent discharge and is considered an anomaly.

3.2 Marine Receiving Environment 5-in-30 Results

The following includes a summary of the September 2024 5-in-30 marine sampling results. Parameters that were observed to exceed applicable guidelines in 2024 are summarized below in tables to show all the individual sampling results from each individual September sampling event and sample site, as well as graphs, which display the average concentrations for each sample site throughout the month of monitoring. Some additional parameters are described below which were observed to be meeting applicable guidelines or there were no confirmed exceedances of guidelines; these have been included as they are either indicator parameters for effluent monitoring and/or the results were considered to be significant regardless of the lack of exceedances.

As detailed in Section 2.6, sample results from individual 5-in-30 sampling events will be considered meeting the BCWQG even if they fluctuate above and below the BCWQG LTC guideline, provided that the individual results do not exceed the Short-Term Acute BCWQG STA guideline and that the mean result calculated from the averaging period meets the LTC guideline (BC ENV 2024). All results and guideline limit values are in mg/L unless otherwise stated.

3.2.1 pH

Throughout the September 5-in-30 in 2024, 3 field measured pH measurements were outside of the BCWQG for pH in marine water (7.0 – 8.7); H1 on September 3rd was less than the lower limit, and H1

and H2 on September 9th were greater than the upper limit (**Table 12; Figure 10**). However, when compared to the acceptable range of 6.5 to 9.0 for the BCWQG Freshwater Aquatic Life guideline, all measurements were within the acceptable range. In the September 5-in-30, field measured pH ranged from 6.69 to 8.94, with an average of 7.73 pH.

Table 12. Field Measured pH During September 5-in-30 Marine Receiving Environment Sampling in 2024.

Field Measured pH					
Sample Site	2024 September 5-in-30 Sampling Events				
	Sept. 3	Sept. 9	Sept. 16	Sept. 24	Sept. 30
A1	7.58	7.57	7.87	7.71	7.71
A2	7.85	7.75	7.94	7.70	7.63
B1	7.55	7.65	8.01	7.77	7.76
B2	7.81	7.75	7.77	7.79	7.64
C1	7.80	7.69	7.83	7.71	7.85
C2	7.90	7.80	7.62	7.69	7.5
D1	7.70	7.39	7.99	7.83	7.79
D2	7.90	8.59	7.96	7.84	7.61
D3	7.64	7.66	7.34	7.59	7.46
E1	7.55	7.87	7.86	7.68	7.81
E2	7.89	7.92	7.61	7.52	7.45
F1	7.79	7.81	7.93	7.70	7.80
F2	7.72	7.90	7.56	7.54	7.46
H1	**6.69**	**8.73**	7.76	7.81	8.14
H2	7.51	**8.94**	7.89	n.s	n.s
I1	7.41	7.74	7.74	7.35	7.28
I2	7.73	7.57	7.89	7.37	7.65
Z1	7.96	7.50	7.62	7.64	7.61
Z2	7.85	7.71	7.77	7.61	7.51

n.s. – Not sampled due to tidal conditions and water level.

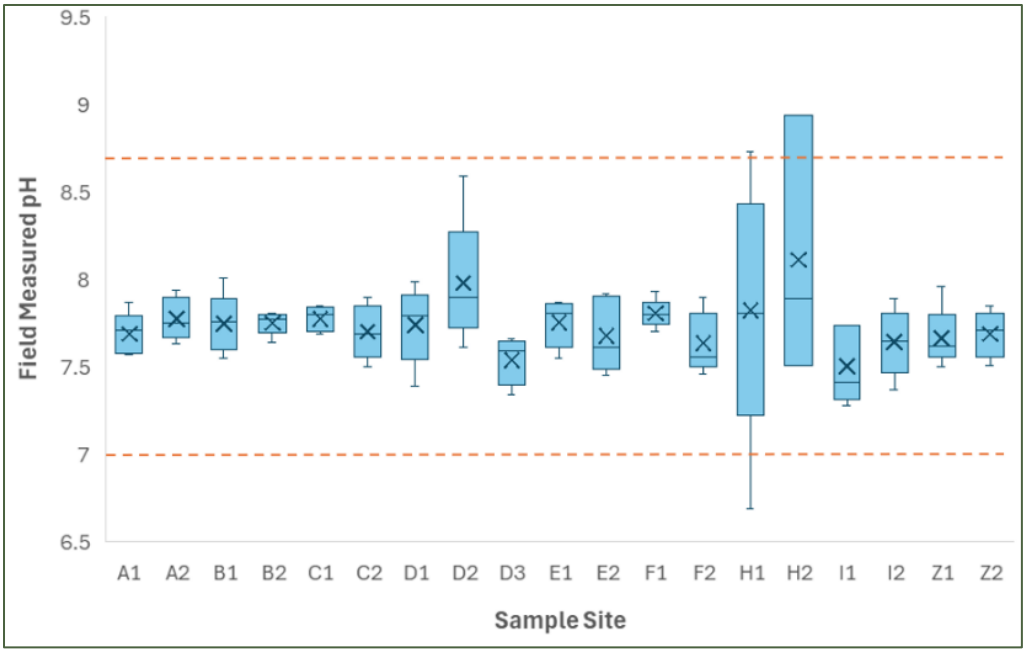


Figure 10: Average Field Measured pH During September 5-in-30 Marine Receiving Environment Sampling in 2024. *Dashed lines represent BCWQG lower and upper limits for pH.*

3.2.2 Dissolved Oxygen

During the September 5-in-30, dissolved oxygen ranged from 1.46 mg/L to 15.78 mg/L, with an average of 7.9 mg/L. 6 field measured dissolved oxygen measurements were less than the BCWQG instantaneous minimum and Long Term Chronic minimum for dissolved oxygen in marine water (5 mg/L, 8 mg/L, respectively); D3 on September 16th, 24th, and 30th, E2 on September 30th, and F2 on September 16th and 30th (**Table 13; Figure 11**). These measurements align with previous findings (AE, 2022; AE, 2024) and are considered to be normal for the estuarine/marine environment, samples depths, and locations. They are not considered to be related to impacts from the WWTF effluent.

The lowest dissolved oxygen measurements (1.46 mg/L and 3.18 mg/L) were found at the deepest sampling location at site D3. Dissolved oxygen is expected to decline with depth in marine/estuarine waters; this is an expected result. The other dissolved oxygen measurements below guidelines were found at the reference sites at the deeper sample locations (E2 and F2).

Table 13. Field Measured Dissolved Oxygen During September 5-in-30 Marine Receiving Environment Sampling in 2024.

Field Measured Dissolved Oxygen (mg/L)					
Sample Site	2024 September 5-in-30 Sampling Events				
	Sept. 3	Sept. 9	Sept. 16	Sept. 24	Sept. 30
A1	8.72	7.97	8.26	8.42	8.93
A2	8.49	7.84	8.35	8.31	7.98
B1	8.74	7.57	8.98	8.64	9.12
B2	8.49	7.73	6.94	7.67	7.67
C1	7.95	7.02	7.63	8.56	9.22
C2	8.39	7.87	5.40	7.61	5.25

D1	7.77	6.95	8.99	8.83	9.08
D2	8.56	8.61	8.38	8.31	6.73
D3	5.52	6.00	**1.46**	**4.39**	**3.18**
E1	7.24	8.31	7.80	8.48	9.08
E2	8.22	8.49	5.02	5.79	**4.54**
F1	8.2	8.20	8.33	8.27	9.02
F2	7.91	8.14	**4.80**	5.51	**4.33**
H1	9.54	10.23	8.34	11.34	10.75
H2	9.54	10.35	8.00	n.s.	n.s.
I1	8.61	8.36	10.17	8.26	9.01
I2	8.11	6.78	15.78	5.52	8.07
Z1	8.79	7.82	7.49	8.40	8.78
Z2	8.71	7.30	7.41	7.72	7.41
n.s. – Not sampled due to tidal conditions and water level.					

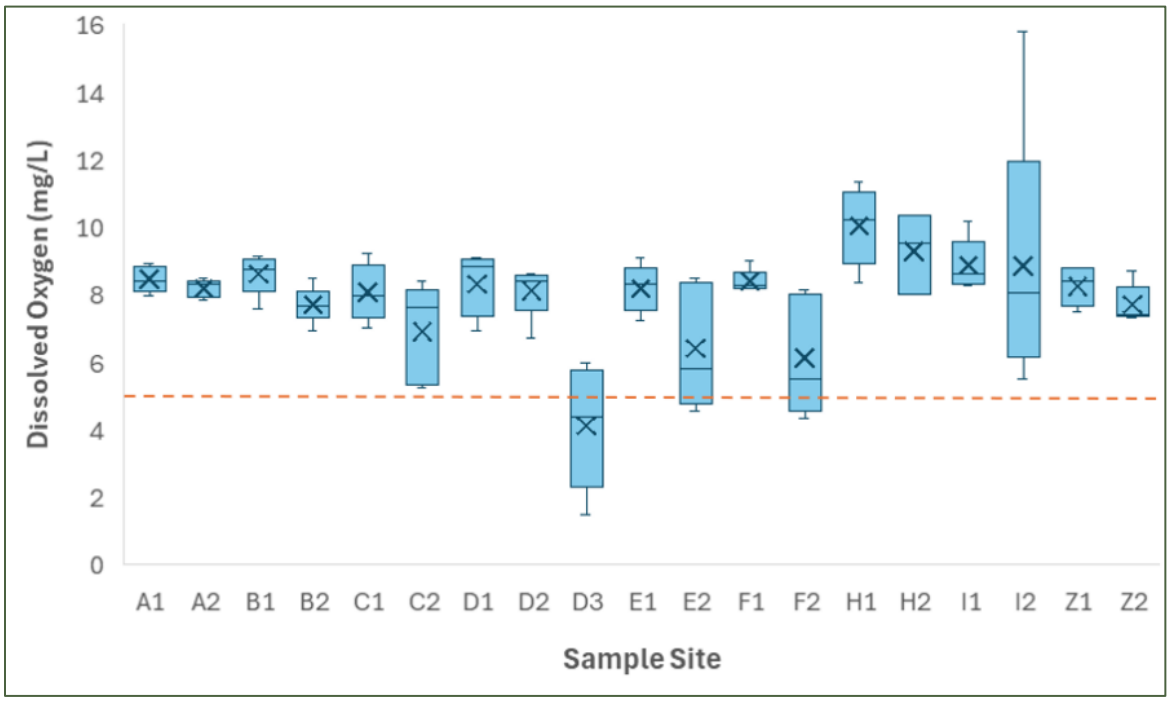


Figure 11: Average Field Measured Dissolved Oxygen During September 5-in-30 Marine Receiving Environment Sampling in 2024. *Dashed line represents BCWQG minimum guideline for Dissolved Oxygen.*

3.2.3 Ammonia

The toxicity of total ammonia, and its water quality guideline, varies depending on pH, salinity, and temperature of the water at the time and depth of sampling. Throughout the September 5-in-30, there were no exceedances of the BCWQG for total ammonia once adjusted for pH, salinity, and temperature. Total ammonia values at sample sites A2 (0.152 mg/L) and Z2 (0.405 mg/L) on September 24th exceeded the most conservative guideline (0.1 mg/L), but once adjusted, the guideline limit for these samples was 2.5 mg/L. Additionally, the average of the 5 samples for each sample site was less than the LTC guideline, which is how it is intended to be compared for 5-in-30 results. The concentration of total ammonia at all sites during September 5-in-30 marine sampling ranged from <0.005 mg/L to 0.405 mg/L.

Table 14. Total Ammonia During September 5-in-30 Marine Receiving Environment Sampling in 2024.

Total Ammonia (mg/L)					
Sample Site	2024 September 5-in-30 Sampling Events				
	Sept. 3	Sept. 9	Sept. 16	Sept. 24	Sept. 30
A1	0.0066	0.0057	<0.0050	0.0190	0.0100
A2	<0.0050	<0.0050	0.0083	**0.152**	0.0155
B1	<0.0050	<0.0050	<0.0050	0.0477	<0.0050
B2	<0.0050	0.0191	0.0132	0.0505	0.0286
C1	0.0052	<0.0050	<0.0050	0.0163	<0.0050
C2	<0.0050	<0.0050	0.0231	0.0326	0.0761
D1	<0.0050	0.0192	<0.0050	0.0604	0.0063
D2	<0.0050	<0.0050	<0.0050	0.0285	0.0111
D3	0.0084	<0.0050	0.0518	0.0408	0.0713
E1	<0.0050	<0.0050	0.0063	0.0139	<0.0050
E2	<0.0050	<0.0050	0.0505	0.0304	0.0752
F1	0.0062	<0.0050	0.0135	0.0161	0.0082
F2	0.0087	0.0068	0.0432	0.0517	0.0769
I1	0.0066	0.0058	0.0068	0.0070	0.0091
I2	<0.0050	0.0116	0.0076	0.0570	0.0220
Z1	0.0061	0.0055	0.0177	0.0185	0.0146
Z2	0.0061	0.0053	0.0297	**0.405**	0.0394

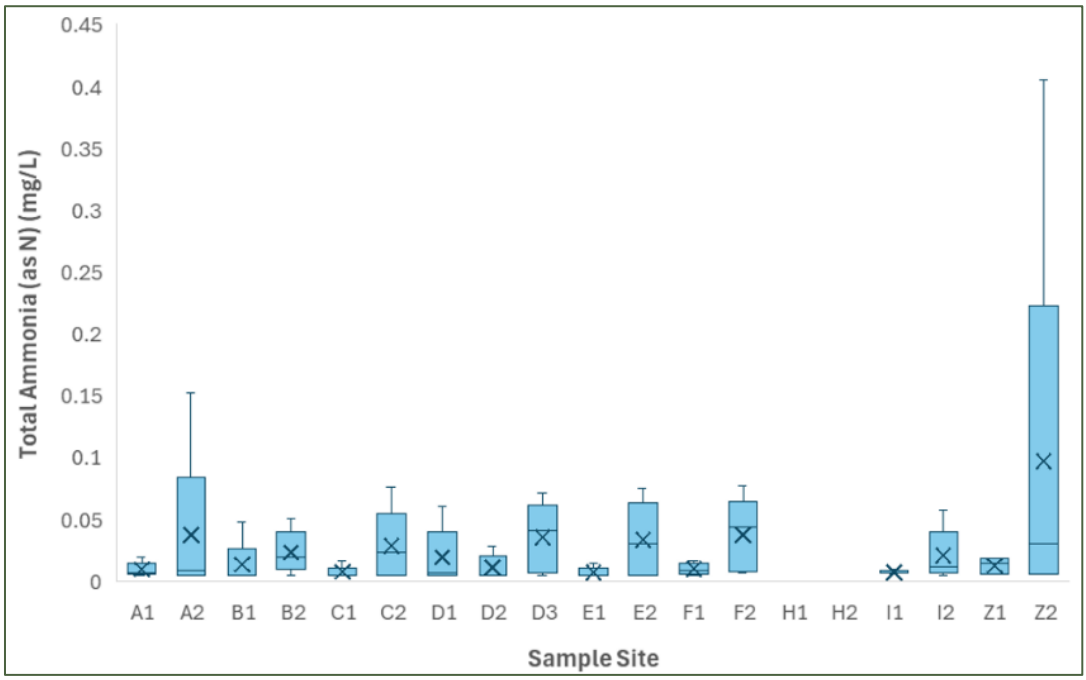


Figure 12: Average Total Ammonia During September 5-in-30 Marine Receiving Environment Sampling in 2024.

3.2.4 Total Phosphorus

During the September 5-in-30, total phosphorus at the sample sites ranged from 0.0049 mg/L to 0.105

mg/L, with an average of 0.033 mg/L. The sample site with the highest average concentration for the month was D3 (0.049 mg/L average), and the lowest average concentration was at I1 (0.0086 mg/L average) (**Table 15**; **Figure 13**). In September 2024, total phosphorus concentrations were observed to be generally higher in the below halocline samples as compared to the within halocline samples.

As stated in Section 3.1.4, the Phosphorus Management in Vancouver Island Streams (MOE, 2014) guideline is not considered to be applicable.

Table 15. Total Phosphorus During September 5-in-30 Marine Receiving Environment Sampling in 2024.

Total Phosphorus (mg/L)					
Sample Site	2024 September 5-in30 Sampling Events				
	Sept. 3	Sept. 9	Sept. 16	Sept. 24	Sept. 30
A1	0.0381	0.105	0.0221	0.0317	0.0416
A2	0.0277	0.0283	0.0256	0.0484	0.0377
B1	0.0274	0.0565	0.0227	0.0253	0.0281
B2	0.0276	0.0340	0.0340	0.0453	0.0352
C1	0.0261	0.0276	0.0265	0.0263	0.0261
C2	0.0294	0.0279	0.0394	0.0300	0.0496
D1	0.0281	0.0419	0.0256	0.0649	0.0301
D2	0.0290	0.0280	0.0208	0.0377	0.0314
D3	0.0519	0.0255	0.0697	0.0265	0.0702
E1	0.0293	0.0288	0.0229	0.0224	0.0291
E2	0.0250	0.0284	0.0570	0.0303	0.0510
F1	0.0272	0.0290	0.0223	0.0222	0.0268
F2	0.0271	0.0298	0.0514	0.0468	0.0581
I1	0.0148	0.0111	0.0059	0.0049	0.0064
I2	0.0202	0.0387	0.0098	0.0459	0.0330
Z1	0.0365	0.0407	0.0297	0.0175	0.0372
Z2	0.0297	0.0328	0.0306	0.0902	0.0281

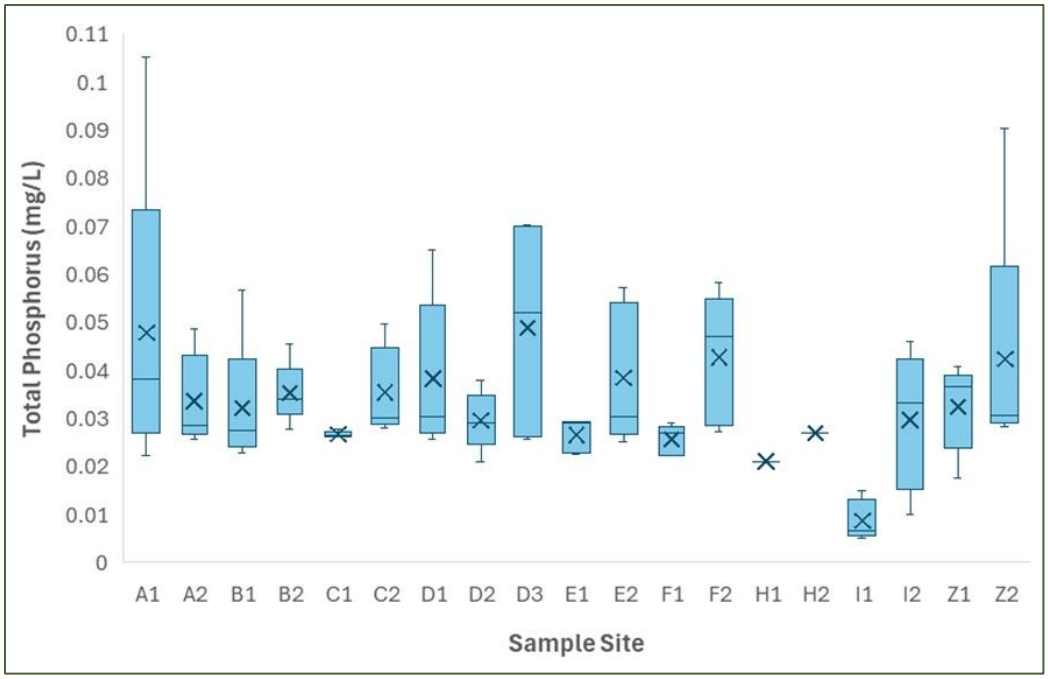


Figure 13: Average Total Phosphorus During September 5-in-30 Marine Receiving Environment Sampling in 2024.

3.2.5 Boron

In the month of September, total boron at the sample sites ranged from <0.30 mg/L to 4.76 mg/L, with an average of 2.37 mg/L (**Table 16, Figure 14**). The sample site with the highest average concentration for the month was D3 (3.238 mg/L), and the lowest average concentration was at I1 (0.514 mg/L) (Figure 14). In September 2024, total boron concentrations were observed to be generally higher in the below halocline samples as compared to the within halocline samples.

Boron concentrations are consistently elevated at the reference sites (E and F). As stated in Section 3.1.5, Roe concludes that the elevated boron concentrations are representative of natural marine/estuarine conditions and not related to impacts from the WWTF effluent.

Table 16. Total Boron During September 5-in-30 Marine Receiving Environment Sampling in 2024.

Total Boron (mg/L)					
Sample Site	2024 September 5-in-30 Sampling Events				
	Sept. 3	Sept. 9	Sept. 16	Sept. 24	Sept. 30
A1	1.32	1.31	2.54	2.38	1.56
A2	2.66	2.20	2.76	2.23	1.94
B1	2.40	1.41	2.64	1.99	1.81
B2	2.60	2.01	3.29	2.91	2.31
C1	2.71	2.27	2.70	1.48	2.01
C2	3.06	2.90	3.35	2.12	3.02
D1	2.78	3.52	2.07	4.76	1.59
D2	3.01	2.97	2.45	2.06	2.23
D3	3.77	2.01	3.85	2.96	3.60

E1	2.72	2.19	2.48	1.77	2.01
E2	2.87	2.76	3.77	2.53	3.20
F1	2.88	2.81	2.74	1.61	1.54
F2	3.06	2.79	3.64	3.25	3.48
I1	0.90	0.74	0.33	<0.30	<0.30
I2	1.59	2.73	0.91	2.58	2.06
Z1	2.70	1.78	1.63	1.54	1.67
Z2	2.82	1.84	2.88	2.65	1.56

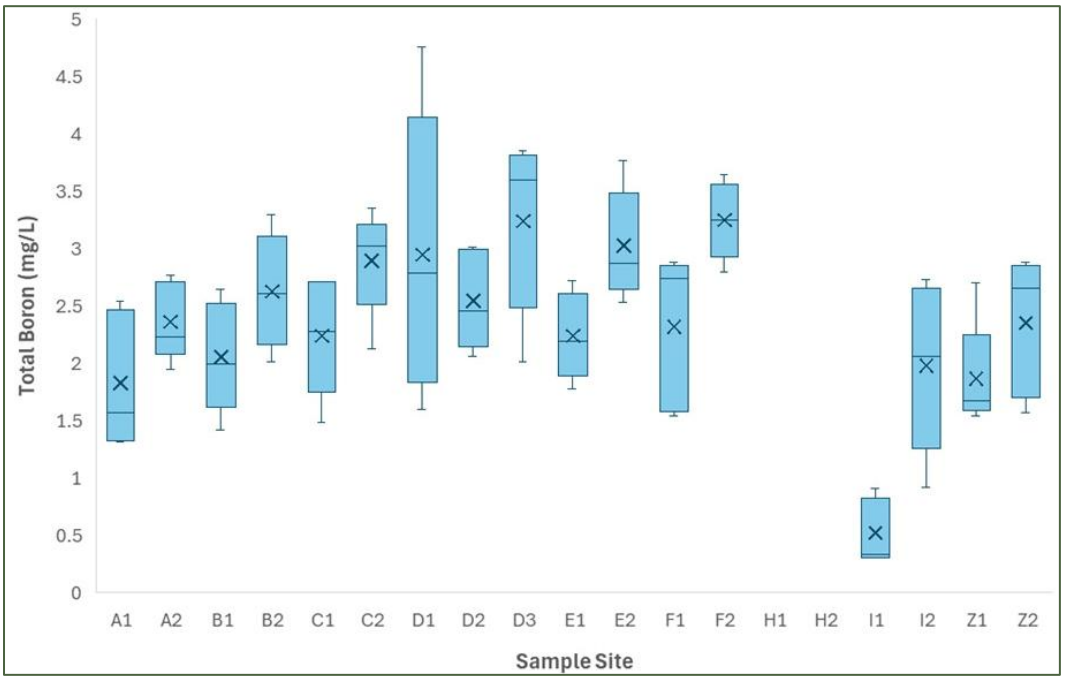


Figure 14: Average Total Boron During September 5-in-30 Marine Receiving Environment Sampling in 2024.

3.2.6 Copper

In the September 5-in-30 sampling, there was one reported copper value that exceeded the guideline; sample site B2 on September 30th (0.00374 mg/L) exceeded the BCWQG STA limit (0.003 mg/L).

The monthly average concentration of total copper at site B2 (0.00115 mg/L) was less than BCWQG LTC limit (0.002 mg/L), however, since the BCWQG STA limit was exceeded on September 30th, it is considered to be an exceedance of BCWQG (as described in Section 2.6). The measurements from all of the other sample sites were less than the guideline limit and/or less than the limit of detection (**Table 17, Figure 15**).

Table 17. Total Copper During September 5-in-30 Marine Receiving Environment Sampling in 2024

Total Copper (mg/L)					
Sample Site	**2024 September 5-in-30 Sampling Events**				
	Sept. 3	**Sept. 9**	**Sept. 16**	**Sept. 24**	**Sept. 30**
A1	0.00060	0.00072	<0.00050	0.00056	0.00058
A2	<0.00050	<0.00050	<0.00050	0.00056	0.00069

B1	<0.00050	0.00084	<0.00050	0.00062	0.00068
B2	<0.00050	<0.00050	<0.00050	<0.00050	**0.00374**
C1	<0.00050	<0.00050	<0.00050	0.00061	0.00054
C2	<0.00050	<0.00050	<0.00050	0.00061	<0.00050
D1	0.00051	<0.00050	0.00062	<0.00050	0.00050
D2	<0.00050	<0.00050	<0.00050	0.00070	0.00057
D3	<0.00050	<0.00050	<0.00050	0.00071	<0.00050
E1	<0.00050	<0.00050	<0.00050	0.00058	<0.00050
E2	<0.00050	<0.00050	<0.00050	<0.00050	0.00133
F1	<0.00050	<0.00050	<0.00050	0.00069	0.00068
F2	0.00074	<0.00050	<0.00050	<0.00050	<0.00050
I1	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
I2	<0.00050	<0.00050	<0.00050	<0.00050	0.00064
Z1	<0.00050	0.00056	0.00058	0.00057	0.00058
Z2	<0.00050	<0.00050	<0.00050	0.00064	0.00053

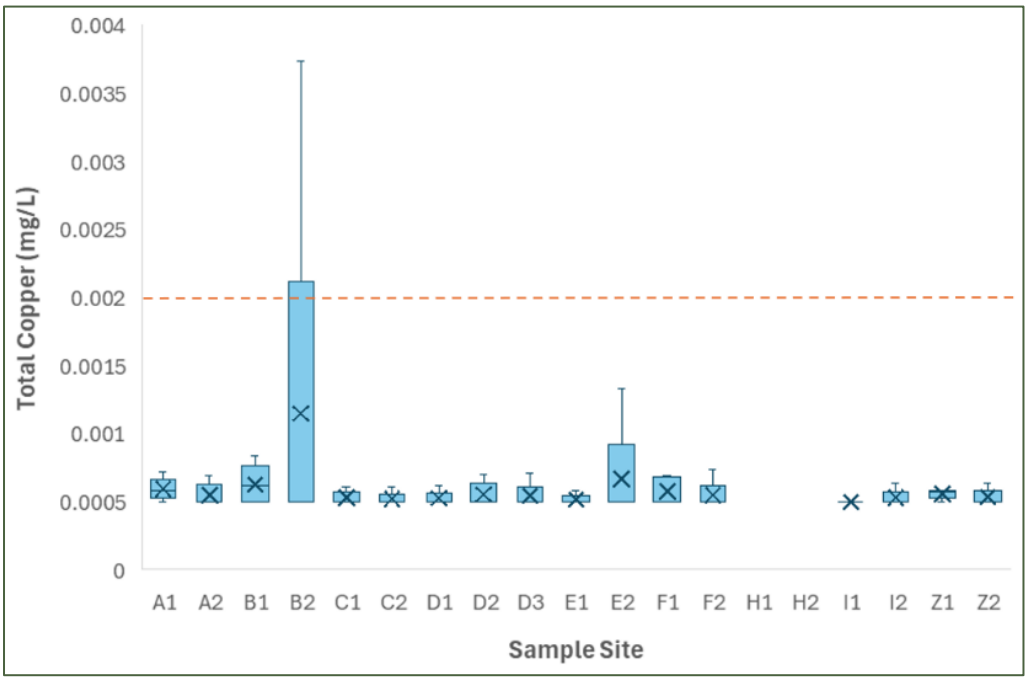


Figure 15: Average Total Copper During September 5-in-30 Marine Receiving Environment Sampling in 2024.

Note: Dashed line represents BCWQG Long Term Chronic limit for total copper (0.002 mg/L).

3.2.7 Lead

Throughout the September 5-in-30, no measurements exceeded BCWQG. Total lead concentrations at all sample sites were less than the guideline limit (0.002 mg/L) and/or less than the limit of detection. The results were not plotted on a graph due to nearly all samples being less than detection limits.

Table 18. Total Lead During September 5-in-30 Marine Receiving Environment Sampling in 2024

Total Lead (mg/L)					
Sample Site	2024 September 5-in-30 Sampling Events				
	Sept. 3	Sept. 9	Sept. 16	Sept. 24	Sept. 30
A1	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
A2	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
B1	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
B2	<0.00010	<0.00010	<0.00010	<0.00010	0.00021
C1	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
C2	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
D1	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
D2	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
D3	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
E1	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
E2	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
F1	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
F2	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
I1	<0.00010	<0.00010	0.00012	<0.00010	<0.00010
I2	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Z1	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Z2	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
n.s. – Not sampled due to tidal conditions and water level.					

3.2.8 Enterococcus

Throughout the September 5-in-30, there were 3 measurements that exceeded the Health Canada BAV limit of 70 CFU/100 mL, and one sample site that exceeded the Health Canada geometric mean limit of 35 mg/L (**Table 19, Figure 16**). These results cannot be solely attributed to WWTF effluent discharge (see Section 6.1 below). Values exceeding the BAV were observed at sample site I1 on September 9th (155 CFU/100 mL) and 30th (73 CFU/100 mL), and at site I2 on September 16th (110 CFU/100 mL). The geometric mean for the month of September at site I1 was 59.3 mg/L, exceeding the geometric mean limit, and the geometric mean at site I2 was 14.7 mg/L, which was within the geometric mean limit.

During the September 5-in-30, Enterococcus concentrations ranged from <1 CFU/100 mL to 155 CFU/100 mL, with an average of 16.2 CFU/100 mL. The highest geometric mean was at sample site I1 (59.3 mg/L) and the lowest geometric mean was at site E1 (1.8 CFU/100 mL). The average concentration of Enterococcus and the geometric mean of enterococcus was generally higher in within halocline samples (i.e. A1, C1, D1, Z1) as compared to the below halocline samples (i.e. A2, C2, D2, Z2).

Table 19. Enterococcus During September 5-in-30 Marine Receiving Environment Sampling in 2024

Enterococcus sp. (CFU/100 mL)					
Sample Site	2024 September 5-in-30 Sampling Events				
	Sept. 3	Sept. 9	Sept. 16	Sept. 24	Sept. 30

A1	7	23	27	26	20
A2	<1	<3	18	26	2
B1	<1	<10	5	22	2
B2	1	11	2	27	2
C1	1	4	15	17	1
C2	<1	<1	1	9	11
D1	<1	<1	41	<1	21
D2	1	1	2	17	2
D3	14	<1	1	2	5
E1	<1	1	17	1	<1
E2	<1	1	18	11	1
F1	1	2	13	8	11
F2	11	<1	10	16	10
H1	10	11	30	36	23
H2	7	9	18	25	21
I1	37	**155**	50	35	**73**
I2	4	5	**110**	45	7
Z1	3	12	>60	57	14
Z2	1	21	>60	35	17

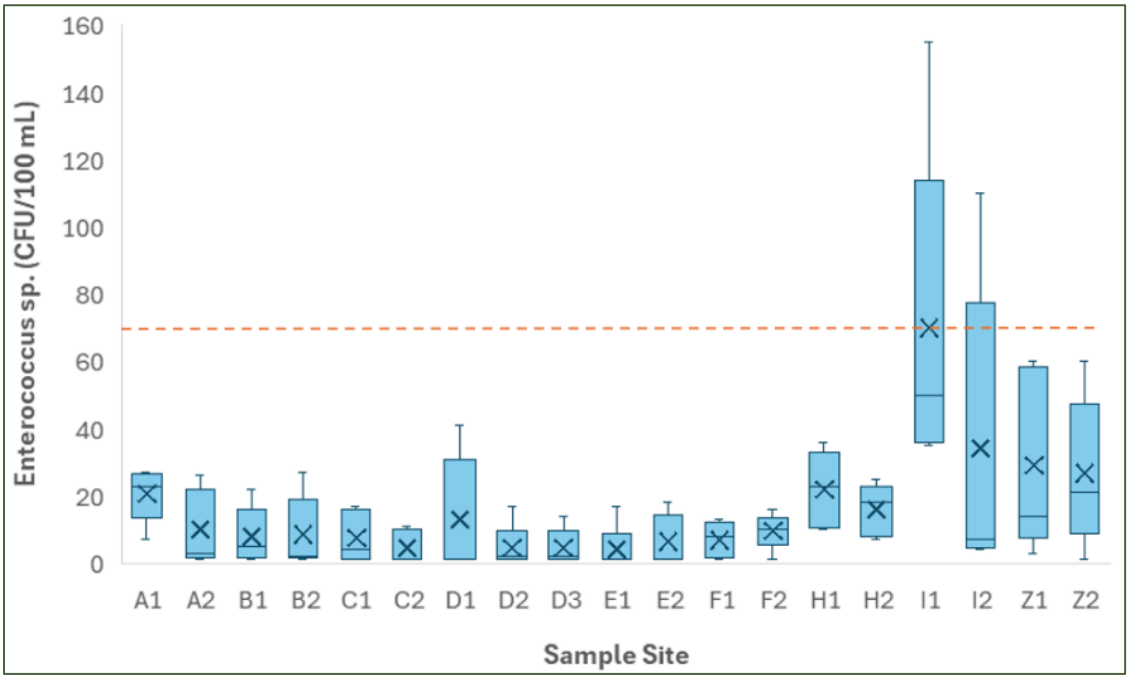


Figure 16: Average Enterococcus During September 5-in-30 Marine Receiving Environment Sampling in 2024.
Dashed line represents Health Canada BAV (single sample maximum) for Enterococcus (70 CFU/100 mL).

3.2.9 Total Chromium

There was a single exceedance of total chromium on September 30th, 2024 at site B2; 0.00219 mg/L. The BCWQG Long Term Chronic guideline for total chromium is 0.0015 mg/L. This result cannot be solely attributed to WWTF effluent discharge and is not considered to be a concern or indication of an issue, as it is an outlier and single exceedance.

3.2.10 Total Zinc

There was a single exceedance of total zinc on September 30th, 2024 at site A2; 0.0212 mg/L. The BCWQG Long Term Chronic guideline for total zinc is 0.01 mg/L. This result does not appear to be attributed to WWTF effluent discharge and is not considered to be a concern or indication of an issue, as it is an outlier and single exceedance.

3.3 Tidal Channel, Groundwater Piezometer Quarterly Results

The following includes a summary of the 2024 quarterly groundwater, tidal channel, and piezometer results. Parameters that were observed to exceed applicable guidelines in 2024 are summarized below in tables and graphs. Some additional parameters are described below which were observed to be meeting applicable guidelines rather than exceeding; these have been included as they are considered to be indicator parameters for potential effluent seepage.

Quarterly receiving environment monitoring of groundwater, tidal channels, and the piezometer was conducted in April (Q1, conducted by AE), July (Q2, conducted by Roe), September (Q3, Roe), and December (Q4, Roe).

BCWQG Marine Aquatic Life guidelines are applicable to results from the tidal channel sites (T1, T2, T3) and in some cases the groundwater sites (MW21-1, MW21-2, MW21-3A, MW21-3B, P1). The BC CSR Schedule 3.2 Generic Numerical Water Standards for freshwater are applicable to the groundwater sites only. All results and guideline values are in mg/L unless otherwise stated.

3.3.1 pH

Throughout the quarterly groundwater and tidal channel sampling events in 2024, nine measurements were outside of the BCWQG Marine Water range for pH (7.0 – 8.7) and/or the BCWQG Freshwater range for pH (6.5 – 9.0) (**Table 20; Figure 17**). Field measured pH was outside of the BCWQG Marine range at site in July (Q3) at site T3 (6.44 pH). Field measured pH was outside of the BCWQG Freshwater range at sites MW21-1 during each quarter, site MW21-3A during Q3 and Q4, site MW21-3B during Q4, and site P1 during Q1. During quarterly sampling in 2024, the field measured pH at all sites ranged from 5.67 to 8.43 pH, with an average of 6.99 pH. The highest average field measured pH was observed in Q3, and the lowest was observed in Q4.

Table 20. Field Measured pH During Quarterly Groundwater and Tidal Channel Sampling in 2024.

Field Measured pH				
Sample Site	**2024 Quarterly Sampling Events**			
	Q1	**Q2**	**Q3**	**Q4**
T1	8.1	7.53	7.85	7.24
T2	8.01	7.58	8.43	7.37
T3	7.7	**6.44**	7.76	7.29
MW21-1	**6.24**	**6.31**	**6.09**	**5.67**
MW21-2	7.27	7.19	6.97	7.07
MW21-3A	6.74	6.71	**6.43**	**6.37**
MW21-3B	6.65	6.69	6.58	**6.49**
P1	**6.47**	6.54	n.s.	n.s.
n.s. – Not sampled, sufficient water not available in piezometer.				

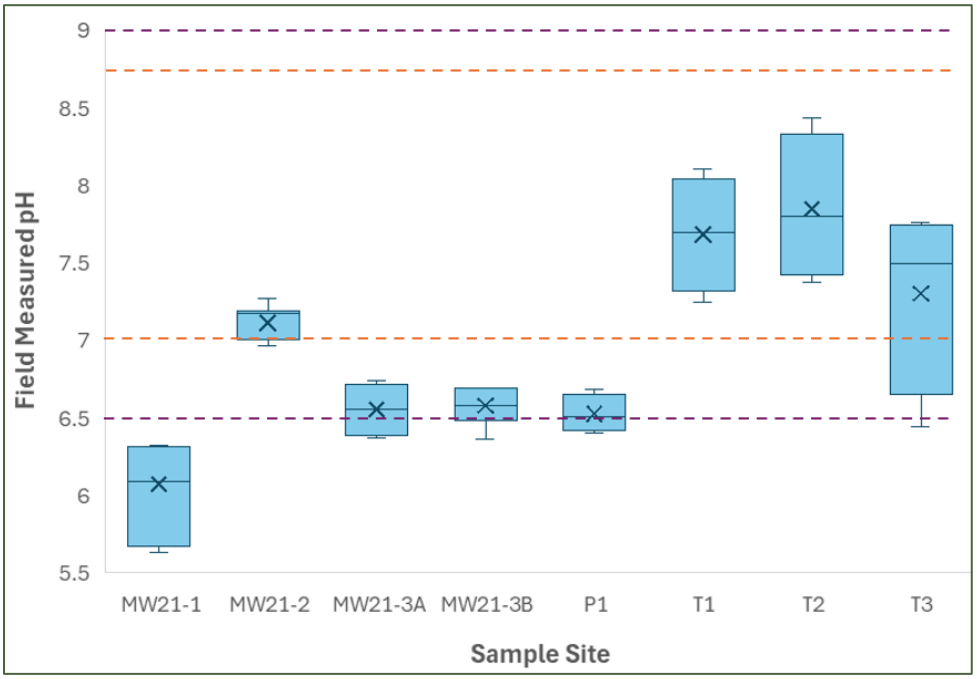


Figure 17: Average Field Measured pH During Quarterly Groundwater and Tidal Channel Sampling in 2024.
Dashed lines represent BCWQG Marine range (orange) and Freshwater range (purple) for pH.

3.3.2 Dissolved Oxygen

Throughout the quarterly groundwater and tidal channel sampling events in 2024, all marine water measurements were observed to meet the BCWQG Marine guideline (5 mg/L instantaneous minimum). There are no applicable dissolved oxygen guidelines for groundwater. During quarterly sampling in 2024, dissolved oxygen at the tidal channel sites ranged from 5.37 mg/L to 21.09 mg/L, with an average of 11.5 mg/L. Dissolved oxygen was lowest in Q2 and highest in Q3 within the tidal channels.

Table 21. Field Measured Dissolved Oxygen During Quarterly Groundwater and Tidal Channel Sampling in 2024.

Field Measured Dissolved Oxygen (mg/L)				
Sample Site	2024 Quarterly Sampling Events			
	Q1	Q2	Q3	Q4
T1	11.69	8.82	21.09	12.63
T2	11.5	8.33	11.46	12.12
T3	11.77	5.37	12.63	10.54
MW21-1	7.49	6.21	5.05	6.84
MW21-2	0.4	0.02	0.31	0.21
MW21-3A	1.09	0.0	0.15	0.24
MW21-3B	0.38	0.0	0.23	0.0
P1	4.22	4.43	n.s.	n.s.
n.s. – Not sampled, sufficient water not available in piezometer.				

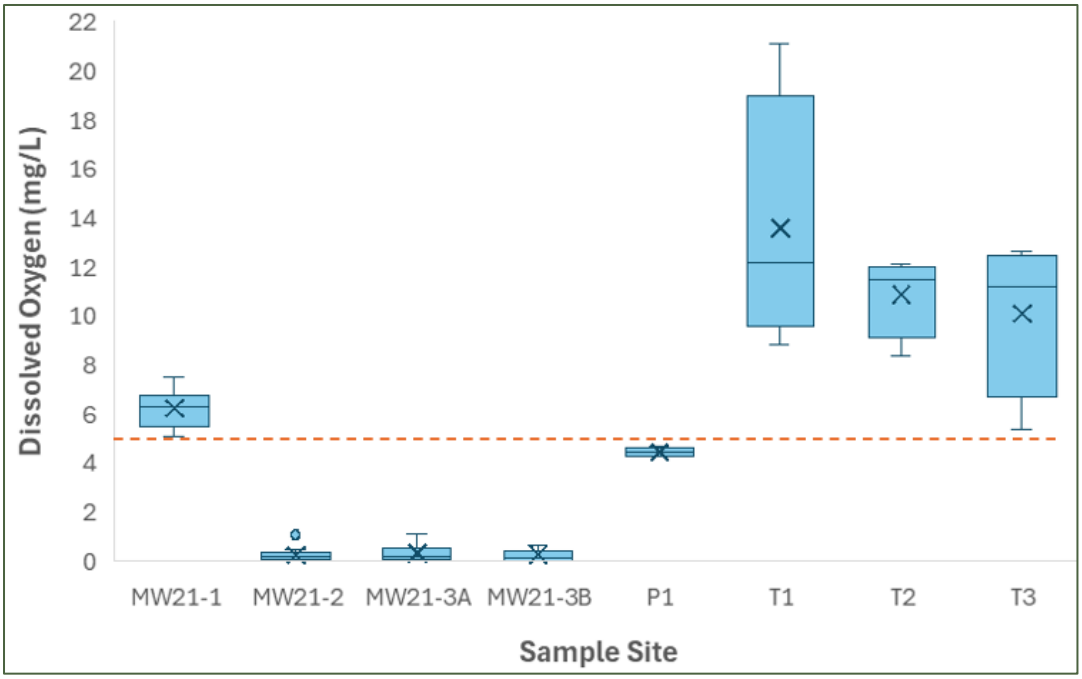


Figure 18: Average Field Measured Dissolved Oxygen During Quarterly Groundwater and Tidal Channel Sampling in. *Note: Dashed line represents BCWQG Marine instantaneous minimum value for dissolved oxygen (5 mg/L).*

3.3.3 Ammonia

Throughout the quarterly groundwater and tidal channel sampling events in 2024, there were no exceedances of the BCWQG Marine LTC guideline for total ammonia within the tidal channels, once the standard was adjusted for pH, salinity, and temperature.

Three groundwater measurements from the monitoring wells, MW21-3A (21.8 mg/L, 19.1 mg/L) and MW21-3B (18.7 mg/L), exceeded the BC CSR Generic Numerical Water Standards adjusted guideline limits for total ammonia. The guideline for MW21-3A and MW21-3B, when adjusted for pH, was 18.4 mg/L (Table 22). The pH adjusted guideline for all sampling events for MW21-2 was 18.5 mg/L, which was not exceeded in any quarterly sampling event.

Average total ammonia concentrations were observed to be highest in Q3 and lowest in Q1. Of the sample sites, the highest average total ammonia was observed at MW21-3A, and the lowest average total ammonia was observed at MW21-1.

It is noted that results for MW21-2, MW21-3A, and MW21-3B were plotted separately as the values were significantly higher than those from the other sites (Figure 19).

Table 22. Total Ammonia During Quarterly Groundwater and Tidal Channel Sampling in 2024.

Total Ammonia (mg/L)				
Sample Site	2024 Quarterly Sampling Events			
	Q1	Q2	Q3	Q4
T1	0.0621	0.550	0.436	0.0180
T2	0.0154	0.0648	0.0394	0.0148

T3	0.0134	0.0230	0.342	0.0316
MW21-1	<0.0050	<0.0050	<0.0050	<0.0050
MW21-2	4.98	8.30	17.2	2.11
MW21-3A	9.83	15.8	**21.8**	**19.1**
MW21-3B	8.78	14.5	**18.7**	13.1
P1	0.0374	0.0437	n.s.	n.s.
n.s. – Not sampled, sufficient water not available in piezometer.				

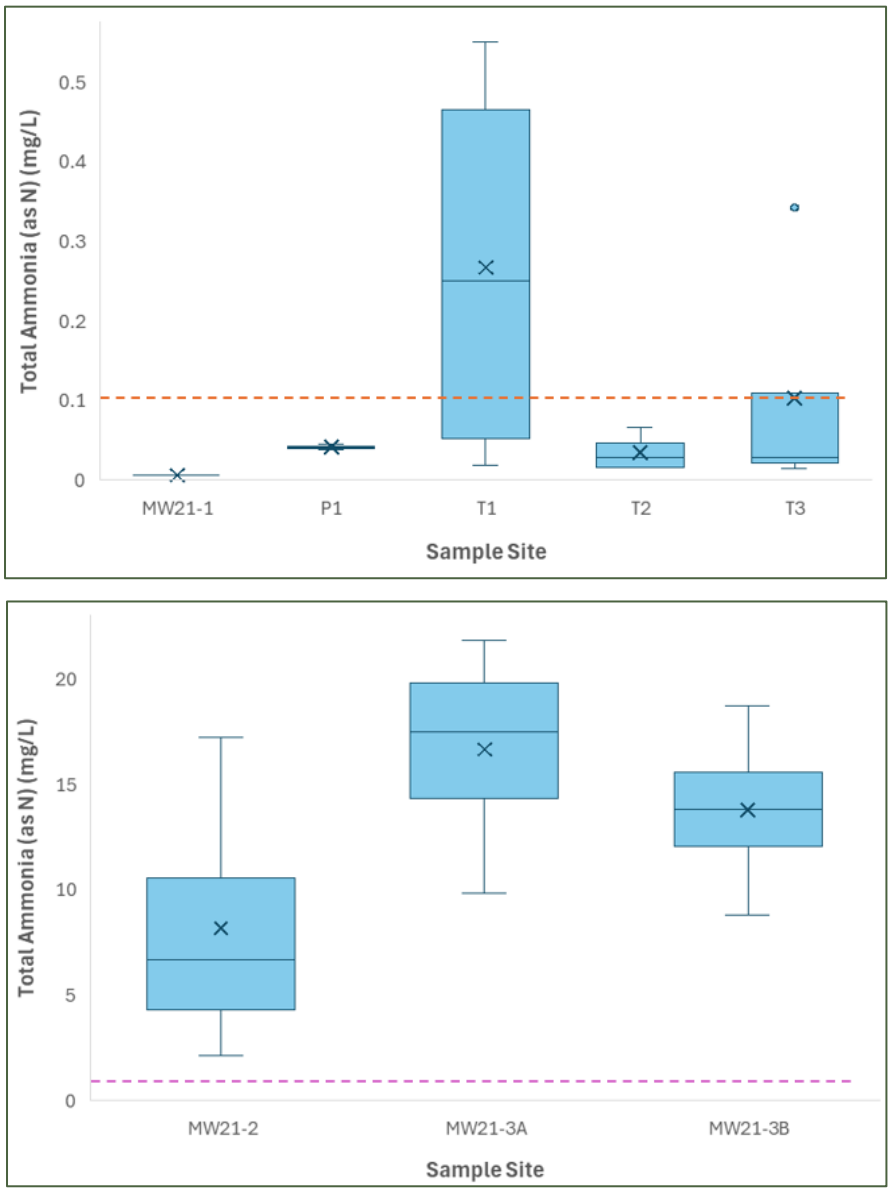


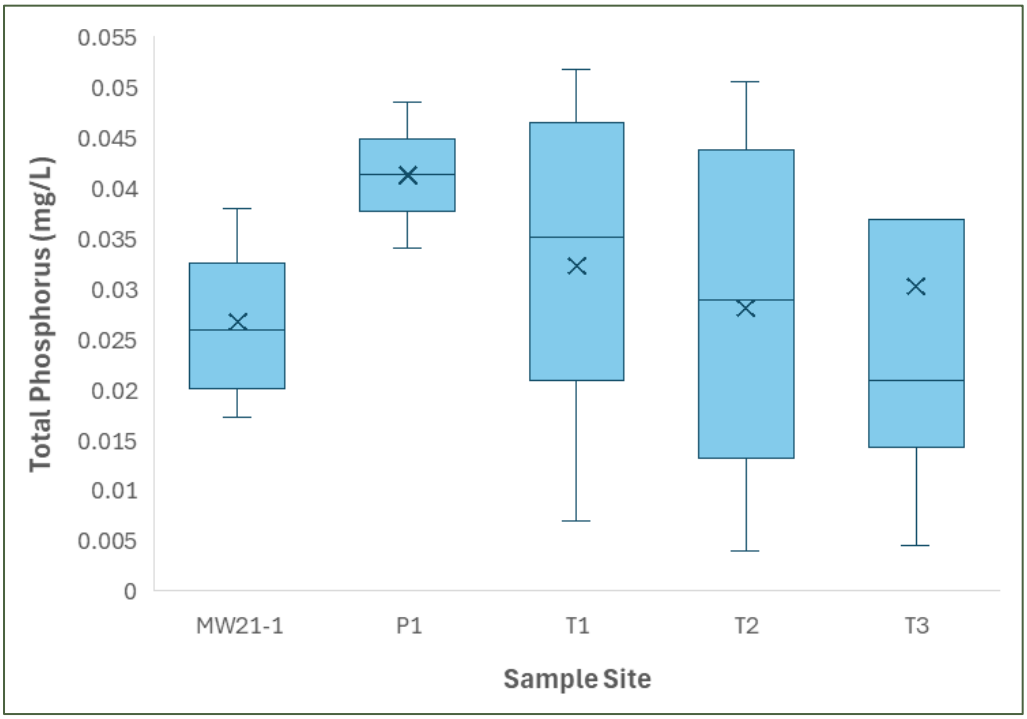
Figure 19: Average Total Ammonia During Quarterly Groundwater and Tidal Channel Sampling in 2024.
Dashed lines represent BCWQG Marine most conservative guideline (0.1 mg/L, orange) and BC CSR Freshwater most conservative guideline (1.31 mg/L, purple) for total ammonia.

3.3.4 Total Phosphorus

During quarterly sampling, total phosphorus ranged from 0.0040 mg/L to 0.998 mg/L. The highest average total phosphorus was observed in Q4 and the lowest average phosphorus was observed in Q1. Of the sample sites, the highest average total phosphorus was observed at MW21-3A, and the lowest at MW21-1. As mentioned in Section 3.1.4, the Phosphorus Management in Vancouver Island Streams (MOE, 2014) guideline is not considered to be applicable.

Table 23. Total Phosphorus During Quarterly Groundwater and Tidal Channel Sampling in 2024.

Total Phosphorus (mg/L)				
Sample Site	2024 Quarterly Sampling Events			
	Q1	Q2	Q3	Q4
T1	0.0070	0.0518	0.0447	0.0256
T2	0.0040	0.0416	0.0162	0.0506
T3	0.0045	0.0244	0.0175	0.0745
MW21-1	0.0172	0.0307	0.0380	0.0210
MW21-2	0.142	0.212	0.270	0.227
MW21-3A	1.10	0.942	0.987	1.06
MW21-3B	0.743	0.984	0.998	1.20
P1	0.0341	0.0485	n.s.	n.s.
n.s. – Not sampled, sufficient water not available in piezometer.				



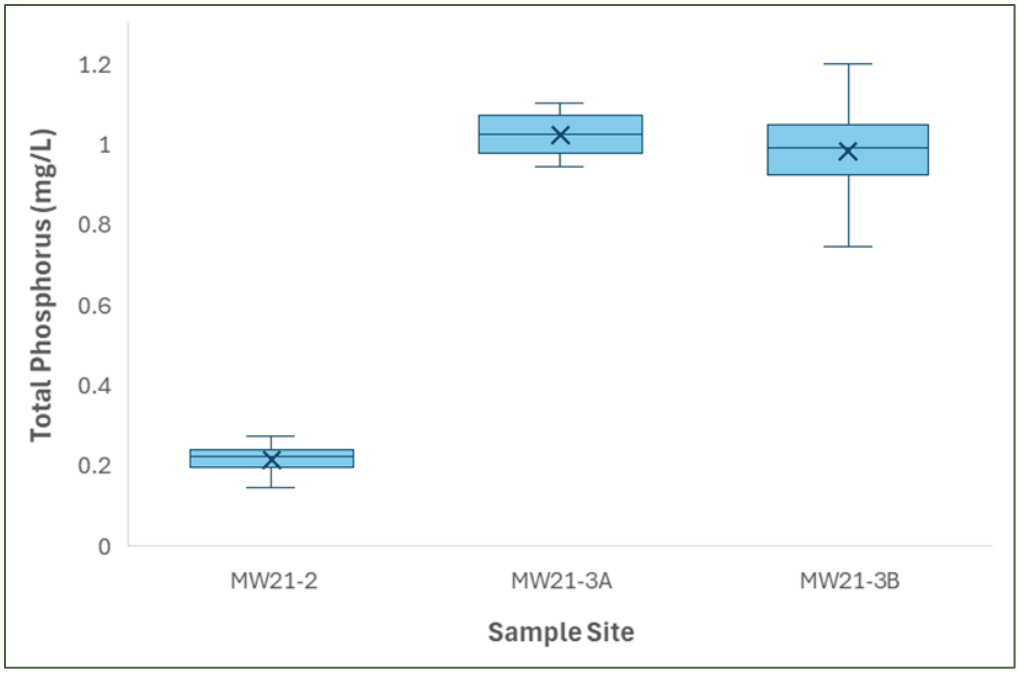


Figure 20: Average Total Phosphorus During Quarterly Groundwater and Tidal Channel Sampling in 2024.

3.3.5 Nitrate

Throughout the quarterly groundwater and tidal channel sampling events in 2024, there were no exceedances of applicable nitrate guidelines at any of the sample sites (**Table 24; Figure 21**). The BCWQG Marine LTC limit is 3.7 mg/L, the BCWQG Freshwater LTC limit is 3.0 mg/L, and the BC CSR Generic Numerical Water Standard for Aquatic Life is 400 mg/L. Majority of the results were less than the limit of detection; therefore, accurate spatial and temporal trends cannot be described.

Table 24. Nitrate (as N) During Quarterly Groundwater and Tidal Channel Sampling in 2024.

Nitrate as N (mg/L)				
Sample Site	2024 Quarterly Sampling Events			
	Q1	Q2	Q3	Q4
T1	<0.050	0.0328	<0.50	<0.50
T2	<0.050	0.0164	<0.50	<0.50
T3	<0.050	<0.0500	<0.50	<0.50
MW21-1	0.0744	0.0568	0.0746	0.0687
MW21-2	<0.100	<0.100	<0.100	<0.0050
MW21-3A	<0.0500	<0.100	<0.100	<0.100
MW21-3B	<0.100	<0.100	<0.100	<0.100
P1	0.479	0.0253	n.s.	n.s.
n.s. – Not sampled, sufficient water not available in piezometer.				

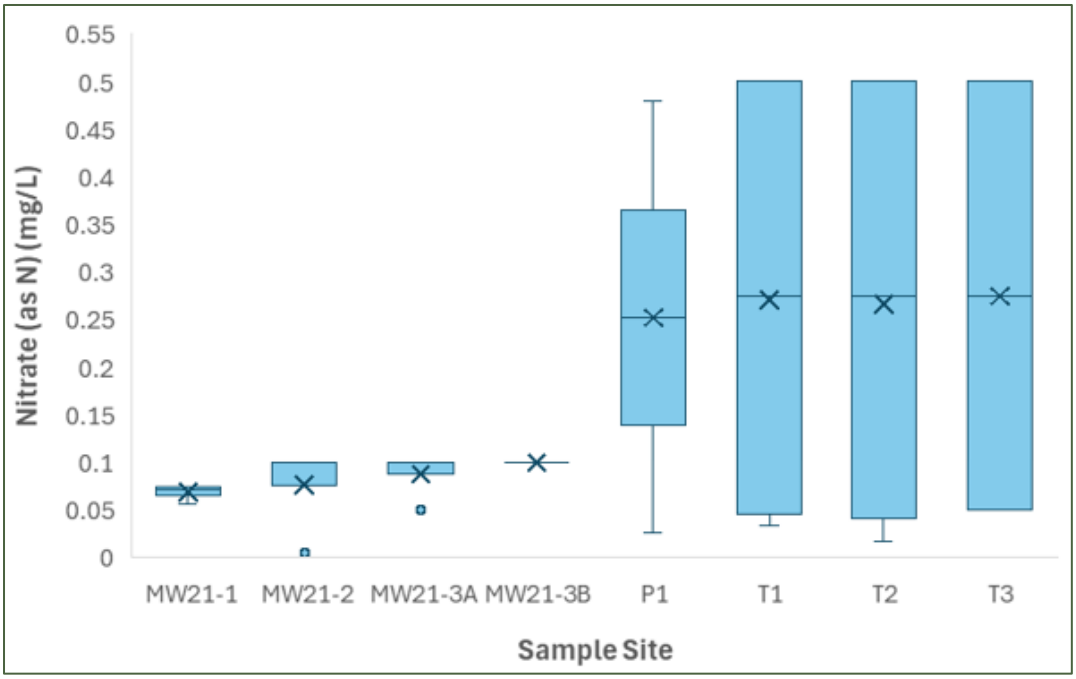


Figure 21: Average Nitrate During Quarterly Groundwater and Tidal Channel Sampling in 2024.

3.3.6 Dissolved Chromium

Throughout the quarterly groundwater and tidal channel sampling events in 2024, there were no exceedances of applicable guidelines at any of the sample sites (**Table 25; Figure 22**). The BCWQG Marine LTC limit is 0.0015 mg/L and the BC CSR Generic Numerical Water Standard for Aquatic Life is 0.01 mg/L. Majority of the results were less than the limit of detection; therefore, accurate spatial and temporal trends cannot be described. It is noted that individual groundwater measurements from MW21-2 and MW21-3A appear to exceed the BCWQG Marine LTC guideline in Figure 23; however, these are not exceedances as they are groundwater samples, and they are within the BC CSR guideline limit for dissolved chromium (0.01 mg/L).

Table 25. Dissolved Chromium During Quarterly Groundwater and Tidal Channel Sampling in 2024.

Dissolved Chromium (mg/L)				
Sample Site	2024 Quarterly Sampling Events			
	Q1	Q2	Q3	Q4
T1	n.s.	0.00059	<0.00050	<0.00050
T2	n.s.	<0.00050	<0.00050	<0.00050
T3	n.s.	<0.00050	<0.00050	<0.00050
MW21-1	n.s.	<0.00050	0.00056	0.00052
MW21-2	n.s.	<0.00100	<0.00250	0.00077
MW21-3A	n.s.	<0.00100	0.00111	0.00156
MW21-3B	n.s.	<0.00050	<0.00100	<0.00050
P1	n.s.	0.00123	n.s.	n.s.
n.s. – Not sampled, sufficient water not available in piezometer.				

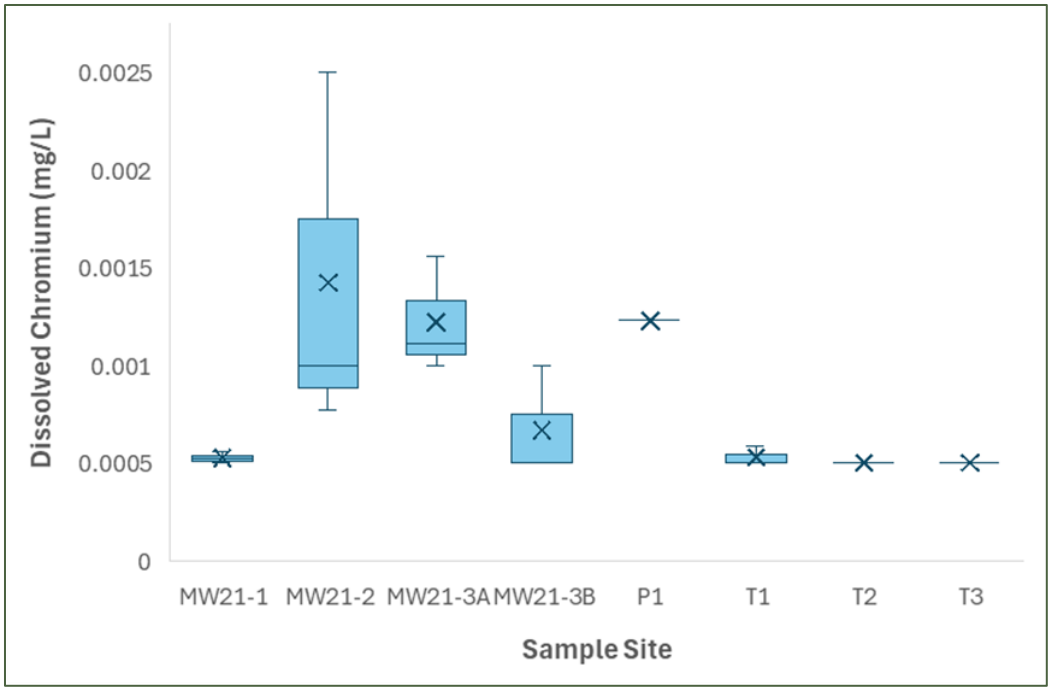


Figure 22: Average Dissolved Chromium During Quarterly Groundwater and Tidal Channel Sampling in 2024.

3.3.7 Dissolved Boron

The applicable BC CSR Generic Numerical Water Standard for Aquatic Life is 12 mg/L and no exceedances of this guideline occurred in groundwater samples. During quarterly sampling, dissolved boron ranged from 0.024 mg/L to 1.58 mg/L. Average dissolved boron was highest in Q3 and lowest in Q2. Of the sample sites, average dissolved boron was highest at site T3 and lowest at MW21-1. As mentioned in Section 3.1.5, the BCWQG Long Term Chronic (LTC) Marine Aquatic Life guideline for total boron is not considered to be applicable to the tidal channels due to background conditions in the estuary.

Table 26. Dissolved Boron During Quarterly Groundwater and Tidal Channel Sampling in 2024.

Dissolved Boron (mg/L)				
Sample Site	2024 Quarterly Sampling Events			
	Q1	Q2	Q3	Q4
T1	n.s.	0.082	0.80	<0.10
T2	n.s.	0.052	0.65	<0.10
T3	n.s.	0.162	**1.58**	0.12
MW21-1	n.s.	0.031	0.024	0.22
MW21-2	n.s.	0.376	0.358	0.154
MW21-3A	n.s.	0.275	0.314	0.383
MW21-3B	n.s.	0.662	0.534	0.543
P1	n.s.	0.210	n.s.	n.s.
n.s. – Not sampled, sufficient water not available in piezometer.				

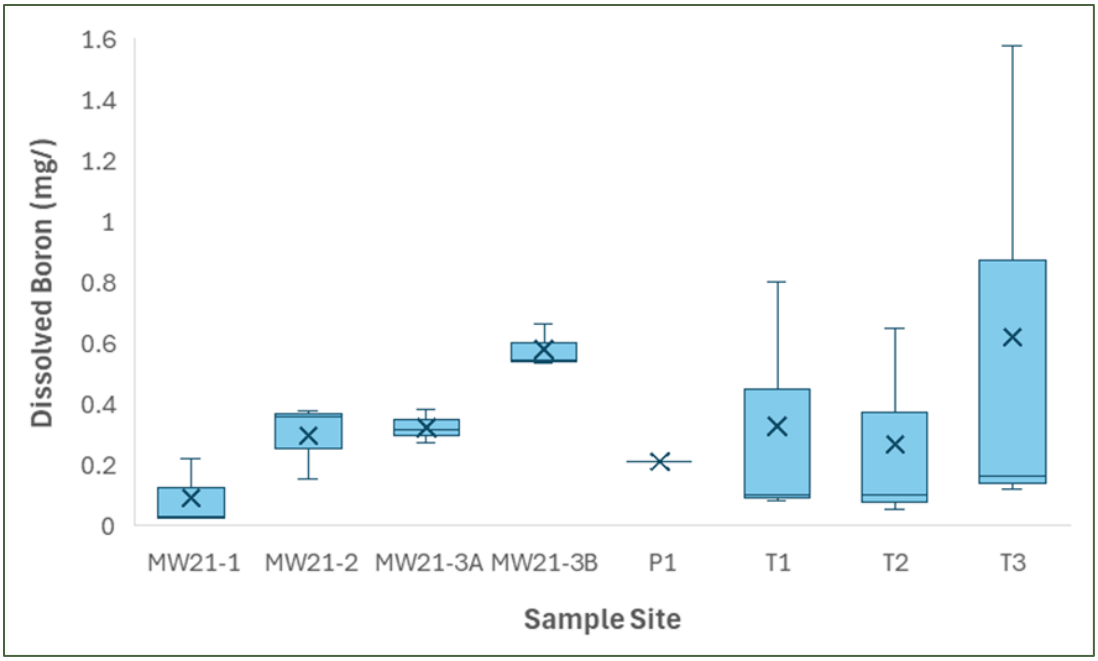


Figure 23: Average Dissolved Boron During Quarterly Groundwater and Tidal Channel Sampling in 2024.

3.3.8 Enterococcus

Throughout the quarterly groundwater and tidal channel sampling in 2024, there were five measurements that exceeded the Health Canada BAV of 70 CFU/100 mL for Enterococcus, which is applicable to both marine and freshwater. In Q4, sample sites T1, T2, T3, and MW21-3B exceeded the BAV, and in Q3 sample site T2 exceeded (**Table 27; Figure 24**). These results cannot be solely attributed to WWTF effluent discharge (see Section 6.1 below). Many of the remaining measurements were less than the detection limit so it is difficult to determine accurate spatial and temporal trends, however, average enterococcus was generally observed to be highest in Q4 and lowest in Q1. Of the sample sites, average enterococcus was highest at site T3 and lowest at sites MW21-1 and P1.

Table 27. Enterococcus During Quarterly Groundwater and Tidal Channel Sampling in 2024.

Enterococcus sp. (CFU/100 mL)				
Sample Site	**2024 Quarterly Sampling Events**			
	Q1	**Q2**	**Q3**	**Q4**
T1	38	32	54	**620**
T2	37	56	**100**	**400**
T3	24	>60	>60	**>600**
MW21-1	<10	<1	<1	10
MW21-2	<10	<1	34	<10
MW21-3A	<10	<10	<10	<10
MW21-3B	<10	<1	1	**140**
P1	<10	<1	n.s.	n.s.
n.s. – Not sampled, sufficient water not available in piezometer.				

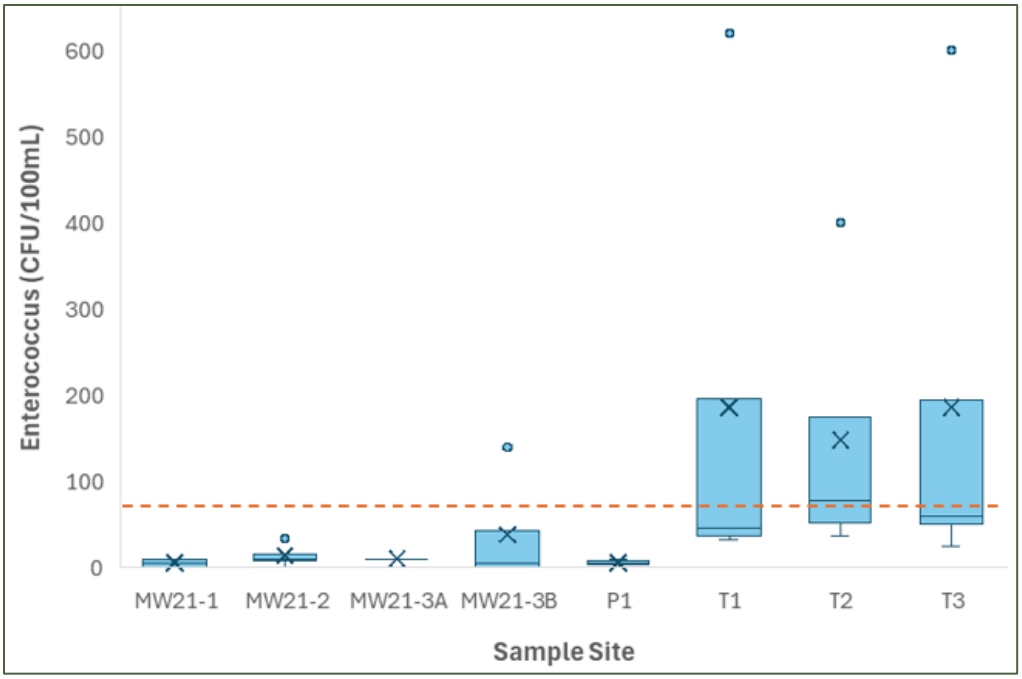


Figure 24: Average Enterococcus During Quarterly Groundwater and Tidal Channel Sampling in 2024.
Dashed line represents Health Canada BAV for Enterococcus (70 CFU/100 mL).

3.4 Tidal Channel, Groundwater, Piezometer 5-in-30 Results

The following includes a summary of the September 5-in-30 groundwater and tidal channel sampling results. Parameters that were observed to exceed applicable guidelines in September 2024 are summarized below in tables and graphs. Some additional parameters are described below which were observed to be meeting applicable guidelines or there were no confirmed exceedances of guidelines; these have been included as they are either indicator parameters for effluent seepage monitoring and/or the results were considered significant regardless of the lack of exceedances.

As mentioned in Section 2.6, sample results from individual 5-in-30 sampling events will be considered meeting the BCWQG even if they fluctuate above and below the Long Term Chronic (LTC) guideline, provided that the individual results do not exceed the Short-Term Acute (STA) guideline and that the mean result calculated from the averaging period meets the LTC guideline (BC ENV 2024). It is noted that all results and guideline limit values are in mg/L unless otherwise stated.

3.4.1 pH

Throughout the September 5-in-30 in 2024, there were 10 measurements that were outside of the BCWQG Marine range for pH (7.0 – 8.7) and/or the BCWQG Freshwater range for pH (6.5 – 9.0). Field measured pH was below the applicable BCWQG Freshwater pH range at MW21-1 throughout the month of September, at MW21-3A on September 3rd, 16th, 23rd, and 30th, and at MW21-3B on September 23rd. During the September 5-in-30, field measured pH ranged from 5.62 pH to 8.66 pH. Average field measured pH was highest at site T2 and lowest at site MW21-1 (**Table 28; Figure 25**).

Table 28. Field Measured pH During September 5-in-30 Groundwater and Tidal Channel Sampling in 2024.

Field Measured pH					
Sample Site	2024 September 5-in-30 Sampling Events				
	Sept. 3	Sept. 9	Sept. 16	Sept. 23	Sept. 30
T1	7.43	7.44	7.85	7.72	7.79
T2	8.11	8.06	8.43	7.59	8.66
T3	8.04	8.61	7.76	7.18	7.7
MW21-1	**5.62**	**6.12**	**6.09**	**6.18**	**6.21**
MW21-2	6.92	6.69	6.97	7.0	6.98
MW21-3A	**6.39**	6.53	**6.43**	**6.48**	**6.42**
MW21-3B	6.6	6.72	6.58	**6.38**	6.62

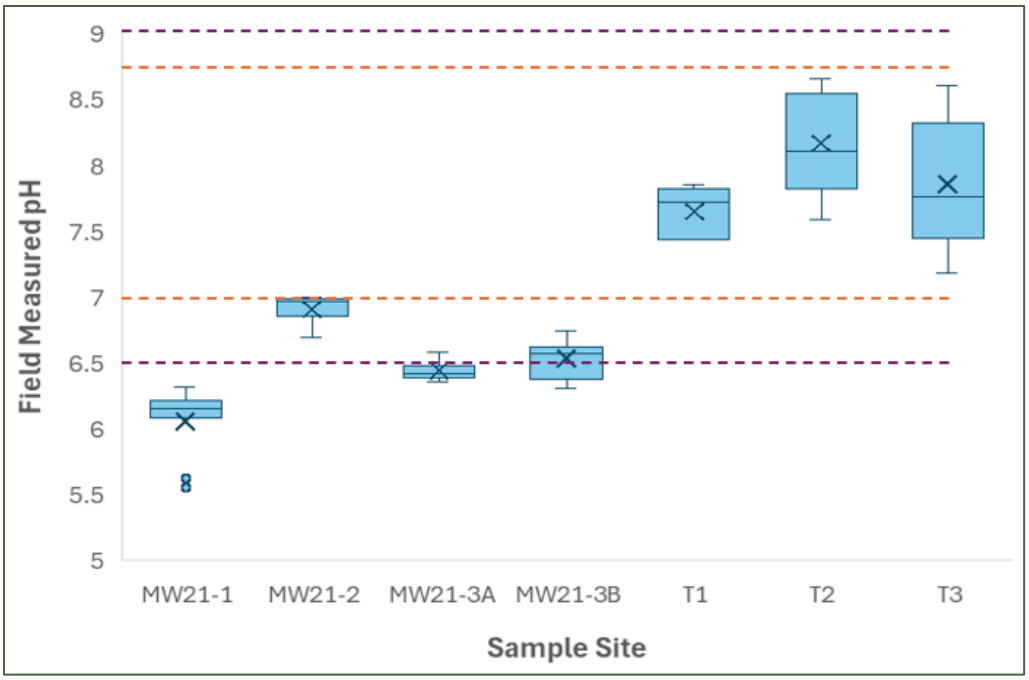


Figure 25: Average Field Measured pH During September 5-in-30 Groundwater and Tidal Channel Sampling in 2024. *Note: Dashed lines represent BCWQG Marine range (7.0 – 8.7, orange) and Freshwater range (6.5 – 9.0, purple) for pH.*

3.4.2 Dissolved Oxygen

Throughout the September 5-in-30 in 2024, all field measured dissolved oxygen measurements in the tidal channels were observed to meet the BCWQG Marine guideline (5 mg/L instantaneous minimum). There are no applicable dissolved oxygen guidelines for groundwater. During the September 5-in-30, field measured dissolved oxygen ranged from 0.09 mg/L to 21.09 mg/L. Average dissolved oxygen was highest at site T1 and lowest at site MW21-3B.

Table 29. Field Measured Dissolved Oxygen During September 5-in-30 Groundwater and Tidal Channel Sampling in 2024.

Field Measured Dissolved Oxygen (mg/L)					
Sample Site	2024 September 5-in-30 Sampling Events				
	Sept. 3	Sept. 9	Sept. 16	Sept. 23	Sept. 30
T1	5.47	9.98	21.09	9.66	11.3
T2	11.28	10.16	11.46	9.8	12.58
T3	10.91	11.05	12.63	12.58	10.97
MW21-1	5.33	4.9	5.05	5.2	5.1
MW21-2	0.2	0.29	0.31	0.2	0.3
MW21-3A	0.21	0.16	0.15	0.26	0.33
MW21-3B	0.09	0.21	0.23	0.24	0.25

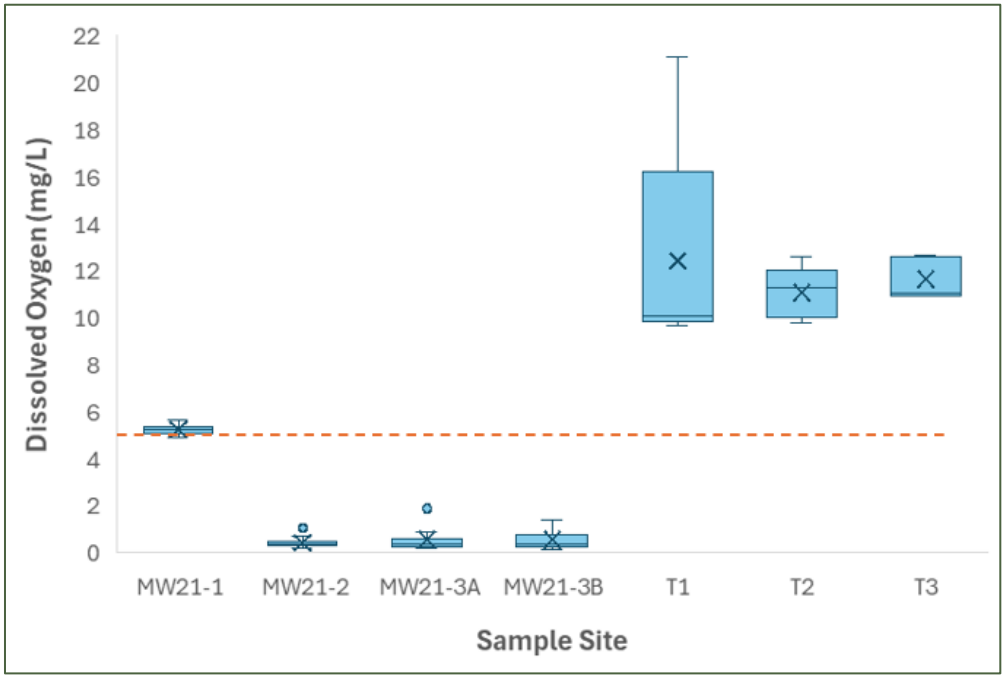


Figure 26: Average Field Measured Dissolved Oxygen During September 5-in-30 Groundwater and Tidal Channel Sampling in 2024. *Note: Dashed lines represent BCWQG Marine instantaneous minimum for dissolved oxygen (5 mg/L).*

3.4.3 Ammonia

Throughout the September 5-in-30 groundwater and tidal channel sampling, there were 6 groundwater measurements that exceeded the BC CSR Freshwater pH adjusted guideline limits for total ammonia; total ammonia concentrations within MW21-3A exceeded the pH adjusted guideline of 18.4 mg/L on each individual September sampling event, and MW21-3B exceeded the pH adjusted guideline of 18.4 mg/L on September 16th (**Table 30**). The total ammonia concentration at sample site P1 on September 9th was within the most conservative BC CSR total ammonia guideline limit (1.31 mg/L).

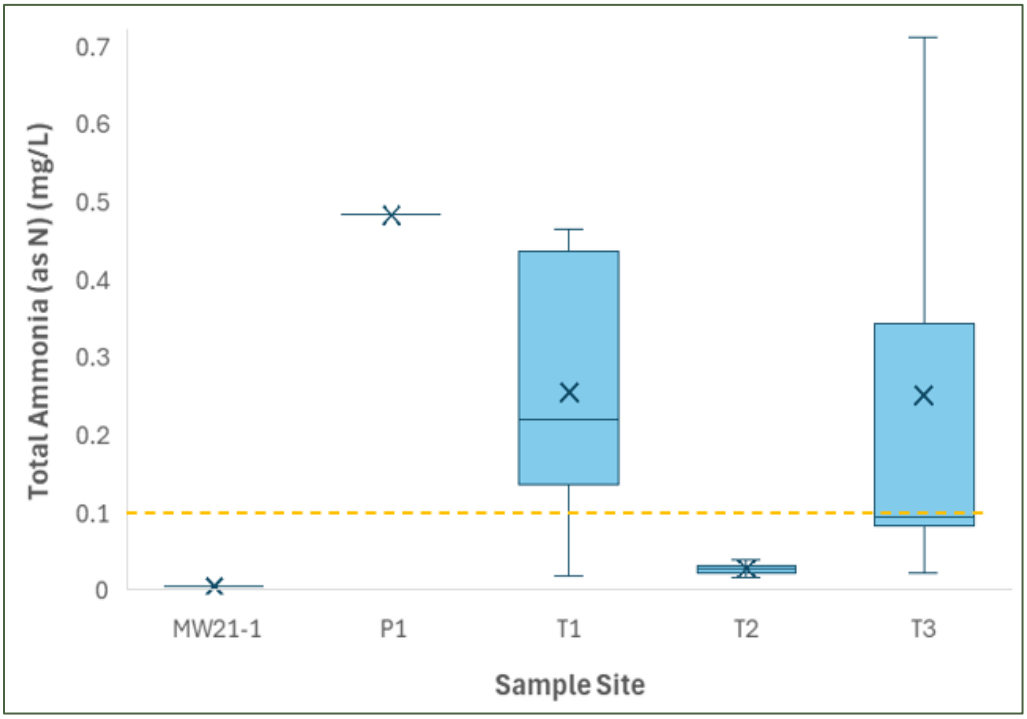
There were no tidal channel measurements that exceeded BCWQG Marine LTC for total ammonia once adjusted for pH, temperature, and salinity; 1.5 mg/L for T1, and 0.27 mg/L for T3. The individual

measurements from sample sites T1 and T3 were within the adjusted guidelines, as well as the monthly average concentrations.

Average total ammonia concentrations were observed to be highest at MW21-3A, and lowest at MW21-1 (**Table 30; Figure 27**). It is noted that results for MW21-2, MW21-3A, and MW21-3B were plotted separately as the values were significantly higher than those from the other sites (Figure 27).

Table 30. Total Ammonia During September 5-in-30 Groundwater and Tidal Channel Sampling in 2024.

Total Ammonia (mg/L)					
Sample Site	2024 September 5-in-30 Sampling Events				
	Sept. 3	Sept. 9	Sept. 16	Sept. 23	Sept. 30
T1	**0.135**	**0.220**	**0.436**	0.0171	**0.464**
T2	0.0267	0.0226	0.0394	0.0303	0.0162
T3	0.0223	0.0832	**0.342**	**0.711**	0.0936
MW21-1	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
MW21-2	**14.6**	**14.9**	**17.2**	**14.5**	**16.6**
MW21-3A	**20.2**	**19.7**	**21.8**	**20.8**	**22.0**
MW21-3B	**15.4**	**15.3**	**18.7**	**17.8**	**18.4**
P1	n.s.	0.482	n.s.	n.s.	n.s.
n.s. – Not sampled, sufficient water not available in piezometer.					



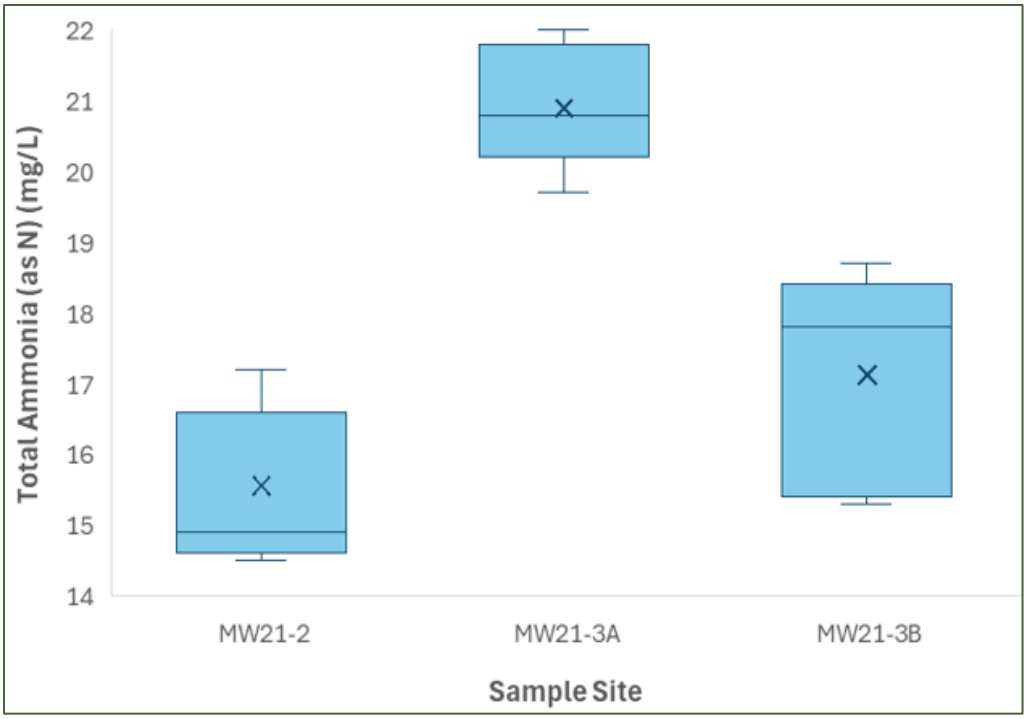


Figure 27: Average Total Ammonia During September 5-in-30 Groundwater and Tidal Channel Sampling in 2024.
Dashed line represents BCWQG Marine most conservative guideline (0.1 mg/L) for total ammonia.

3.4.4 Total Phosphorus

During September 5-in-30 sampling, total phosphorus ranged from 0.0128 mg/L to 1.46 mg/L. The highest average total phosphorus was observed at site MW21-3B and the lowest at site T3. As mentioned in Section 3.1.4, the Phosphorus Management in Vancouver Island Streams (MOE, 2014) guideline is not considered to be applicable.

Table 31. Total Phosphorus During September 5-in-30 Groundwater and Tidal Channel Sampling in 2024.

Total Phosphorus (mg/L)					
Sample Site	2024 September 5-in-30 Sampling Events				
	Sept. 3	Sept. 9	Sept. 16	Sept. 23	Sept. 30
T1	0.0285	0.0354	0.0447	0.0325	0.0362
T2	0.0250	0.0333	0.0162	0.0206	0.0339
T3	0.0232	0.0157	0.0175	0.0301	0.0138
MW21-1	0.0128	0.0252	0.0380	0.0236	0.0372
MW21-2	0.272	0.273	0.270	0.203	0.281
MW21-3A	0.738	1.08	0.987	1.38	0.985
MW21-3B	1.27	1.46	0.998	1.27	1.31
P1	n.s.	0.0405	n.s.	n.s.	n.s.
n.s. – Not sampled, sufficient water not available in piezometer.					

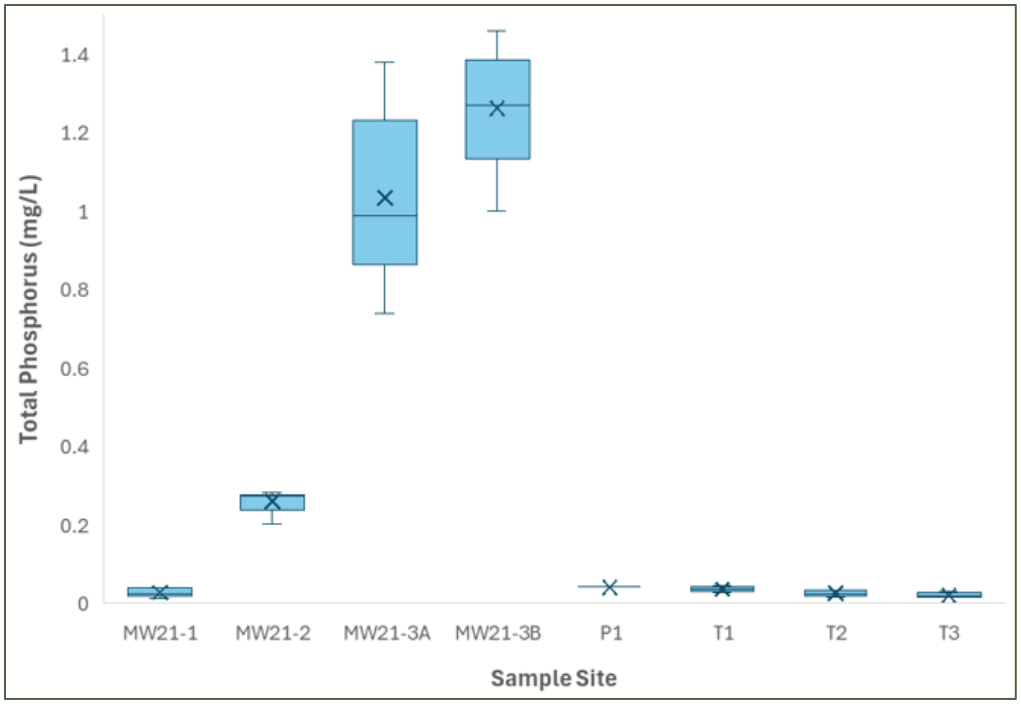


Figure 28: Average Total Phosphorus During September 5-in-30 Groundwater and Tidal Channel Sampling in 2024.

3.4.5 Nitrate

Throughout the September 5-in-30 groundwater and tidal channel sampling, there were no exceedances of applicable nitrate guidelines at any of the sample sites (**Table 32; Figure 29**). The BCWQG Marine LTC limit is 3.7 mg/L, the BCWQG Freshwater LTC limit is 3.0 mg/L, and the BC CSR Generic Numerical Water Standard for Aquatic Life is 400 mg/L. Majority of the results were less than the limit of detection; therefore, accurate spatial and temporal trends cannot be described.

Table 32. Total Nitrate During September 5-in-30 Groundwater and Tidal Channel Sampling in 2024.

Nitrate (as N) (mg/L)					
Sample Site	2024 September 5-in-30 Sampling Events				
	Sept. 3	Sept. 9	Sept. 16	Sept. 23	Sept. 30
T1	<0.50	<0.50	<0.50	<0.50	<0.10
T2	<0.50	<0.50	<0.50	<0.50	<0.10
T3	<0.50	<0.50	<0.50	<0.50	<0.10
MW21-1	0.0665	0.0744	0.0746	0.0596	<0.0010
MW21-2	<0.100	<0.100	<0.100	<0.100	<0.0200
MW21-3A	<0.100	<0.100	<0.100	<0.100	<0.0200
MW21-3B	<0.100	<0.100	<0.100	<0.100	<0.0200
P1	n.s.	<0.100	n.s.	n.s.	n.s.
n.s. – Not sampled, sufficient water not available in piezometer.					

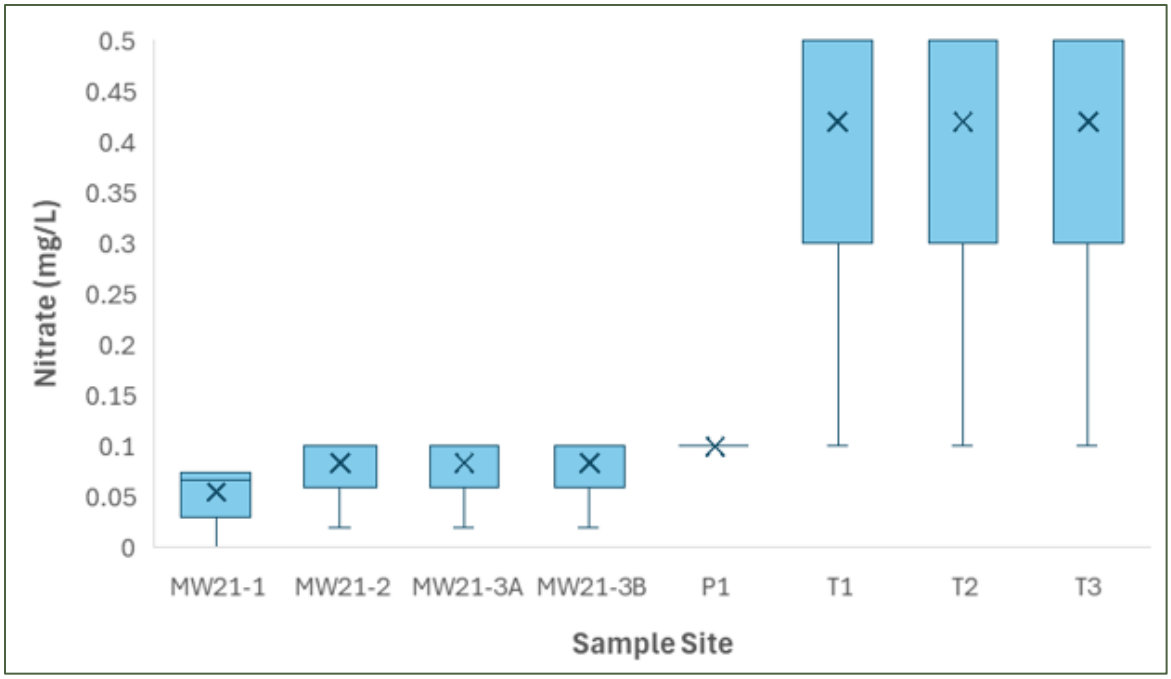


Figure 29: Average Nitrate During September 5-in-30 Groundwater and Tidal Channel Sampling in 2024.

3.4.6 Dissolved Chromium

Throughout the September 5-in-30 groundwater and tidal channel sampling, there were no measurements that exceeded guidelines for dissolved chromium. The BCWQG Marine LTC limit for chromium is 0.0015 mg/L and the BC CSR Generic Numerical Water Standard for Aquatic Life for chromium is 0.01 mg/L. Majority of the results were less than the limit of detection; therefore, accurate spatial and temporal trends cannot be described. It is noted that individual groundwater measurements from MW21-2 and MW21-3A appear to exceed the BCWQG Marine LTC guideline in Figure 30; however, these are not exceedances as they are groundwater samples, and they are within the applicable BC CSR guideline limit for dissolved chromium in groundwater (0.01 mg/L).

Table 33. Dissolved Chromium During September 5-in-30 Groundwater and Tidal Channel Sampling in 2024.

Dissolved Chromium (mg/L)					
Sample Site	2024 September 5-in-30 Sampling Events				
	Sept. 3	Sept. 9	Sept. 16	Sept. 23	Sept. 30
T1	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
T2	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
T3	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
MW21-1	0.00054	<0.00050	0.00056	0.00054	0.00058
MW21-2	<0.00100	<0.00100	<0.00250	<0.0050	0.00050
MW21-3A	<0.00100	<0.00100	0.00111	<0.0050	0.00108
MW21-3B	<0.00050	<0.00050	<0.00100	<0.0050	<0.00100
P1	<0.00250	<0.00100	n.s.	n.s.	n.s.
n.s. – Not sampled, sufficient water not available in piezometer.					

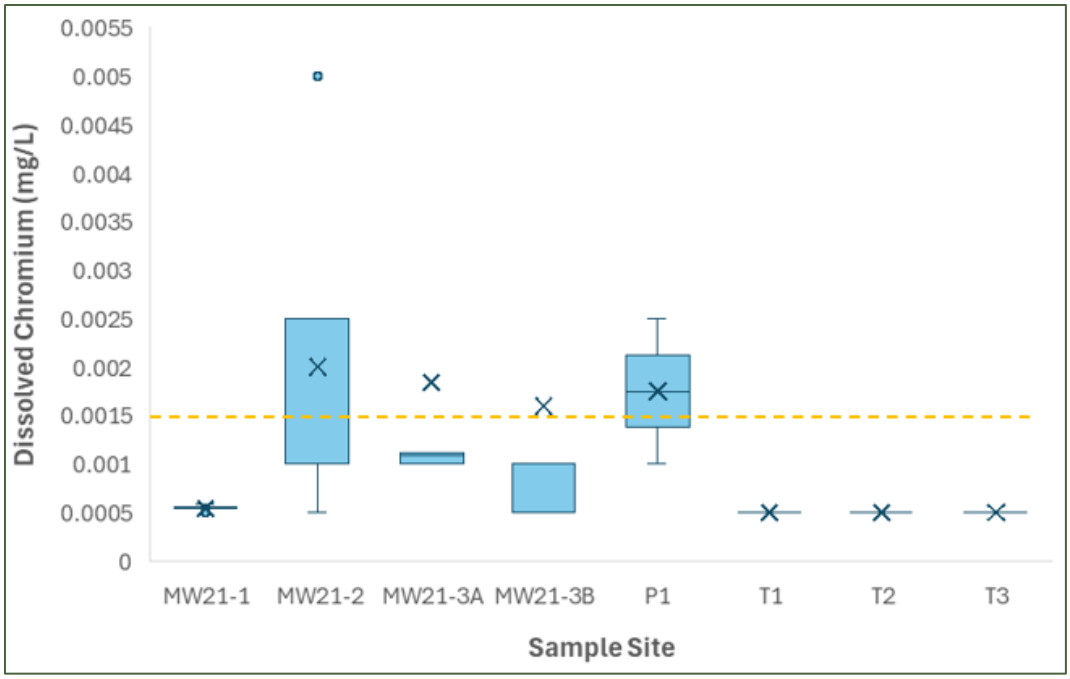


Figure 30: Average Dissolved Chromium During September 5-in-30 Groundwater and Tidal Channel Sampling in 2024. *Note: Dashed line represents BCWQG Marine LTC limit for chromium in marine water (0.0015 mg/L).*

3.4.7 Dissolved Boron

The applicable BC CSR Generic Numerical Water Standard for Aquatic Life is 12 mg/L and no exceedances of this guideline occurred in groundwater samples. During the September 5-in-30, dissolved boron ranged from 0.024 mg/L to 1.58 mg/L. The highest average monthly concentration of dissolved boron was at site T3 and the lowest was at MW21-1. As mentioned in Section 3.1.5, the BCWQG Long Term Chronic (LTC) Marine Aquatic Life guideline for total boron is not considered to be applicable to the tidal channels due to background conditions in the estuary.

Table 34. Dissolved Boron During September 5-in-30 Groundwater and Tidal Channel Sampling in 2024.

Dissolved Boron (mg/L)					
Sample Site	2024 September 5-in-30 Sampling Events				
	Sept. 3	Sept. 9	Sept. 16	Sept. 23	Sept. 30
T1	0.57	<0.30	0.80	<0.30	0.42
T2	0.53	<0.30	0.65	<0.30	0.33
T3	0.64	0.30	1.58	0.44	0.40
MW21-1	0.026	0.023	0.024	0.024	0.024
MW21-2	0.410	0.377	0.358	0.380	0.408
MW21-3A	0.318	0.302	0.314	0.374	0.363
MW21-3B	0.622	0.546	0.534	0.490	0.602
P1	0.375	0.348	-	-	-
n.s. – Not sampled, sufficient water not available in piezometer.					

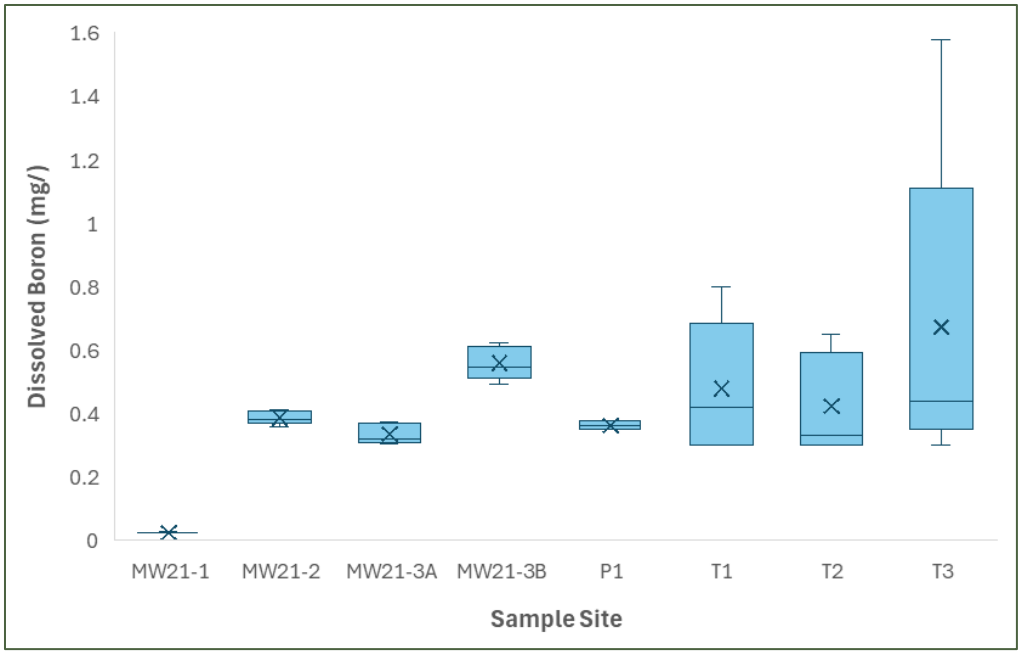


Figure 31: Average Dissolved Boron During September 5-in-30 Groundwater and Tidal Channel Sampling in 2024.

3.4.8 Enterococcus

Throughout the September 5-in-30 groundwater and tidal channel sampling, there were 6 measurements that exceeded the Health Canada BAV (70 CFU/100 mL) and 3 sample sites that exceeded the geometric mean monthly average limit (35 CFU/100 mL). Sample site T1 exceeded the BAV on September 3rd, and the geometric mean of T1 for the month of September was 39.8 CFU/100 mL. Sample site T2 exceeded the BAV on September 9th and 16th, and the geometric mean of T2 was 56.0 CFU/100 mL. Sample site T3 exceeded the BAV on September 3rd, 9th, and 23rd, and the geometric mean of T3 was 80.2 CFU/100 mL. These results cannot be solely attributed to WWTF effluent discharge (see Section 6.1 below). Many of the remaining measurements were less than detection limits so spatial and temporal trends could not be determined for the other sample sites (**Table 35, Figure 32**).

Table 35. Enterococcus During September 5-in-30 Groundwater and Tidal Channel Sampling in 2024.

Enterococcus sp. (CFU/100 mL)					
Sample Site	2024 September 5-in-30 Sampling Events				
	Sept. 3	Sept. 9	Sept. 16	Sept. 23	Sept. 30
T1	**118**	20	54	60	13
T2	>60	**610**	**100**	10	15
T3	**270**	**190**	>60	**270**	4
MW21-1	<1	<1	<1	<1	<1
MW21-2	<1	<1	34	<1	3
MW21-3A	<10	<10	<10	<10	<10
MW21-3B	<1	<1	1	<10	<10
P1	n.s.	<1	n.s.	n.s.	n.s.
n.s. – Not sampled, sufficient water not available in piezometer.					

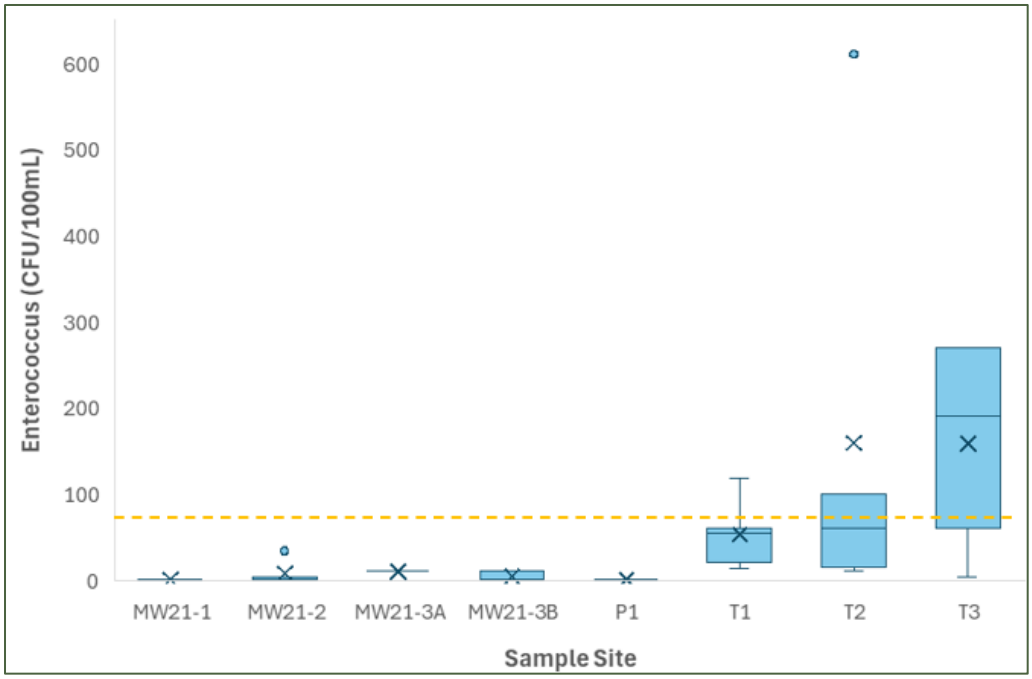


Figure 32: Average Enterococcus During September 5-in-30 Groundwater and Tidal Channel Sampling in 2024.
Note: Dashed line represents Health Canada BAV for Enterococcus (70 CFU/100 mL).

3.5 Sediment

Sediment samples collected on September 23rd and 24th, 2024, were analyzed for particle size distribution, chlorinated phenols, total organic carbon and total nitrogen. The sediment samples are composite samples with three aliquots collected from the three replicate sediment samples at each receiving environment site.

3.5.1 Particle Size Distribution

Particle size distribution results show that sediment composition at sites A and B, the shallower sites near to the WWTF outlet, were dominated by sand with small amounts of silt, clay or gravel. Sediment composition in sites C,D, E and F show a higher percentage of silt, less sand, and more gravel. Particle size distribution is shown in **Figure 33**.

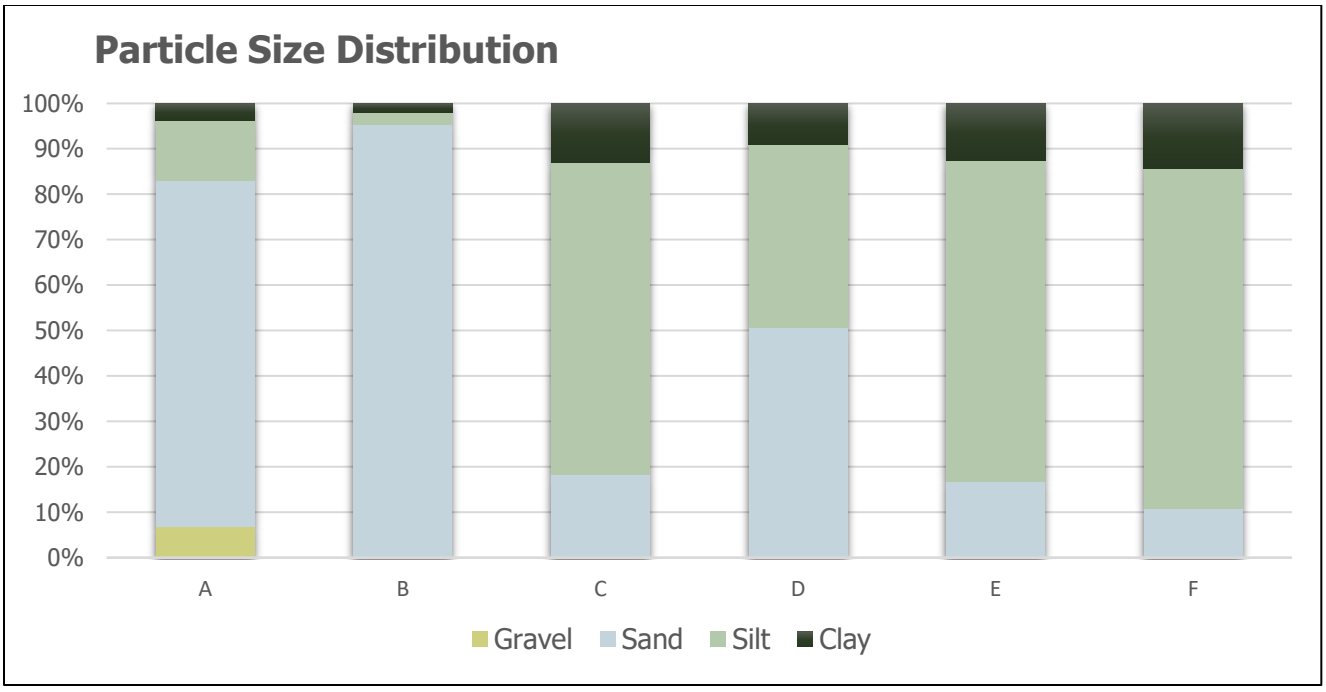


Figure 33. Particle size distribution of sediment.

3.5.2 Chlorinated Phenols

Chlorinated phenols were analyzed in the sediment samples. All chlorinated phenols for all sites were reported under laboratory detection limits and below applicable provincial guidelines.

3.5.3 Total Organic Carbon and Total Nitrogen

Total organic carbon (TOC) and total nitrogen are indicators of organic enrichment impacts. TOC and total nitrogen were lowest at sites A and B nearest to the WWTF outfall. TOC was 2.07% at Site A and 0.749% at Site B. TOC ranged from 4.06 to 11.1 at sites C, D, E and F. Total nitrogen was 0.152% at Site A and 0.105% at Site B. Total nitrogen ranged from 0.226% to 0.350% at sites C, D, E and F. The lower TOC and nitrogen at sites A and B, relative to the deeper marine sites and reference sites, may be the result of bedload movement due to tidal and river currents.

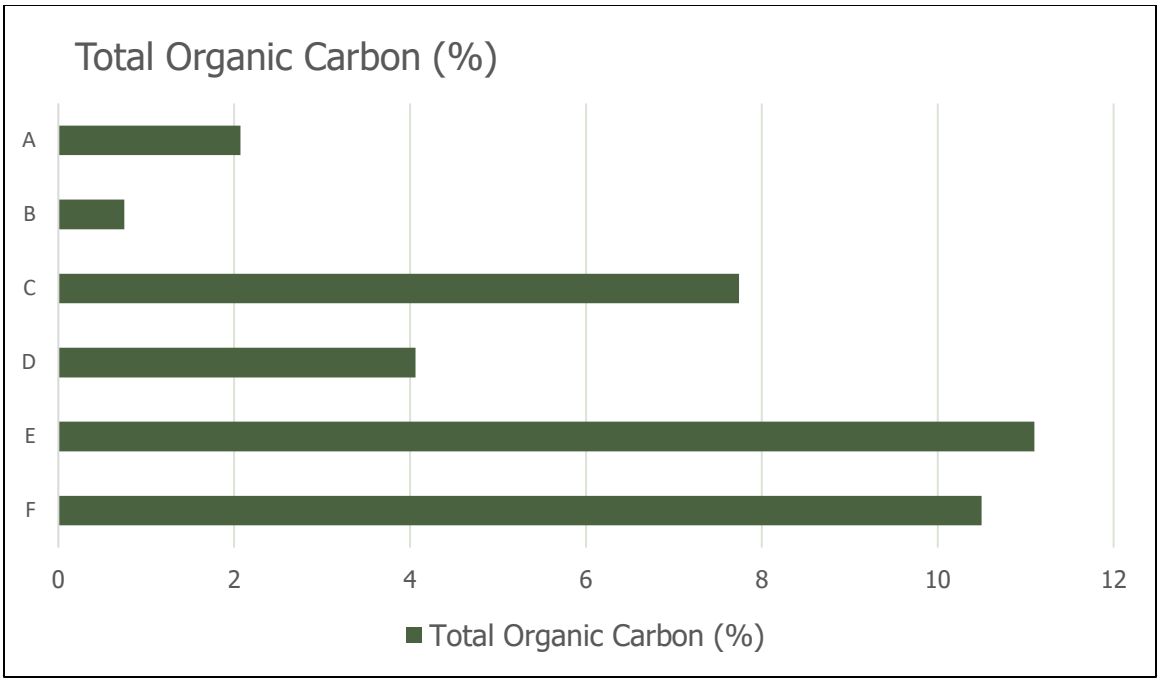


Figure 34. Total organic carbon in sediment.

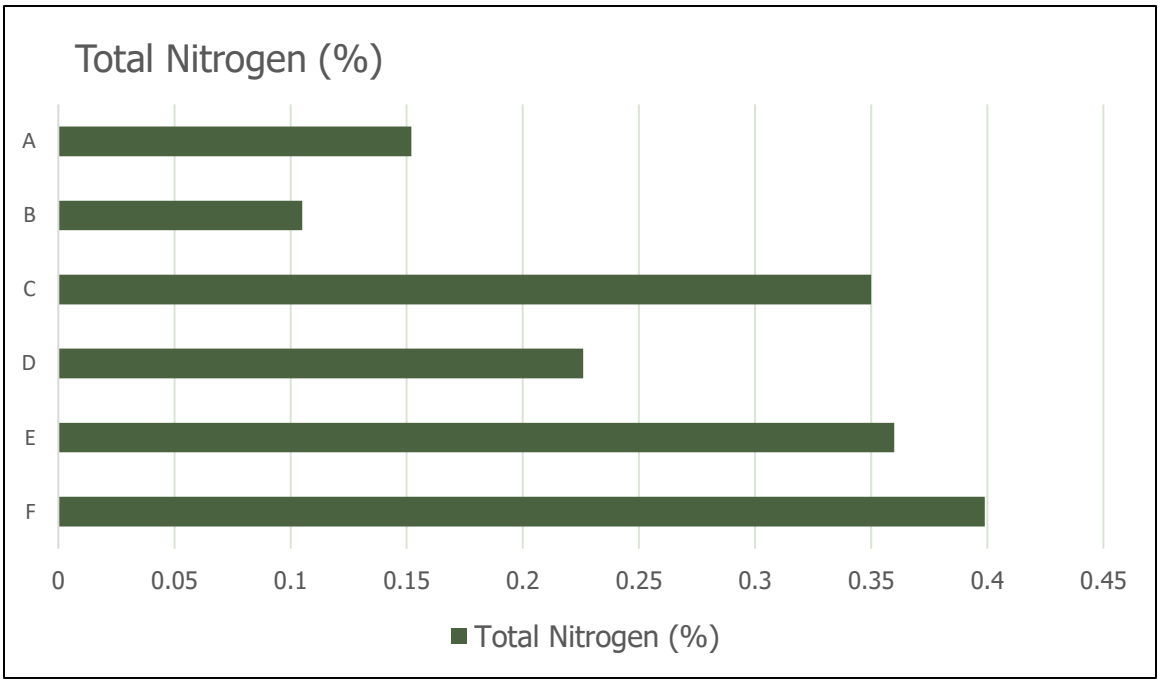


Figure 35. Total nitrogen in sediment.

3.5.4 Comparison and Trends

Chlorinated Phenols

In the 2022 AE sediment samples, chlorinated phenols concentrations were also reported to be below laboratory detection limits at all sampling sites.

Total Organic Carbon and Total Nitrogen

2024 sediment sampling yielded similar TOC and total nitrogen results to AE's (2022) results and the pre-discharge sampling. During all sample events, TOC was reported to be lower at Sites A and B (<1% to 5%) and higher at Sites C, D E and F (4% to 11%). During all sample events, total nitrogen was reported to be lower at Sites A and B (<.01% to 0.152%) and higher at Sites C, D E and F (0.20% to 0.45%). More data will be needed to better determine spatial and temporal trends.

3.6 Benthic Invertebrates

Based on the taxonomic results, metrics of density, richness, evenness and diversity were calculated for each site using methods consistent with those described in the AE REMP (AE, 2021a). Density is a measurement of the number of individual organisms per square metre, which is calculated by dividing the total abundance (number of individuals) in a sample by the 0.05244 square metre (229 mm x 229 mm) area sampled by the standard Ponar grab sampler. Richness is a simple count of the number of different species found in a sample, while evenness is a unitless index that compares both the number of species and the relative abundance of each species within each sample. Simpson's Diversity is an index used to measure the number of families present as well as the relative abundance of individuals in each family. As richness and diversity increases, so does Simpson's Diversity.

3.6.1 Total Abundance and Prolific Species

In the September 2024 samples, Biologica counted a total abundance of 11,661 benthic invertebrates with 68 unique species. For the purpose of this report, the counted juvenile invertebrates have been omitted as it is recommended that juvenile fauna should be enumerated separately for marine invertebrate studies. The analysis below is based on data for 10,215 intermediate and adult invertebrates, as classified by Biologica.

The overall benthic community was dominated by the arthropod families Corophiidae and Aoridae comprising of 49% of the total benthic invertebrates. The two most dominant species were arthropods*; Grandidierella japonica* (18% of overall abundance) and undetermined *Monocorophium* genus (15% overall abundance). Two annelid species, *Hobsonia florida* and *Capitella capitata complex* both comprised of 11% of the overall abundance.

The most prolific benthic invertebrate families and species are shown in Tables 36 and 37 below.

Table 36. Prolific benthic invertebrate families.

Family	Percentage of Overall Abundance	Family	Percentage of Overall Abundance
Corophiidae	29%	Ampharetidae	6%
Aoridae	20%	Fabriciidae	6%
Capitellidae	13%	Naididae	6%
Lasaeidae	8%		

Table 37. Prolific benthic invertebrate species.

Phylum	Class	Order	Family	Species	Percentage of Overall Abundance
Arthropoda	Malacostraca	Amphipoda	Aoridae	*Grandidierella japonica*	18%
Arthropoda	Malacostraca	Amphipoda	Corophiidae	*Monocorophium* sp.	15%
Annelida	Polychaeta	Terebellida	Ampharetidae	*Hobsonia florida*	11%
Annelida	Polychaeta	-	Capitellidae	*Capitella capitata complex*	11%
Arthropoda	Malacostraca	Amphipoda	Corophiidae	*Monocorophium insidiosum*	8%
Mollusca	Bivalvia	Galeommatida	Lasaeidae	*Kurtiella tumida*	7%
Annelida	Polychaeta	Sabellida	Fabriciidae	*Manayunkia aestuarina*	5%

3.6.2 Abundance, Species Richness, Evenness, and Diversity

Benthic invertebrate abundance and family richness, evenness, and diversity is presented in Table 38. The data is presented for each Impact and Reference site.

Table 38. Benthic invertebrate abundance, species richness, evenness, and diversity

Site	Avg. Total Abundance in Sample*	Mean Density (#/m^2)	St. Dev. Of Mean Density	Total Richness (# of Families)	Evenness Index	Simpson's Diversity Index (1-D)
Impact Sites						
A	1926	36727	9526	23	0.125	0.804
B	334	6363	3154	16	0.070	0.206
C	263	5022	1509	13	0.107	0.639
D	367	7005	6223	21	0.049	0.416
Reference Sites						
E	447	8524	8153	17	0.073	0.585
F	68	1290	642	11	0.298	0.823

*Average of the three replicate sample results.

3.6.3 Discussion and Comparison to Past Year's Results

The highest invertebrate density was found at Site A with a mean density of 36727 organisms per m2. Site A is the closest site to the WWTF diffuser and one of the closest sites to the Catalyst mill output,

which might explain the higher high mean density. The lowest density occurred at Reference Site F. The greatest diversity was found at Site A, with diversity varying amongst the other sites.

Sites B, C and D yielded similar benthic invertebrate densities with Site C having the greatest diversity. Reference site F shows a far lower density than reference site E, this may be due to the sample locations being located in log booming grounds and the influence of woody debris and a wood fibre mat.

Comparison of the 2024 benthic invertebrate data to AE's 2022 data is hindered by an inconsistency in how the invertebrates were counted. AE's 2022 invertebrate results contain data for the phylum Nematoda, and the 2024 data does not. In marine invertebrate analysis, nematodes, along with other meiofauna (organisms <0.5mm), are considered incidental because of their small size. Our study focuses on macrofauna as an indicator. Meiofauna present an issue because abundances/diversity can represent hyper-localized conditions and they are ephemeral and shorter lived so they are not suitable for annual comparisons. Due to the inclusion of Nematoda data in AE's results and the absence from the 2024 results, comparison to the 2022 data is not practical. Future benthic invertebrate sampling will use methods and reporting consistent with the 2024 program.

3.7 Vegetation Survey Results

The OC and AE's REMP (2021) require vegetation monitoring to be conducted annually with the intent of detecting potential impacts to biodiversity and plant health caused by lagoon seepage. The objectives and methodology of the vegetation monitoring program are described within AE (2021), AE (2023), and AE (2024b). The general objectives of the vegetation monitoring program are to:

- Map the ecosystem site units that are present within the 30 m wide buffer zone around the lagoon, based on the existing ecological mapping in the Somass River Estuary Management Plan (Catherine Berris Associates Inc. 2004).
- Establish replicate vegetation plots within each ecosystem unit (the number of plots will be proportional to the area; minimum n=3) and reference (control) plots in other areas outside the potential influence of the lagoon seepage.
- Inventory plant species in the plots.
- Conduct data analyses including calculation of relevant biodiversity indices (e.g. species richness, Shannon Index, Simpson Index).
- Include visual/photographic assessments for evidence of stress as compared to nearby unaffected/reference areas. Typical symptoms of stress in affected plants include leaf edge and tip necroses (dead tissue), dis-colouration, necrotic spots along veins, and intercostal stippling.

In 2022, AE completed the first annual vegetation monitoring survey which accomplished all of the objectives described above. Three replicate plots were established for each ecosystem unit in both the reference and zone of influence (ZOI), resulting in 36 total plots. In 2022, AE completed the following tasks:

- Confirmed current vegetation conditions are broadly similar to the classifications provided by the Somass River Estuary Management Plan (CBA, 2004);
- Established replicate plots within each ecosystem unit at randomly-selected locations within 30 m of the lagoon and control plots in areas outside the potential influence of lagoon seepage;
- Documented plant inventory and dominant species in each plot;
- Documented percent cover of each species as a measure of relative abundance;
- Calculated species richness and diversity indices for each plot;

- Confirmed Ecosystem units within and outside of the lagoon's zone of influence included riparian forest, levee forest, upland forest, riparian shrub, upland shrub, and tidal marsh;
- Determined dominant plant species differed between habitat types and whether or not the habitat was located within the zone of influence;
- Determined riparian forest had the highest vegetation diversity and tidal marsh had the lowest diversity; and there did not appear to be differences in vegetation diversity indices between ecosystem units located within and outside of the zone of influence.

Roe conducted the second vegetation monitoring survey on July 31, 2024. Roe attempted to survey all 36 ZOI and Reference sites shown in **Figure 36**.

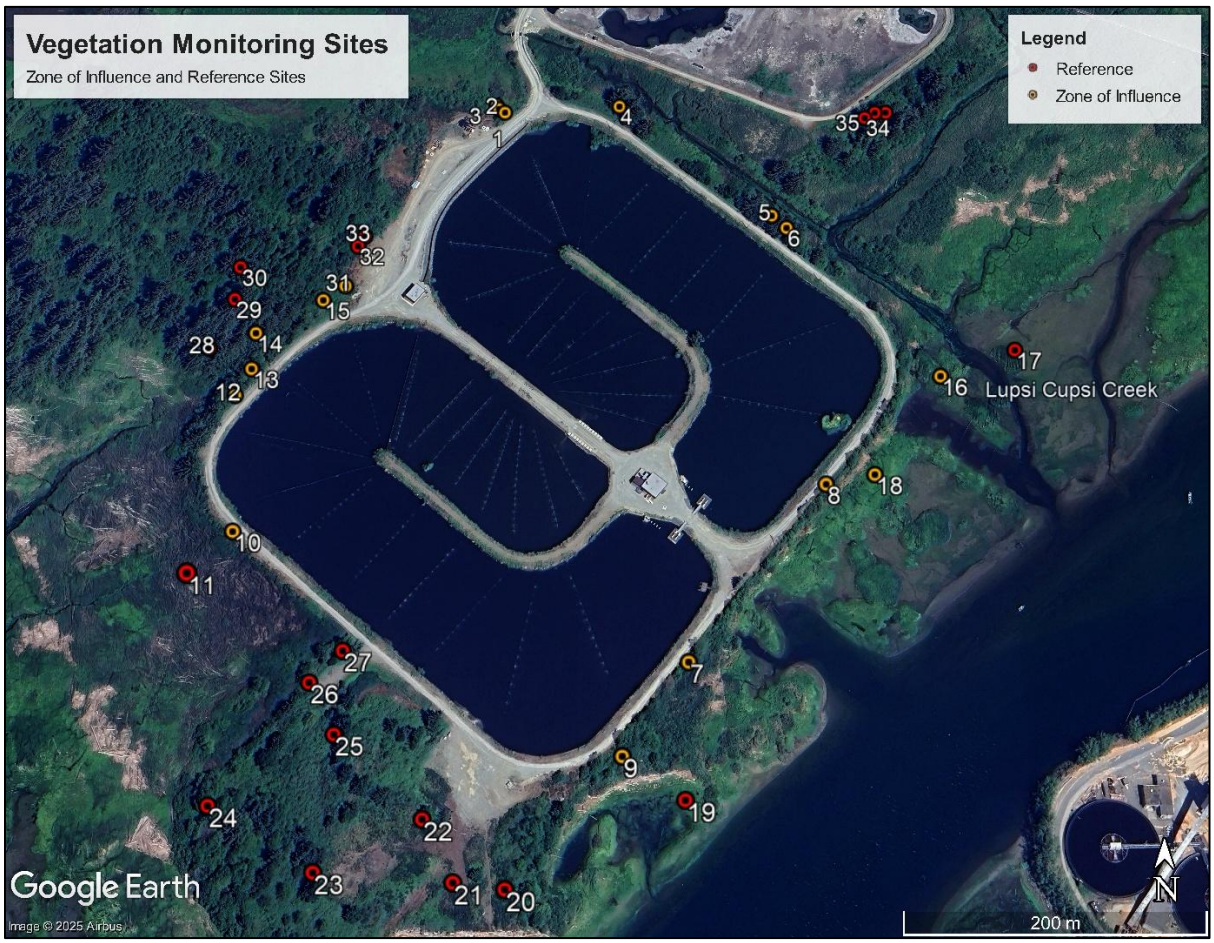


Figure 36. Locations of Vegetation Survey Plots at Port Alberni WWTF.

Of the 36 sites, 20 sites were accessible and 16 were inaccessible. Proliferation of invasive Himalayan blackberry and scotch broom has occurred at the WWTF since the first vegetation monitoring session. For the inaccessible sites, either access was blocked by invasive plants, or invasive plants have become the dominant species. "Dominant species" is defined as the species with the highest percent cover at each site. For the accessible sites, plot centers were demarcated by a piece of re-bar with an orange cap and pink flagging (Photo 1). The accessibility of each individual site, associated habitat type, and dominant species are presented in **Tables 39 and 40.**

Within the context of the WWTF site, rapid proliferation of invasive plant species is considered to be normal following land clearing for the new lagoon. This proliferation is not considered to be related to

seepage from the lagoon. Although several ZOI sites were accessible, most corresponding Reference sites for the relevant Habitat Type were inaccessible. Since data collection of dominant species and percent cover were not possible for 16 of the sites, calculation of species richness, Shannon and Simpson diversity indices, and comparison amongst ZOI and Reference sites was not possible.

Table 39. Sites which are currently accessible, although accessibility is expected to decrease due to increased presence of invasive plants each year.

Sites Which Are Accessible	Habitat Type	ZOI or Reference	Dominant Species	Sites Which Are Accessible	Habitat Type	ZOI or Reference	Dominant Species
1	Upland Shrub	ZOI	Himalayan blackberry	12	Riparian Forest	ZOI	Western red cedar
2	Upland Shrub	ZOI	Reed canary grass	13	Riparian Forest	ZOI	Sword fern
3	Upland Shrub	ZOI	Nootka rose	14	Riparian Forest	ZOI	Bracken fern
4	Levee Forest	ZOI	English ivy	16	Tidal Marsh	ZOI	Bulrush
5	Levee Forest	ZOI	English ivy	17	Tidal Marsh	Reference	Bulrush
6	Levee Forest	ZOI	Sitka spruce	18	Tidal Marsh	ZOI	Creeping Spike rush
7	Upland Forest	ZOI	Red alder	19	Tidal Marsh	Reference	Arctic rush
8	Upland Forest	ZOI	Bigleaf maple	28	Riparian Forest	Reference	Sitka spruce
9	Upland Forest	ZOI	Reed canary grass	29	Riparian Forest	Reference	Sedge
10	Tidal Marsh	ZOI	Common cattail	30	Riparian Forest	Reference	Red alder

Table 40. Sites which are currently inaccessible and likely to become more inaccessible.

Sites Which are Not Accessible	Habitat Type	ZOI or Reference	Dominant Species	Sites Which are Not Accessible	Habitat Type	ZOI or Reference	Dominant Species
11	Tidal Marsh	Reference	Overgrown	26	Riparian Shrub	Reference	Himalayan blackberry
15	Riparian Shrub	ZOI	Himalayan blackberry	27	Riparian Shrub	Zone of Influence	Himalayan blackberry
20	Upland Shrub	Reference	Scotch broom	31	Riparian Shrub	Zone of Influence	Himalayan blackberry
21	Upland Shrub	Reference	Scotch broom	32	Riparian Shrub	Reference	Himalayan blackberry
22	Upland Shrub	Reference	Himalayan blackberry	33	Riparian Shrub	Reference	Himalayan blackberry
23	Upland Forest	Reference	Himalayan blackberry	34	Levee Forest	Reference	Himalayan blackberry
24	Upland Forest	Reference	Himalayan blackberry	35	Levee Forest	Reference	Himalayan blackberry

25	Upland Forest	Reference	Himalayan blackberry	36	Levee Forest	Reference	Himalayan blackberry

Re-establishing access to all vegetation monitoring sites would require significant time and effort. Maintenance activities such as brushing paths to the individual sites or re-establishing the sites may increase the likelihood of spreading invasive plants. Furthermore, it did not seem likely that new plots could be established using the same or similar methodology due to the amount of invasive plant material which has primarily spread amongst the west, east, and south edges of the lagoon. The amount of invasive plant material surrounding the lagoon is expected to increase on an annual basis.

Regarding the accessible sites, primarily located along the northeastern edge of the lagoon, Roe's findings generally aligned with those of AE (2024b), however presence of invasive English holly and English ivy plants had increased overall (Photo 2).

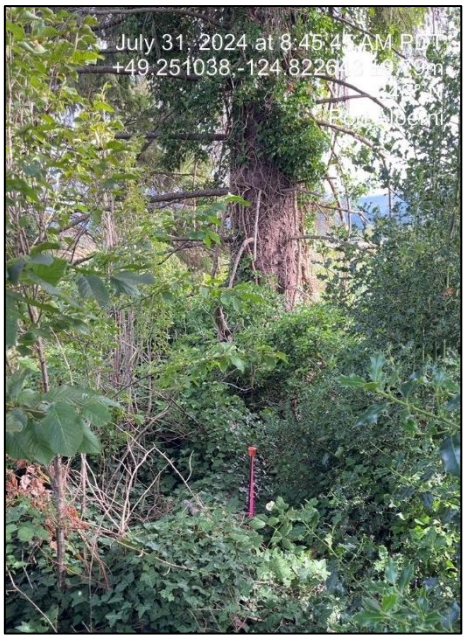


Photo 1. Plot center for site #4, showing re-bar with orange cap and pink flagging.

Photo 2. Plot center for site #5, showing increased presence of english ivy since AE's 2022 vegetation survey.

Although the concept of detecting plant stress both within and outside of the ZOI could theoretically assist in detecting lagoon seepage, and perhaps more so in a newly-cleared setting with low density of invasive plants, it is not currently feasible based on the amount of invasive plant material which has grown since the first vegetation monitoring survey. Competitive stresses from invasive plants and other climatic stressors may also contribute to vegetation decline or mortality, making it hard to identify whether indicators of stress detected in vegetation are related to lagoon seepage alone. Since trees could be viewed from above an understory of invasive plants, Roe considered monitoring of trees as an alternative, however trees are also subject to a variety of non-seepage related stressors making it hard to isolate the effects of lagoon seepage.

In consideration of these factors, Roe recommends that the annual vegetation monitoring program be discontinued and that emphasis is placed on other indicators of lagoon seepage as referenced in AE (2021).

4 LANDFILL LEACHATE

Leachate from the flow equalization pond at Alberni Valley Landfill is gravity-fed by a 2.7 km long pipe to the WWTF. Due to the changeover of the influent piping at the facility in 2022, influent sampling did not occur at the WWTF in 2024.

At the Alberni Valley Landfill, Piteau Associates Engineering (2024) conducted sampling at the aeration lagoon (the "Lagoon Inlet") in 2024, which is located immediately upstream of the flow equalization pond. Sampling occurred on February 12th and April 22nd. Sampling was intended for July 29th but the Lagoon Inlet was dry, and no samples were analyzed on October 21st. Samples were compared to the following guidelines:

- Guidelines for Canadian Drinking Water Quality (GCDWQ, Health Canada, 2022);
- Working and approved guidelines for freshwater aquatic life (FWAL) in BC (BC MOE, 2023);
- Contaminated Sites Regulation (CSR) standards for aquatic water (AW) and drinking water (DW).

Exceedances for TDS and Ammonia were detected on February 12. Exceedances for iron, manganese, and ammonia nitrogen were detected on April 22. Exceedances for manganese were also detected at the Lagoon Inlet in 2022 and 2023. The fraction of the total inflow from the landfill to the WWTF lagoon was not determined. Any effects of these exceedances on the WWTF influent was not confirmed due to no influent sampling occurring at the WWTF in 2024. No trends are apparent from landfill leachate monitoring conducted in 2023 and 2024.

5 2024 EFFLUENT MONITORING RESULTS

Table 41 below from AE's (2022) Annual Report summarizes annual effluent quality and sampling requirements for the CPA's final effluent monitoring program as determined by the Operational Certificate and the Sampling Plan. All 2024 samples were collected from the lagoon by CPA staff and were analyzed by MB Labs in Sidney, BC. At the lagoon, samples were taken following UV treatment but prior to discharge to the marine environment.

Averaged values for program parameters are included in Table 41 below. None of the averaged values exceeded their operating limits. Two exceedances of the Operational Certificate limits occurred during 2024: a measurement of 52.60 mg/L for CBOD5 on August 13, 2024 which exceeded the CBOD5 operating limit of 45 mg/L, and a measurement of 8600 CFU/100mL for fecal coliforms on October 22, 2024 which exceeded the fecal coliform operating limit of 3200 CFU/100 mL.

Table 41. Effluent quality and sampling requirements.

Effluent Discharge Parameter	Limit	Units	Collection Method	Collection Frequency	Reporting Frequency
Flow	79,400	m^3/d	Flowmeter	Daily or continuous	Annually
$CBOD_5$	45	mg/L	Composite	Twice/week	Annually
TSS	45	mg/L	Composite	Twice/week	Annually
Fecal Coliform Organisms	3,200	MPN/100mL	Grab	Twice/month	Annually
Escherichia coli	6,400	e.coli/100 mL	Grab	Twice/month	Annually
Enterococci	1,120	Enterococci/100 mL	Grab	Twice/month	Annually
Ammonia-N	None	mg/L	Composite	Twice/Month	Annually
pH (for determination of un-ionized ammonia)	6-9	pH units	Field measurement and Laboratory analysis of composite samples	With all samples at time of sampling	Annually
Total and Dissolved Metals	None	mg/L	Composite	Monthly	Annually
Toxicity (96 Hr RBT single concentration)	Test must pass in 100% effluent concentration	N/A	Grab	Twice/year (February and September)	Annually
Total Phosphorus	6[1]	mg/L	Composite	Twice/Month	Annually
Orthophosphate	4[1]	mg/L	Composite	Twice/Month	Annually

Table 42. 2024 average effluent sampling results.

Parameter	Operating Limit	Average Value from Sampling Results
pH	6-9	7.5
Ammonia	27.2 mg/L	11.1 mg/L
Carbonaceous Biochemical Oxygen Demand	45 mg/L	13.7 mg/L
Ortho Phosphate (as P)	4 mg/L	1.5 mg/L
Total Phosphorus	6 mg/L	1.8 mg/L
Total Suspended Solids	45 mg/L	9.8 mg/L

5.1 Carbonaceous 5-day Biochemical Oxygen Demand (cBOD5)

Table 43 below documents the monthly average, minimum and maximum cBOD5 concentrations for the 2024 sample program. **Figure 37** shows all effluent CBOD5 data for 2024. A single exceedance of the effluent CBOD5 operating limit of 45 mg/L occurred on August 13, 2024 at 52.60 mg/L. This exceedance was also the maximum recorded cBOD5 concentration for 2024 (**Table 43**). Composite effluent samples were required to be taken twice per week downstream of UV disinfection and prior to discharge. Samples

were taken twice per week with the following exceptions in which samples were taken once per week: first week of January, third week of January, second and fourth weeks of March, first and fourth weeks of April, second week of May, fifth week of June, first and third weeks of July, second week of August, first week of September, first and third weeks of October. No samples were taken during the fourth week of February, fourth week of May, fourth week of August, and second and fourth weeks of December.

Table 43. 2024 monthly cBOD5 concentrations.

Month	Average (mg/L)	Minimum (mg/L)	Maximum (mg/L)
January	9.89	5.98	13.80
February	10.10	6.33	12.20
March	12.86	9.30	17.70
April	12.78	9.15	16.70
May	21.95	11.10	41.60
June	19.27	13.40	26.30
July	10.88	6.55	14.70
August	24.81	7.83	52.60
September	13.64	9.50	16.00
October	11.24	9.00	14.20
November	8.75	6.22	14.40
December	10.58	7.50	13.80
Annual Average	13.89	8.49	21.17

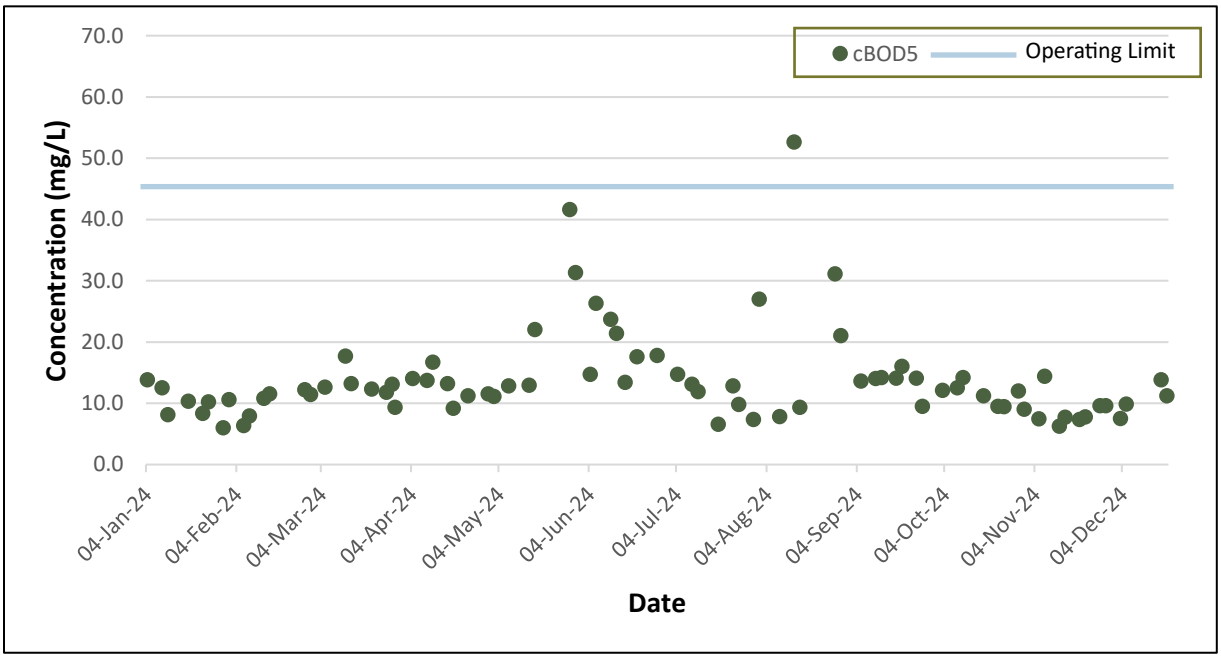


Figure 37. Composite cBOD5 effluent concentrations for 2024.

5.2 Total Suspended Solids (TSS)

Table 44 documents the monthly average, minimum and maximum TSS concentrations for the 2024 sample program. **Figure 38** shows all effluent TSS data for 2024. Effluent TSS concentrations did not exceed the operating limit of 45 mg/L in 2024. The maximum recorded TSS concentration was 37.5 mg/L on June 27, 2024 (**Table 44**). Composite effluent samples were required to be taken twice per week downstream of UV disinfection and prior to discharge. Samples were taken twice per week with the following exceptions in which samples were taken once per week: first week of January, third week of January, second and fourth weeks of March, first and fourth weeks of April, second week of May, fifth week of June, first and third weeks of July, second week of August, first week of September, first and third weeks of October. No samples were taken during the fourth week of February, fourth week of May, fourth week of August, and second and fourth weeks of December.

Table 44. 2024 monthly TSS concentrations.

Month	Average (mg/L)	Minimum (mg/L)	Maximum (mg/L)
January	8.67	4.00	12.00
February	9.15	3.67	13.20
March	10.31	6.25	15.00
April	6.66	4.25	10.30
May	12.01	4.00	33.00
June	21.17	7.67	37.50
July	10.99	5.25	22.00
August	11.17	8.00	14.00
September	6.24	1.30	10.70
October	8.36	4.33	11.00
November	4.79	1.33	7.67
December	8.82	5.67	14.30
Annual Average	9.86	4.64	16.72

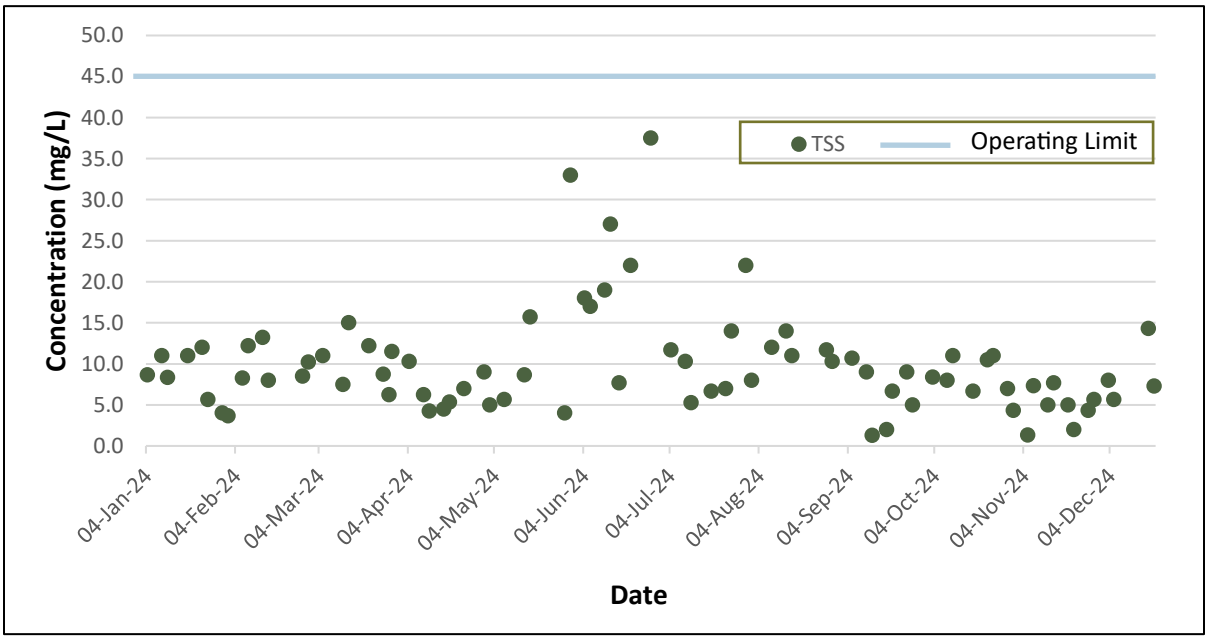


Figure 38. Composite TSS effluent concentrations for 2024.

5.3 Ammonia as Nitrogen (NH_3-N) and Un-ionized Ammonia

Although the Operational Certificate does not provide a guideline for NH_3-N, the 2022 Annual Report provides an upper limit of 27.2 mg/L. **Table 45** documents the monthly average, minimum and maximum NH_3-N concentrations for the 2024 sample program. **Figure 39** shows all 2024 effluent NH_3-N data. Effluent NH_3-N concentrations did not exceed the suggested limit of 27.2 mg/L in 2024. The maximum concentration throughout the year was 20.10 mg/L on September 5, 2024. Composite effluent samples were required to be obtained prior to discharge twice per month. Sampling was conducted twice per month in February, April, May, June, July, September, October, and November, and once per month in January, March, August, and December.

Table 45. 2024 monthly NH_3-N concentrations.

Month	Average (mg/L)	Minimum (mg/L)	Maximum (mg/L)
January	0.00	0.00	0.00
February	7.29	4.82	9.75
March	7.86	7.86	7.86
April	11.73	10.00	12.90
May	12.60	11.30	13.90
June	9.02	7.04	11.00
July	12.17	9.23	15.10
August	10.30	10.30	10.30
September	19.60	19.10	20.10
October	17.35	14.90	19.80
November	7.44	5.95	8.92
December	8.21	8.21	8.21
Annual Average	10.30	9.06	11.49

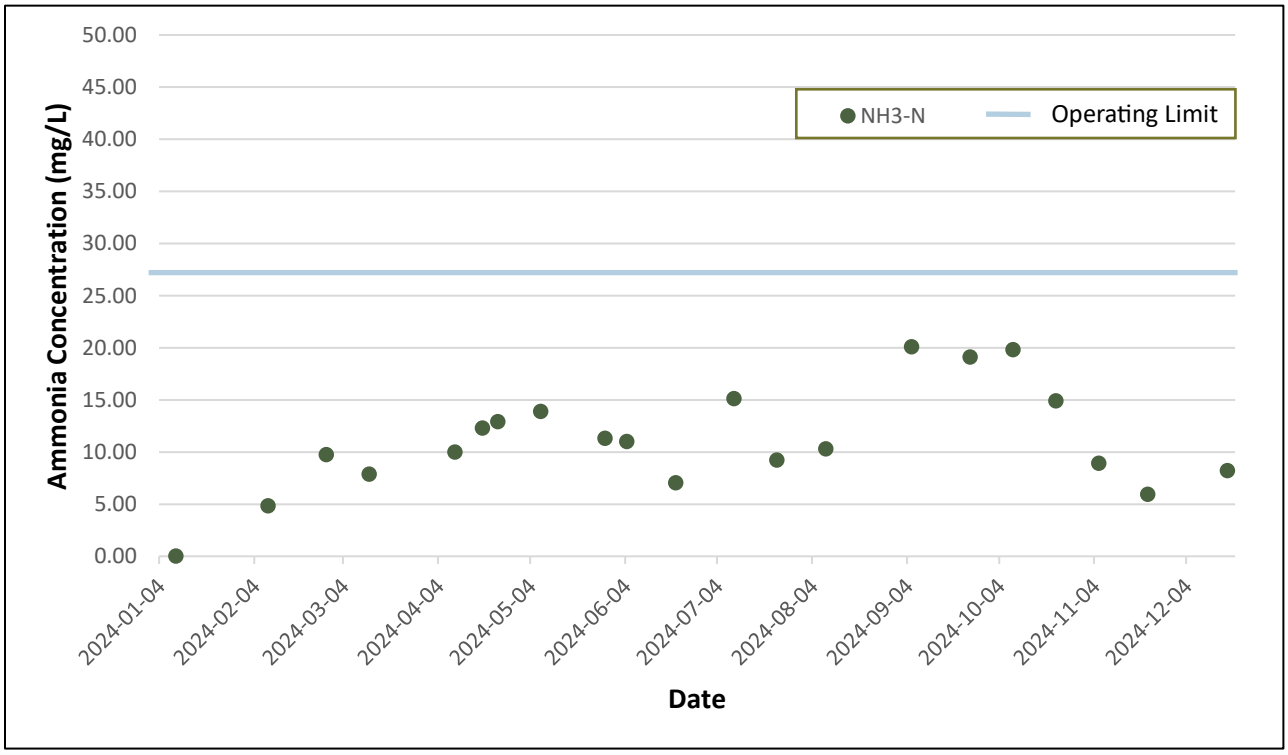


Figure 39. Composite NH3-N effluent samples for 2024.

5.4 pH

The Municipal Wastewater Regulation provides an effluent pH range between 6 and 9. **Table 46** and **Figure 40** shows stable pH values throughout 2024, with an average annual value of 7.53. No maximum pH values exceeded the range of 6-9. The Sampling Plan required pH to be sampled during all events which included sampling for NH_3-N. In 2024, pH values were obtained twice per month in January, February, April, June, July, October, November, and once per month in March, May, August, September, and December.

Table 46. 2024 monthly pH values.

Month	Average (mg/L)	Minimum (mg/L)	Maximum (mg/L)
January	7.84	7.72	7.96
February	7.46	7.15	7.77
March	7.41	7.41	7.41
April	7.32	6.57	7.79
May	7.35	7.35	7.35
June	7.55	7.40	7.70
July	7.45	7.39	7.51
August	7.45	7.45	7.45
September	7.30	7.30	7.30
October	7.75	7.38	8.11
November	7.64	7.35	7.93
December	7.48	7.48	7.48
Annual Average	7.50	7.33	7.65

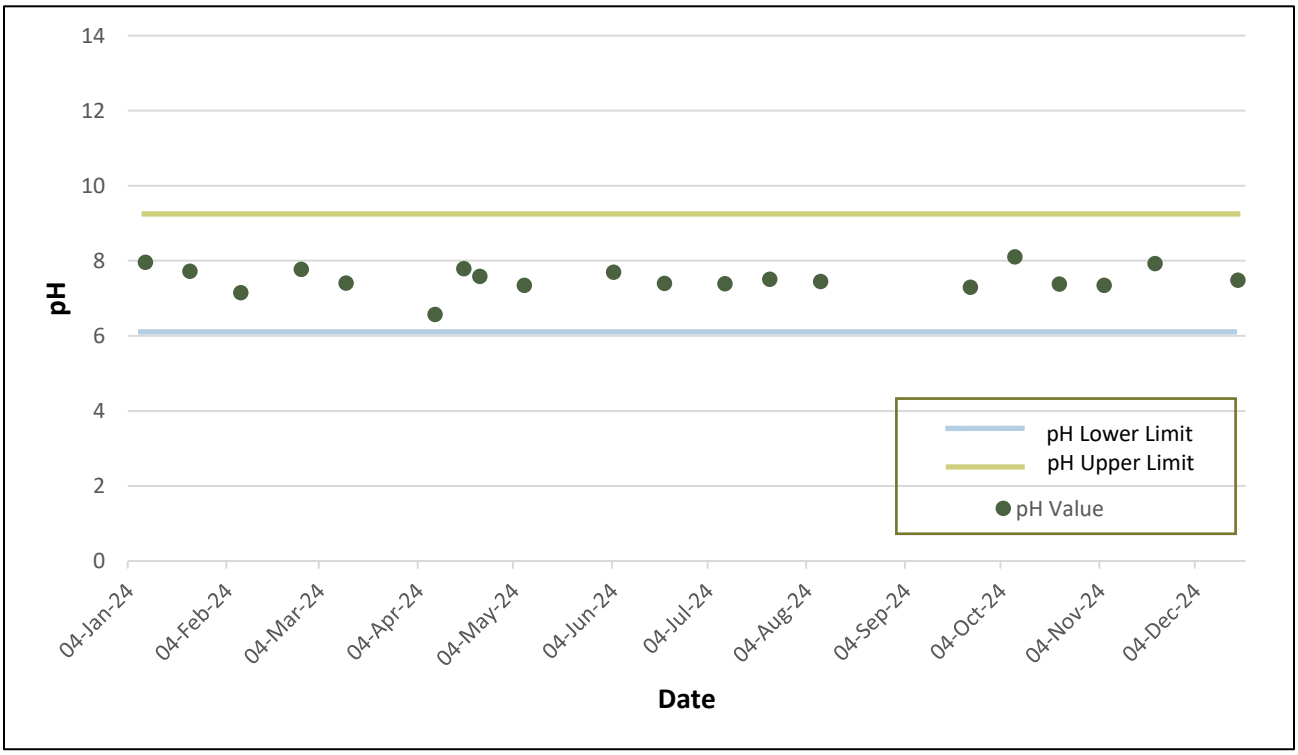


Figure 40. Composite pH effluent monitoring results for 2024.

5.5 Total Phosphorus (TP) and Orthophosphate (PO_4-P)

Total phosphorus data is presented in **Table 47** and **Figure 41**, and orthophosphate data is presented in **Table 48** and **Figure 42**. The Operational Certificate provides limits for Total Phosphorus (TP) and Orthophosphate (PO_4-P) of 6 and 4 mg/L respectively. Maximum TP and PO_4-P concentrations of 3.12 mg/L and 2.89 mg/L respectively occurred on September 15, 2024. TP and PO_4-P effluent concentrations did not exceed operating limits in 2024. Composite effluent samples were required to be obtained prior to discharge for both TP and PO_4-P twice per month. Sampling was conducted twice per month in January, February, April, May, July, September, October, November, and once per month in March, June, August, and December.

Table 47. 2024 monthly TP values.

Month	Average (mg/L)	Minimum (mg/L)	Maximum (mg/L)
January	0.52	0.44	0.59
February	0.71	0.63	0.80
March	1.44	1.44	1.44
April	1.27	1.05	1.42
May	1.91	1.64	2.17
June	2.82	2.82	2.82
July	2.65	2.62	2.68
August	3.09	3.09	3.09
September	3.03	2.94	3.12
October	2.46	2.11	2.80
November	1.04	0.78	1.29
December	0.95	0.95	0.95
Annual Average	1.82	1.71	1.93

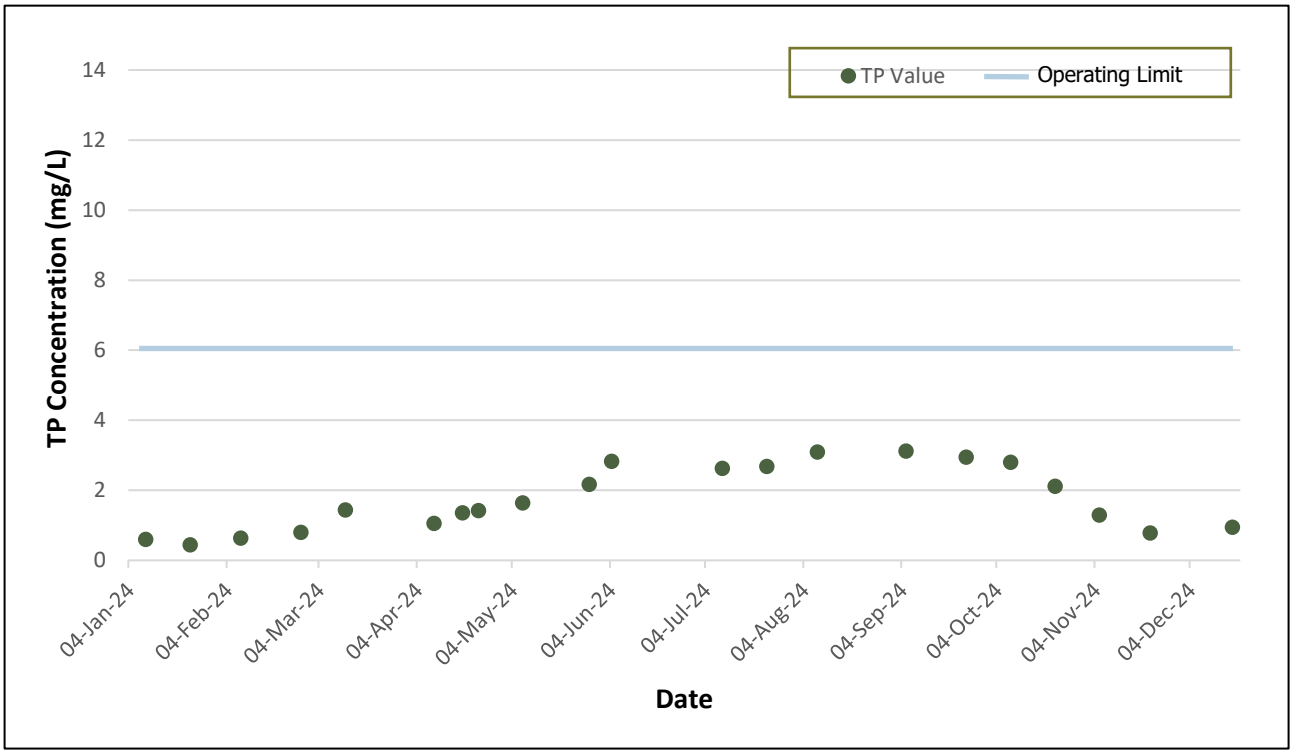


Figure 41. Composite TP effluent monitoring results for 2024.

Table 48. 2024 monthly PO_4-P values.

Month	Average (mg/L)	Minimum (mg/L)	Maximum (mg/L)
January	0.47	0.47	0.47
February	0.50	0.36	0.63
March	0.63	0.63	0.63
April	1.07	0.93	1.31
May	1.50	1.34	1.66
June	1.44	1.20	1.67
July	2.28	2.17	2.39
August	2.56	2.56	2.56
September	2.74	2.60	2.87
October	2.04	1.47	2.61
November	0.92	0.71	1.13
December	0.79	0.79	0.79
Annual Average	1.41	1.27	1.56

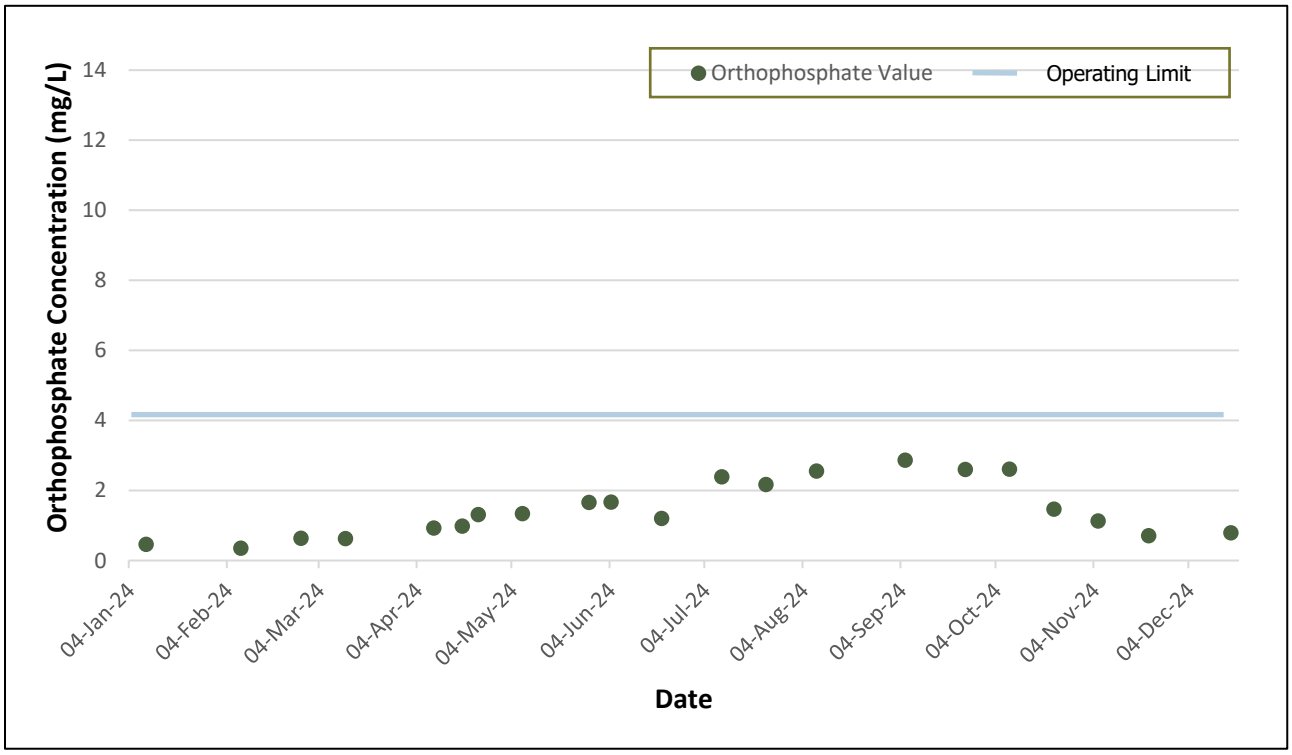


Figure 42. Composite PO4-P effluent monitoring results for 2024.

5.6 Microbiological Parameters - Enterococci, E.Coli, Fecal Coliforms

The Operating Certificate requires grab sampling of the following microbiological parameters twice per month: *Enterococcus* sp., E.coli, and fecal coliforms. Average sampling results and operating limits for each parameter are provided in **Table 49**. Averaged results for fecal coliforms were heavily skewed by a singular exceedance of 8600 CFU/100mL which occurred on October 22, 2024. An elevated result for E.coli (5600 CFU/100mL) also occurred on October 22, 2024 and skewed the E.coli average. Otherwise, **Figures 43-45** depict all microbiological parameters remaining within operating limits in 2024. Sampling occurred twice per month in January, February, April, May, June, July, September, October, November and once per month in March, August, and December.

Table 49. 2024 average effluent sampling results for microbiological parameters.

Parameter	Operating Limit	Average Value from Sampling Results
Enterococcus sp.	1120 CFU/100 mL	43 CFU/100 mL
E.Coli	6400 CFU/100 mL	238 CFU/100 mL
Fecal Coliforms	3200 CFU/100 mL	440 CFU/100 mL

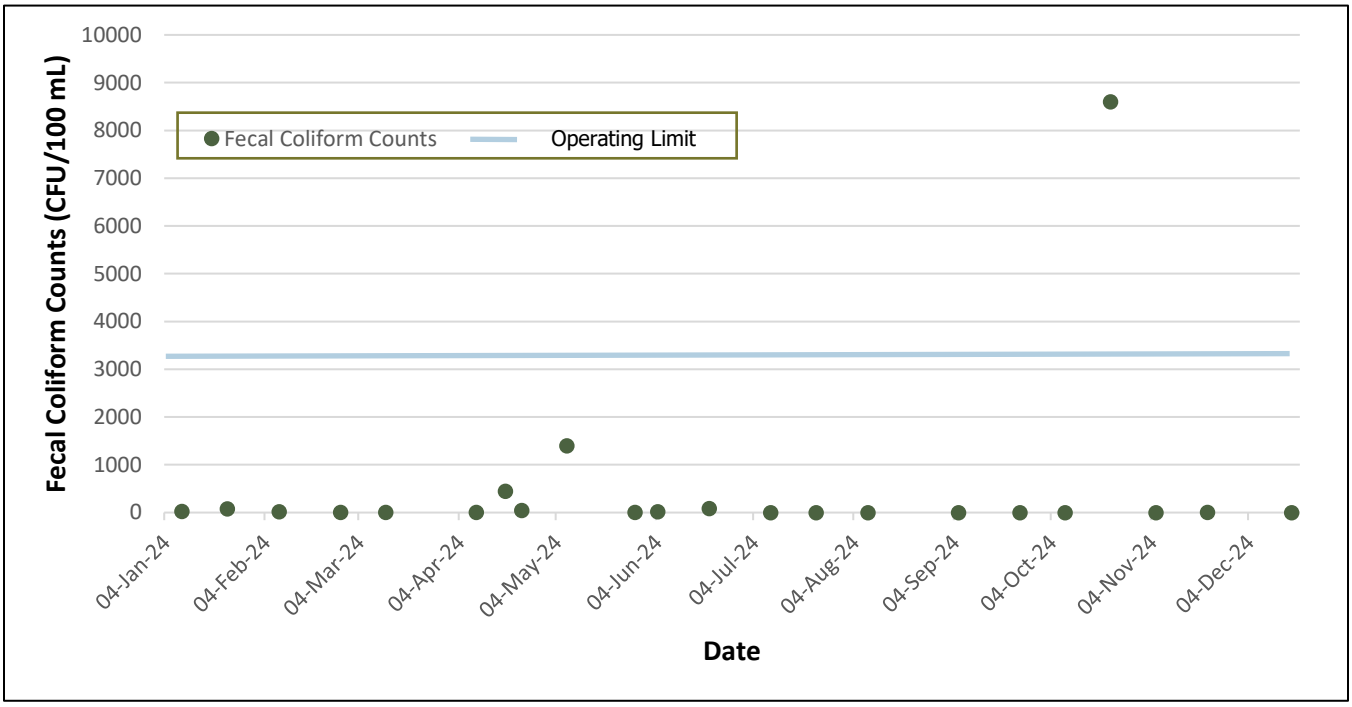


Figure 43. Fecal coliform effluent monitoring results for 2024.

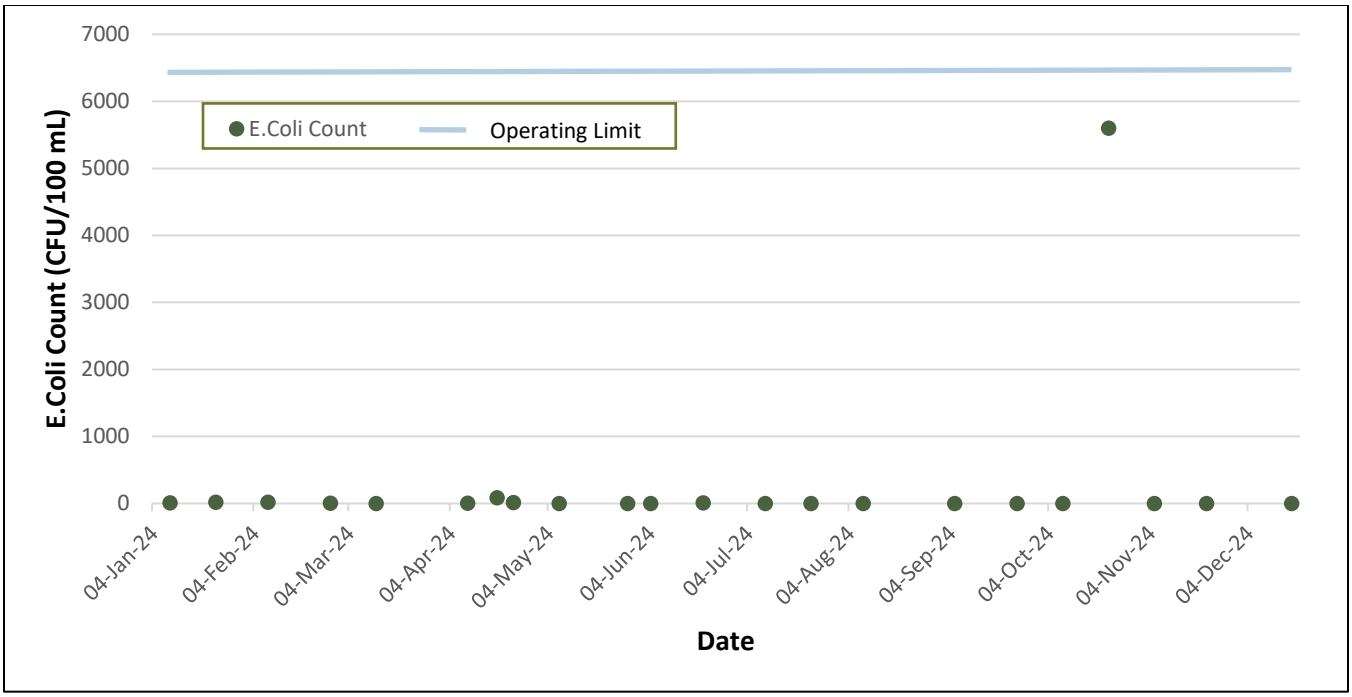


Figure 44. E.coli effluent monitoring results for 2024.

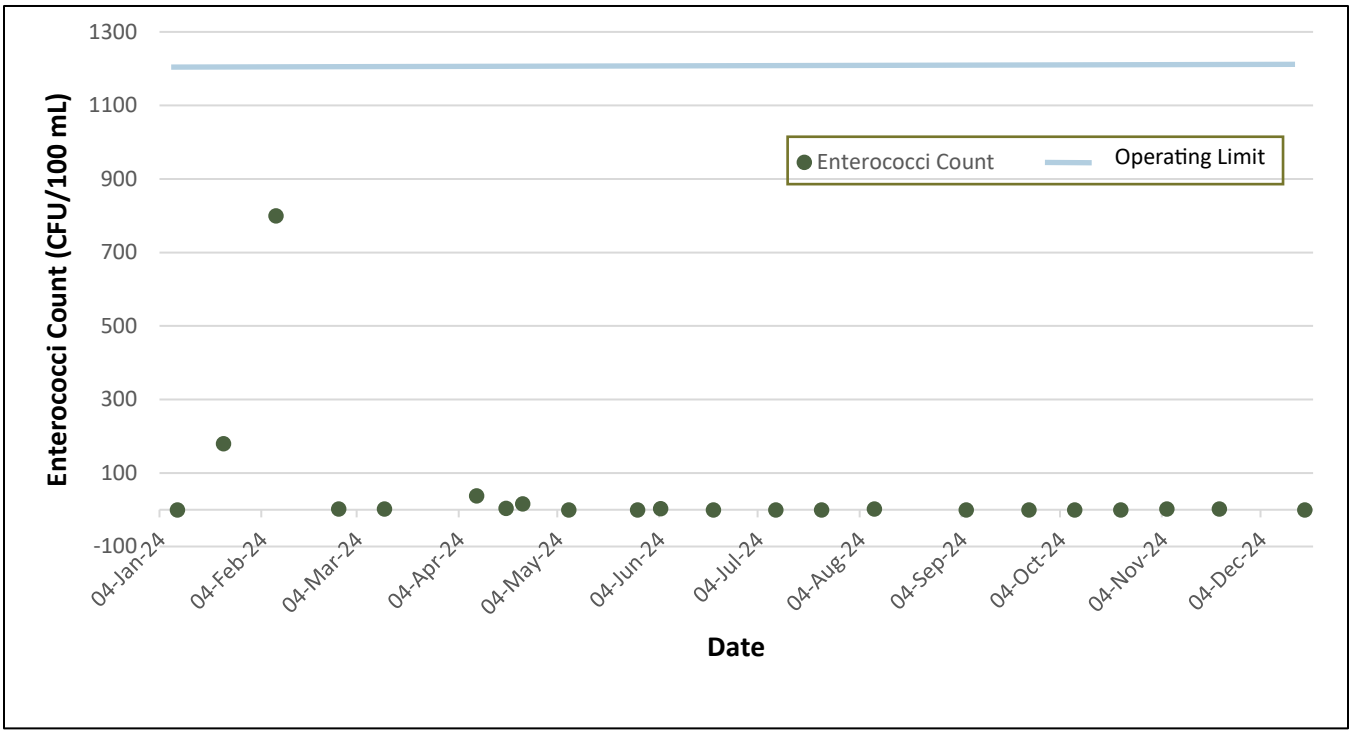


Figure 45. Enterococci effluent monitoring results for 2024.

5.7 Effluent Toxicity (LC50)

Effluent grab samples for acute toxicity testing were tested twice in 2024; once in February and once in September. In both tests, after 96 hours of exposure, the effluent samples passed with no observed mortality of rainbow trout (0% mortality). Both samples were analyzed by Nautilus Environmental.

5.8 Total & Dissolved Metals

The Operational Certificate requires total and dissolved metals to be sampled monthly. Sampling occurred monthly at a minimum, however samples were taken twice per month in January, February, April, May, June, July, October, and November. **Table 50** below summarizes average and maximum effluent sampling results for 2024. The Operating Certificate does not provide operating limits for metals.

Table 50. Average and maximum effluent sampling results for 2024.

Metal	Dissolved Metal Concentration		Total Metal Concentration	
	Average	Maximum	Average	Maximum
Aluminum (mg/L)	0.149	0.254	0.212	0.373
Antimony (mg/L)	<0.500	0.503	<0.500	<0.500
Arsenic (ug/L)	0.685	1.110	0.705	1.200
Barium (ug/L)	0.014	0.032	0.020	0.084
Beryllium (mg/L)	<0.003	<0.003	<0.003	<0.003
Boron (mg/L)	0.663	1.120	0.681	1.170
Cadmium (ug/L)	<0.010	<0.010	<0.010	<0.010
Calcium (mg/L)	38.876	63.800	40.981	68.900
Chromium (mg/L)	<0.003	0.003	0.004	0.004
Cobalt (mg/L)	<0.005	<0.005	0.011	0.011
Copper (mg/L)	0.020	0.059	0.026	0.061
Gold (mg/L)	<0.040	<0.040	<0.040	<0.040
Iron (mg/L)	0.160	0.464	0.305	0.710
Lanthanum (mg/L)	<0.020	<0.020	<0.020	<0.020
Lead (ug/L)	1.203	1.970	0.835	2.200
Magnesium (mg/L)	40.119	76.400	41.648	77.000
Manganese (mg/L)	0.087	0.229	0.118	0.269
Mercury (ug/L)	<0.010	<0.010	<0.010	<0.010
Molybdenum (mg/L)	<0.005	0.005	0.049	0.078
Nickel (mg/L)	0.007	0.011	0.017	0.062
Phosphorus (mg/L)	1.097	2.430	1.331	2.210
Potassium (mg/L)	25.718	56.400	26.989	55.400
Scandium (mg/L)	<0.050	<0.050	<0.050	<0.050
Selenium (ug/L)	<0.500	<0.500	<0.500	<0.500
Silicon (mg/L)	5.188	8.560	5.830	10.000
Silver (mg/L)	<0.010	<0.010	<0.010	<0.010
Sodium (mg/L)	435.571	953.000	467.276	969.000
Strontium (mg/L)	0.243	0.530	0.289	0.550
Tin (mg/L)	<0.020	<0.020	0.022	0.036
Titanium (mg/L)	<0.010	<0.010	0.045	0.077
Tungsten (mg/L)	<0.050	<0.050	<0.050	<0.050

Vanadium (mg/L)	<0.010	<0.010	0.126	0.175
Zinc (mg/L)	0.049	0.152	0.070	0.193

5.9 Summary of Effluent Flow

Continuous monitoring of effluent discharge is conducted by a flow meter located on the outlet of the UV disinfection building. Measurements for level (mm), velocity (m/s), temperature (C°), and flow (l/s) were recorded every 30 seconds. Under the Operational Certificate the maximum rate of effluent discharge is 79,400 m³ per day. A *Warning Letter* (the "Warning Letter") from the Province of BC dated December 3, 2024 and addressed to the City of Port Alberni referenced the January 2024 flowmeter data as corrupted and unavailable. It was also stated to Roe by CoPA that flow meter data is collected when the effluent pumps are off and the valves are closed. Since the function of the flowmeter was impacted in 2024, the status of the data shown in **Table 51** below is unconfirmed.

Average daily discharge, minimum and maximum daily discharge, and total effluent volume by month are presented in **Table 51**. The 2024 average annual flow rate was 12,167 m³/d. The maximum recorded daily flow was 59,219 m³/d on October 27, 2024. In 2024 there were no exceedances of the daily flow maximum of 79,400 m³/d.

Table 51. Summary of Effluent Flow.

Month	Average Daily Discharge (m³/d)	Minimum Daily Discharge (m³/d)	Maximum Daily Discharge (m³/d)	Total Effluent Volume (m³)
January	21,894	2,295	37,917	678,712
February	15,959	415	42,442	462,811
March	15,870	478	41,879	491,975
April	8,672	448	25,529	260,158
May	6,130	379	22,099	190,027
June	7,697	152	32,083	230,915
July	4,748	543	12,074	147,190
August	4,564	336	17,465	141,469
September	4,388	245	32,227	131,648
October	21,894	498	59,219	678,712
November	21,442	361	43,407	664,699
December	17,926	551	12,166	555,706
Annual	12,167	152	59,219	4,634,021

6 COMPARISON TO PREVIOUS DATA AND RECOMMENDATIONS

6.1 Marine Receiving Environment Quarterly and 5-in-30

Elevated levels and exceedances which occurred during the 2024 marine quarterly and 5-in-30 sampling are discussed below. Elevated levels are placed within the context of previous results. Past exceedances specifically mentioned within the Warning Letter are discussed. Recommendations for resolving these elevated levels and exceedances are included.

6.1.1 Boron

Elevated boron results aligned with results reported by AE in 2018, 2019, 2020 (AE, 2021), 2022 (AE, 2023), and Roe in 2023. AE (2024) proposed that Boron exceedances may reflect natural conditions in the Somass Estuary and Roe supports this statement. Past exceedances for Boron were specifically noted in the Warning Letter. Roe concludes that elevated levels of Boron are naturally occurring in the marine/estuarine environment, they do not require further investigation, and they should not be viewed as exceedances.

6.1.2 Copper

Singular exceedances for copper occurred in both the quarterly and 5-in-30 samples. AE's 2022 sampling yielded similar singular exceedances (AE 2024b). The pre-discharge vs post-discharge comparison showed lower copper concentrations in post-discharge samples (AE 2024b).

Roe recommends that copper monitoring be continued to ensure exceedances are detected. Reinitiation of landfill influent sampling at the WWTF will better determine copper concentrations at the lagoon prior to discharge.

6.1.3 pH

pH measurements out of guideline range were detected during quarterly marine sampling events (Q1, Q2, and Q4). These exceedances included pH values of lower than 7.0 and 6.5. Exceedances were also detected at Site H during 5-in-30 sampling (one below 7.0 and two above). In 2022, all pH exceedances occurred above the upper limit of 8.7 (AE, 2023). Roe concludes exceedances which occurred at the downstream sites are unlikely to be related to WWTF effluent discharge. When levels below the recommended guideline occurred at stations C1-C2 and H1-H2 during Q4 sampling (December 17, 2024), the sampling result for the lagoon prior to discharge on the same day was 7.48, which is within the acceptable range (**Figure 46**). It should also be noted that Site H is a primarily freshwater site located upstream from the estuary in the Somass River. No trend is detected within in-situ pH measurements over the years, and briefly lowered or elevated levels are not expected to impact aquatic organisms.

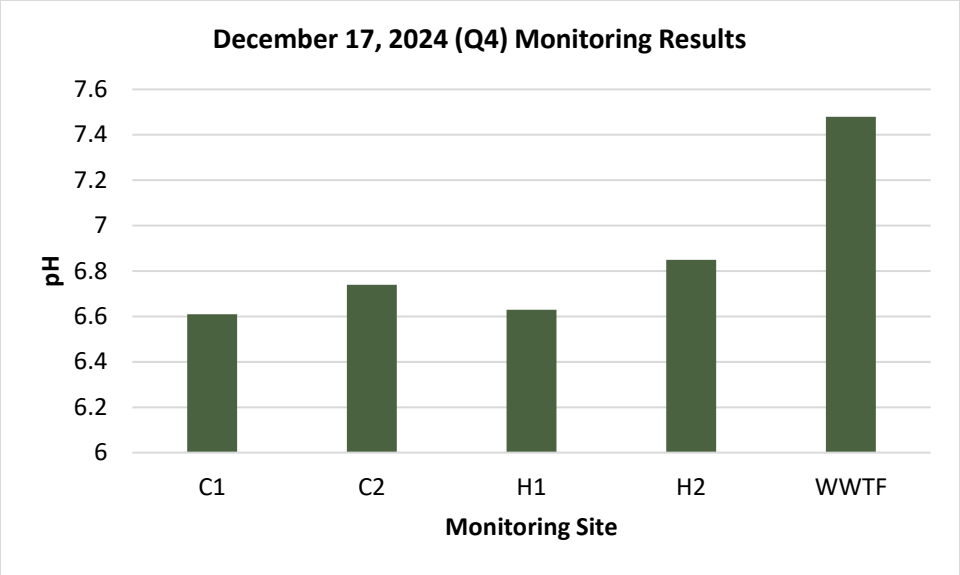


Figure 46. Comparison of Q4 pH sampling results for marine REMP and WWTF lagoon.

6.1.4 Dissolved Oxygen

Low DO has been historically detected in the Alberni Inlet in the summer and fall, as a function of natural processes and the fibre mat at the bottom of the inlet (AE, 2023). During quarterly marine sampling in 2024, a single exceedance occurred at F2 (reference site) and two exceedances occurred at D3 (downstream site). These exceedances occurred below the halocline. During 5-in-30 sampling, exceedances also occurred at F2 and D3, with an additional exceedance at E2 (reference site). Similar results were seen in 2022 and 2023, with exceedances at both the reference and downstream sites. Throughout all sampling years, DO measurements are consistently lower below the halocline. Roe concludes these results are due to normal decreases in dissolved oxygen which occur with depth, they cannot be specifically attributed to the WWTF, and they should not be viewed as exceedances. They are not expected to impact aquatic organisms. Past elevated levels for DO were specifically noted in the Warning Letter.

6.1.5 Phosphorus

Elevated phosphorus levels consistently occurred throughout Q2 and Q3 marine sampling, and throughout nearly all samples during the 5-in-30 event. These results are consistent with 2022 (AE 2024b) and 2023. Elevated phosphorus was observed in pre-discharge sampling at several sites and was observed elevated at reference stations in the 2022 sampling (AE 2024b). Due to elevated levels within both the downstream and reference sites, Roe concludes that the elevated phosphorus levels are not attributed to the WWTF. Past elevated levels of phosphorus were specifically noted in the Warning Letter.

6.1.6 Enterococcus

During quarterly marine sampling, elevated enterococcus levels occurred at I2 in Q3 and at 10 of 19 sites in Q4. Elevated levels also occurred at Site I during the 5-in-30 sampling event. These levels do not appear to be solely associated with the WWTF because effluent monitoring results from CPA's lagoon prior to discharge show enterococcus to be consistently low (**Figure 45**). While exceedances occurred at 10 marine stations during Q4 sampling (December 17, 2024), the sampling result for the lagoon prior to discharge on the same day was 0.0 CFU/100 mL, and results were 0.02 CFU/100 mL on both November

5 and November 21 (**Figure 47**). Roe concludes elevated levels should therefore not be viewed as exceedances specific to WWTF effluent discharge.

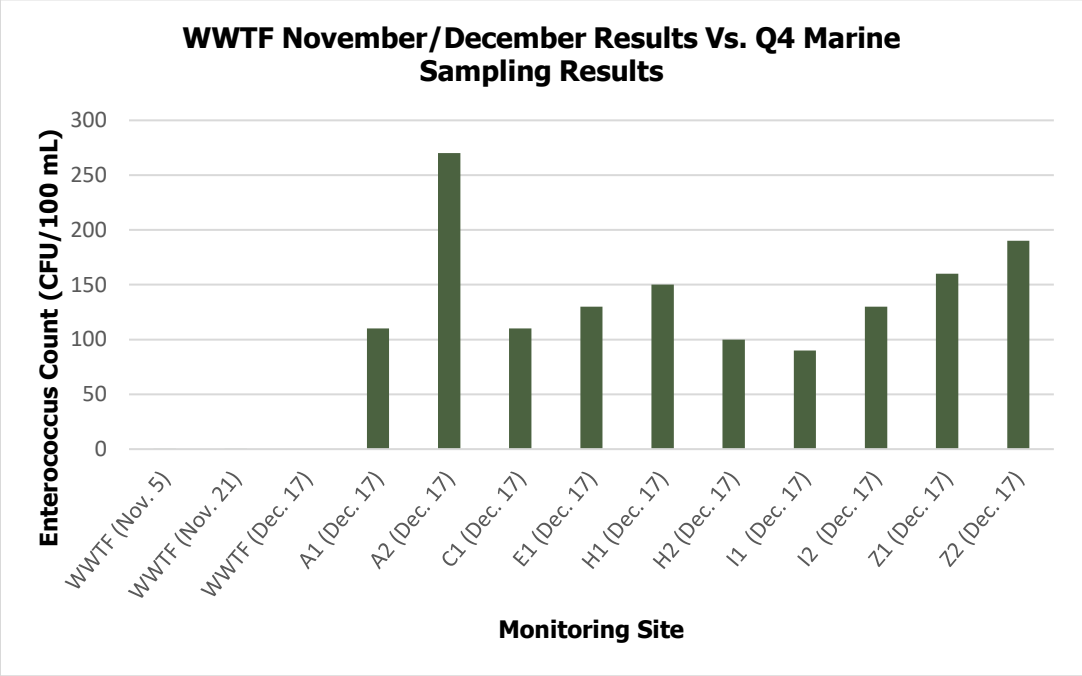


Figure 47. Comparison of Q4 enterococcus sampling results for WWTF lagoon (November 5, November 21, December 17) and marine REMP (December 17).

Elevated enterococci levels were also detected during marine sampling in November/December in 2022 and December 2023. AE (2023) hypothesized that elevated levels from November/December 2022 may be associated with enterococci having more nutrients to consume from post salmon-spawn mortality. AE (2021) also hypothesized that marine and freshwaters sediments can be significant sources or reservoirs of enterococci. Wildlife such as Canada geese are also commonly observed near the tidal channels in the estuary. Elevated levels at Site I may also be related to sewage discharge from boats near the marina. Roe recommends that monitoring for enterococcus continue, with emphasis on reviewing monitoring results in December.

6.2 Tidal Channels, Groundwater, Piezometer

Elevated levels and exceedances which occurred during the 2024 tidal channel, groundwater, and piezometer sampling are discussed below, and elevated levels are placed within the context of previous results. AE (2021) previously stated that groundwater sampling should occur at quarterly intervals for three years after operation begins. Groundwater results from 2022 and 2024 show that there has been little to no impact from the effluent on the environment surrounding the WWTF. If groundwater results from 2025 also show similar results, it is recommended that groundwater sampling be discontinued for 2026.

6.2.1 Ammonia

In 2024, all tidal channel samples were within BCWQG adjusted guideline limits for ammonia. This trend remains consistent; pre-discharge and post-discharge total ammonia concentrations within tidal channels were all within applicable guideline limits (AE 2024b).

The highest total ammonia concentrations in 2024 during groundwater and tidal channel sampling were observed at MW21-2, MW21-3A, and MW21-3B, which is overall consistent with pre-discharge and post-discharge results; the highest concentrations of total ammonia have been observed in previous years at MW21-2 and MW21-3B. The 2024 results differ slightly from pre-discharge and post-discharge results because the highest total ammonia concentration was observed within MW21-3A in 2024.

Concentrations of total ammonia at the other sample sites in pre-discharge and post-discharge samples, including 2024, were observed to be generally low and within similar ranges year to year.

Roe concludes that the elevated levels in the monitoring wells cannot be solely attributed to the WWTF effluent. There were elevated levels in all the monitoring wells in 2024, except for the reference well, which does indicate a potential influence from the WWTF effluent. However, the elevated levels were only marginally exceeding the BC CSR pH adjusted guideline for total ammonia (ex. the concentration at MW21-3B in Q3 was 18.7 mg/L and had a pH adjusted BC CSR guideline of 18.4 mg/L, i.e. a difference of 0.3 mg/L; Table 22). Additionally, the maximum total ammonia concentration from the WWTF effluent in 2024 was 20.1 mg/L in September (Table 45), which was *lower* than the maximum total ammonia concentration in the monitoring wells (21.8 mg/L at MW21-3A in September; Table 22). Because there are consistently elevated levels in the monitoring wells as compared to the reference well, this trend should be continued to be investigated in 2025, however, there is evidence that there may be factors influencing the total ammonia concentrations in the monitoring wells other than the WWTF effluent. Roe recommends that monitoring for total ammonia continue in 2025, with emphasis on determining potential outside factors and continued review of effluent results.

6.2.2 Total Phosphorus

Elevated total phosphorus levels consistently occurred throughout 2024 and pre-discharge and post-discharge sampling events at sites MW21-3A and MW21-3B. Concentrations of total phosphorus at the other sample sites were observed to be generally within similar ranges year to year. Due to the lack of an applicable guideline, Roe concludes that these elevated levels cannot be solely attributed to the WWTF and should not be viewed as exceedances. Monitoring will continue in 2025 to determine why concentrations have been observed to be higher in the monitoring wells at the southwest corner of the lagoon (MW21-3A, 3B).

6.2.3 Nitrate

Nitrate (as N) is considered to be an indicator parameter of effluent seepage (AE 2024b). In all pre-discharge and post-discharge samples, including 2024 samples, nitrate concentrations are consistently very low, with little to no variation in concentration ranges year to year or between sample sites, and there have been no exceedances observed to date. Roe concludes that there is no impact from the WWTF effluent in relation to nitrate levels in the groundwater and tidal channels.

6.2.4 Dissolved Chromium

Dissolved chromium concentrations were less than the laboratory detection limits and/or less than the guideline limits for all pre-discharge and post-discharge samples, including samples collected in 2024. However, it is noted that in pre-discharge sampling events, dissolved metals were not analyzed at tidal channel and piezometer sites, except for P1 in 2021. Concentrations of dissolved chromium were highest at sample sites MW21-2, MW21-3A, and P1 in 2024, and highest at sample site P1 in pre-discharge (2021) and post-discharge (2022) samples (AE 2024b).

6.2.5 Dissolved Boron

The highest and lowest dissolved boron results reported by AE in pre-discharge and previous post-discharge sampling results align with the 2024 results; concentrations were highest at T3 and lowest at MW21-1. It is noted that in 2024 there was a single elevated dissolved boron measurement during all groundwater and tidal channel sampling events; 1.58 mg/L at T3 in Q3. This could be due to the T3 channel being narrow which could limit flushing and concentrate dissolved metals and nutrients in this area (AE 2024b). Concentrations of dissolved boron at the other sample sites in pre-discharge and post-discharge samples were varied, but were observed to be generally within similar ranges year to year.

As shown in the marine sampling sections, boron is found to be elevated at the reference stations. Roe concludes that elevated levels of boron in the tidal channels are naturally occurring in the marine/estuarine environment, they do not require further investigation, and they should not be viewed as exceedances.

6.2.6 Enterococcus

Enterococcus has not been consistently analyzed within groundwater and tidal channels throughout pre-discharge and post-discharge sampling events, and/or the data available at the time of writing this report was limited; therefore, it is difficult to discuss spatial and temporal trends. There are no monitoring well sample results from 2020 as the monitoring wells were installed in May 2021. The results following monitoring well installation and sampling in May 2021 are summarized in a report (AE 2021) that was not made available to Roe at the time of this report. In 2022, there were no reported groundwater or tidal channel exceedances of Enterococcus (AE 2024b).

In December 2023, concentrations of enterococcus were found to be exceeding the Health Canada BAV of 70 CFU/100 mL at sample sites MW21-3A (104 CFU/100 mL) and MW21-3B (119 CFU/100 mL). This trend was partially repeated in 2024; enterococcus concentration exceeded the guideline at MW21-3B in December 2024 (140 CFU/100 mL). The remaining results from 2024 differ; the highest enterococcus concentrations were observed at sample sites T1, T2, and T3. However, when comparing elevated enterococcus results in the tidal channels from the September 5-in-30 sampling event and the Q3/Q4 sampling events with WWTF enterococcus results for the relevant time periods, these levels do not appear to be solely associated with the WWTF (**Figure 48 and Figure 49**). Effluent monitoring results from CPA's lagoon prior to discharge show enterococcus to be consistently lower than the values observed in the monitoring wells and tidal channels (**Figure 48 and Figure 49**).

The cause of the elevated levels in the monitoring wells could be attributed to historic or local biophysical factors which allow for in-situ growth and retention of the bacteria within the sediment surrounding the monitoring wells. Numerous studies have shown that marine and freshwater sediments are both sources and reservoirs of enterococci, containing much higher bacterial densities than what is seen in the surrounding water (Byappanahalli et al. 2012). Other identified sources of enterococci include algal mats, decaying seaweed, and submerged aquatic vegetation, which in addition to potential fecal inputs from local wildlife that frequent the area such as Canada Geese, could explain why there were much higher enterococci levels in the tidal channels (Byappanahalli et al. 2012).

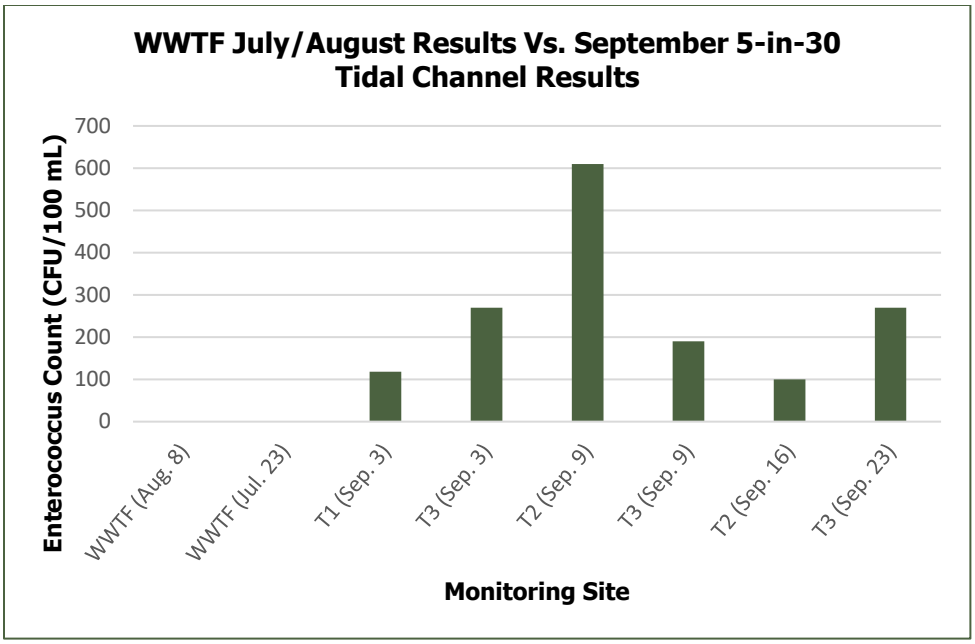


Figure 48. Comparison of enterococcus results for the WWTF (July/August) and September 5-in-30 tidal channels.

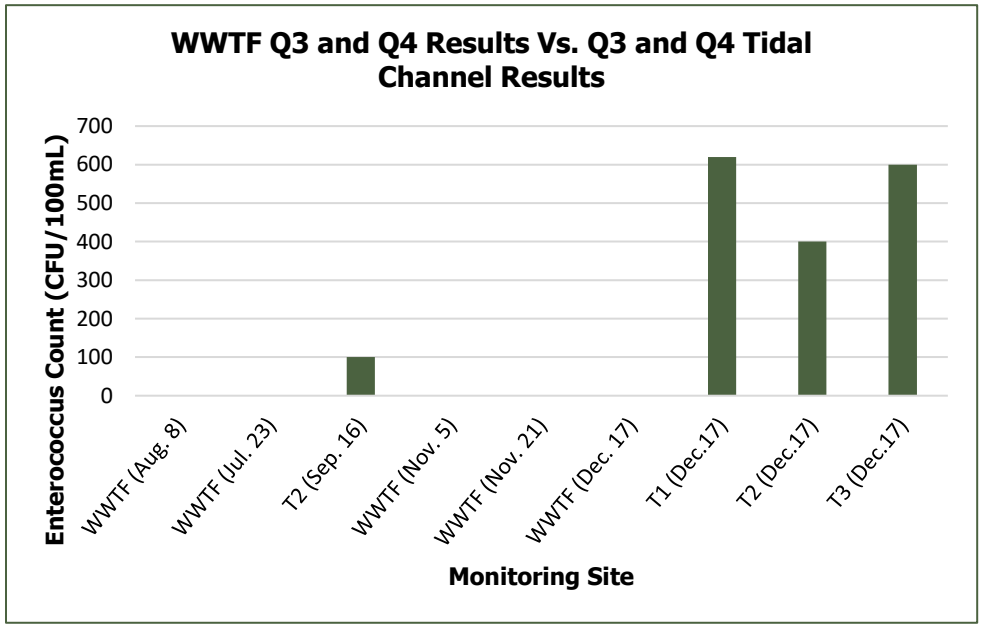


Figure 49. Comparison of enterococcus results for the WWTF (Q3/Q4) and tidal channels (Q3/Q4).

7 CONCLUSION

Section 4.5 of the OC requires the following items to be addressed as components of the Annual Report. Based on the 2024 data, Roe opines the following with regards to each item:

The operational certificate holder must, by March 31st of each year, submit to the director an Annual Report that includes, but is not limited to:

a) A compendium of the municipal effluent flow, municipal effluent quality and receiving environment monitoring data;

This report summarizes municipal effluent flow, municipal effluent quality, and receiving environment monitoring data for 2024.

b) A discussion of the impact of landfill leachate on effluent quality;

No impacts of landfill leachate on effluent quality were observed.

c) A statement outlining the number of non-compliance with the authorization requirements that occurred during the reporting period, the dates of each such non-compliances, an explanation as to the cause of the noncompliance, and a description of the measures taken by the operational certificate holder to rectify the cause of each such non-compliance. If compliance occurred over the reporting period, the required statement must indicate that no non-compliances of the authorization occurred during the reporting period;

Elevated levels of specific parameters are addressed throughout the report. Rationale for why elevated levels may or may not be considered exceedances are included.

d) A comparison of receiving environment monitoring results to the appropriate Water Quality Guidelines and a discussion of the effect of any exceedances on the quality of the receiving environment, using appropriate statistical and graphical analysis;

Comparison of the receiving environment monitoring results to the appropriate Water Quality Guidelines and a discussion of the effect of these exceedances on the quality of the receiving environment is addressed throughout the report.

e) Include summary tables of parameters discussed to relate data spatially and to data compare between sites and over time for parameters discussed;

This is included within the report.

f) Any trends in environmental quality in the receiving environments affected by the discharge, using background and pre-discharge data and all the years of record in which the discharge has taken place;

This is included within the report.

g) All laboratory reports of data collected under this authorization;

Laboratory reports are included within the report (Appendix F).

h) A summary of all quality assurance/quality control (QA/QC) issues during the calendar year;

QA/QC issues during 2024 are included within the report (Appendix D).

i) Include recommendations from the Plan Monitoring Committee and how they have been addressed including copies of the Plan Monitoring Committee minutes;

Nothing to report for 2024.

j) An evaluation of the performance of the authorized works and any planned improvements of wastewater facilities for the coming year;

Similar to 2024, the WWTP is operating and providing quality treatment, however CPA has experienced process control issues requiring further operator involvement and manual control. CPA are currently investigating solutions and plan to replace the entire SCADA control system including the programmable logic controllers and logic in 2025.

Measurement difficulties have been encountered with the effluent flow meter that was installed during construction, with replacement of the flow meter scheduled for 2025.

k) Discuss any implementation of managed release of effluent during ebbtides for the previous year;

From Late July until September, the WWTP operator operated the effluent pumps manually to flow effluent between the hours of 8:00 am - 4:00 pm and during the ebb tide only, and never during the slack or flood tide. There is limited confidence in the process-controlled tide sensor or tide chart system, and after the SCADA upgrades it is hoped that this process will be automated.

l) Discuss any implementation of the trigger response plan for the non-point source discharge the previous year;

Nothing to report for 2024.

m) Outfall inspection report, when applicable;

Nothing to report for 2024.

n) Updated dilution modelling, when applicable;

Nothing to report for 2024.

o) Stormwater management plan, when applicable;

Nothing to report for 2024.

p) Combined sewer overflow elimination report, when applicable;

Nothing to report for 2024.

q) A revised Operating Plan and/or Contingency Plan and/or Plan Monitoring Committee Terms of Reference, when applicable.

Nothing to report for 2024.

8 APPLICATION AMENDMENT

Roe proposes that the following amendments be made to Operational Certificate 110576.

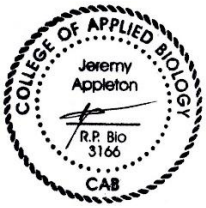
- The tidal channel sampling component of *Wastewater Treatment System Upgrades Pre-discharge and Operational Receiving Environment Monitoring Program* (AE, 2021) should be removed due to significant influence from the marine environment, made apparent by enterococcus concentrations (Section 6.2.6). Tidal channel data is not an effective measure to determine the impact of lagoon seepage on the marine environment. Program focus should remain on IDZ site and groundwater monitoring.
- The vegetation monitoring component of *Wastewater Treatment System Upgrades Pre-discharge and Operational Receiving Environment Monitoring Program* (AE, 2021) should be removed due to influencing variables which may contribute to plant mortality but cannot be separated from lagoon seepage. Furthermore, the majority of sites are significantly overgrown with invasive plants and re-establishment of the sites is not recommended due to undetermined benefit.
- Unless future results differ significantly, total and dissolved boron, total phosphorus, and dissolved oxygen levels in the marine, groundwater, and tidal channel environments should be considered reflective of existing marine and groundwater environments and should not be considered exceedances.

9 ENDORSEMENT

Roe Environmental Inc.

Prepared by:

The undersigned certifies the work described herein fulfils standards acceptable of a Registered Professional Biologist.



[Digital Copy, Original Signed]

Jeremy Appleton, RP Bio, ISA Arborist

Senior Biologist

Prepared by:

The undersigned certifies the work described herein fulfils standards acceptable of a BIT.

[Digital Copy, Original Signed]

Danae Shephard, BIT

Project Biologist

Reviewed by:

The undersigned certifies the work described herein fulfills standards acceptable of a Registered Biology Technologist.

[Digital Copy, Original Signed]

Blake Aleksich, RB Tech

Project Manager

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APPENDIX A: THE OPERATIONAL CERTIFICATE

March 7, 2022

Tracking Number: 398941
Authorization Number: 110576

REGISTERED MAIL

CITY OF PORT ALBERNI
4850 ARGYLE ST
PORT ALBERNI, BC
V9Y 1V8

Dear Operational Certificate Holder:

Enclosed is Operational Certificate 110576 issued under the provisions of the *Environmental Management Act*. Your attention is respectfully directed to the terms and conditions outlined in the operational certificate. An annual fee will be determined according to the Permit and Approval Fees and Charges Regulation.

Archaeological sites, whether known or undocumented are protected under the Heritage Conservation Act and must not be damaged or altered without a permit from the Archaeology Branch. If an archaeological site is disturbed without a permit, halt activities and immediately inform the Provincial Archaeology Branch. If you have any questions about the protection of archaeological sites please contact the Archaeological Branch at 250-953-3334.

This operational certificate does not authorize entry upon, crossing over, or use for any purpose of private or Crown lands or works, unless and except as authorized by the owner of such lands or works. The responsibility for obtaining such authority rests with the operational certificate holder. It is also the responsibility of the operational certificate holder to ensure that all activities conducted under this authorization are carried out with regard to the rights of third parties, and comply with other applicable legislation that may be in force.

When a spill occurs, or there is an imminent risk of one occurring, the responsible person must ensure that it is reported in accordance with the Spill Reporting Regulation, which among other things, requires notification to Emergency Management BC at 1-800-663-3456. Additional information on spill reporting requirements is available at gov.bc.ca/reportaspill

This decision may be appealed to the Environmental Appeal Board in accordance with Part 8 of the *Environmental Management Act*. An appeal must be delivered within 30 days from the date that notice of this decision is given. For further information, please contact the Environmental Appeal Board at (250) 387-3464.

Administration of this operational certificate will be carried out by staff from the Environmental Protection Division's Regional Operations Branch. Documents pertinent to the operational certificate must submitted by email or electronic transfer to the director in accordance with the ministry Data & Report Submissions website at: https://www2.gov.bc.ca/gov/content/environment/waste-management/waste-discharge-authorization/comply , or as further instructed.

Please be reminded that the director may require the operational certificate holder to do one or more of the following at any time in accordance with section 14(1) of the *Environmental Management Act*:

- repair, alter, remove, improve or add to existing works, or to construct new works, and to submit plans and specifications for works specified in this authorization;
- conduct monitoring, and may specify procedures for monitoring and analysis, and procedures or requirements respecting the handling, treatment, transportation, discharge or storage of waste;
- conduct studies and to report information in accordance with the specifications of the director; and,
- recycle certain wastes and recover certain reusable resources, including energy potential from wastes, in accordance with the specifications of the director.

For more information about how the Ministry will assess compliance with your operational certificate please refer to https://www2.gov.bc.ca/gov/content/environment/waste-management/waste-discharge-authorization/comply.

For more information about how to make changes to your operational certificate and to access waste discharge amendment forms and guidance, please refer to https://www2.gov.bc.ca/gov/content/environment/waste-management/waste-discharge-authorization/change

If you have any questions or concerns, please contact Regional Operations Branch staff at Authorizations.South@gov.bc.ca .

Yours truly,

Liz Archibald, P.Ag.
for Director, *Environmental Management Act*
Authorizations - South Region

MINISTRY OF

CLIMATE CHANGE STRATEGY

OPERATIONAL CERTIFICATE

110576

Under the Provisions of the Environmental Management Act, and in accordance with the City of Port Alberni's approved Liquid Waste Management Plan

CITY OF PORT ALBERNI

4850 ARGYLE ST
PORT ALBERNI, BC
V9Y 1V8

is authorized to discharge effluent from a municipal wastewater treatment facility serving the City of Port Alberni (the City), the Alberni-Clayoquot Regional District landfill (*Environmental Management Act* authorization 524), IR 1 Tsahaheh, and IR 1 Ahahswinis, located in Port Alberni, British Columbia, subject to the requirements listed below.

Contravention of any of these requirements is a violation of the *Environmental Management Act* and may lead to prosecution.

This Operational Certificate supersedes waste management Permit PE-297.

General Provisions

Where this authorization provides that the director may require an action to be carried out, the operational certificate holder must carry out the action in accordance with the requirements of the director.

Date issued: March 7, 2022

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for Director, *Environmental Management Act*
Authorizations - South Region

Publication of Documents

The Ministry of Environment and Climate Change Strategy publishes Regulatory Documents on its website for the purpose of research, public education and to provide transparency in the administration of environmental laws. The operational certificate holder acknowledges that the province may publish any Regulatory Documents submitted by the operational certificate holder, excluding information that would be exempted from disclosure if the document was disclosed pursuant to a request under section 5 of the *Freedom of Information and Protection of Privacy Act*, and the operational certificate holder consents to such publication by the Province.

1. AUTHORIZED DISCHARGES

1.1. Port Alberni Wastewater Treatment Facility to the Somass River Estuary

This section applies to the discharge of municipal effluent from the City of Port Alberni wastewater treatment facility (facility) to the Somass River estuary via outfall. The EMS site reference number for this discharge is E325851.

1.1.1. The maximum rate of discharge is 79,400 cubic meters per day.

1.1.2. The characteristics of the discharge must not exceed:

a)	5-day Carbonaceous Biochemical Oxygen Demand	45 mg/L
b)	Total Suspended Solids	45 mg/L
c)	Fecal coliforms	3,200 fecal coliforms/100 mL
d)	*Escherichia coli*	6,400 *e. coli*/100mL
e)	Enterococci	1,120 Enterococci/100mL
f)	Total phosphorus	6 mg/L
g)	Orthophosphates	4 mg/L

Date issued: March 7, 2022

Liz Archibald, P.Ag.
for Director, *Environmental Management Act*
Authorizations - South Region

h)	96-Hr RBT single concentration	Test must pass in 100% effluent concentration

1.1.3. The authorized discharge period is continuous.

1.1.4. The Authorized Works are fine screen, two-cell aerated lagoon run in parallel, ultraviolet disinfection and an 778m outfall with 5 operational diffuser ports at a minimum depth of 2.5 m and related appurtenances approximately located as shown on Site Plan A.

1.1.5. The discharge must not cause surface water quality at or beyond the Initial Dilution Zone to exceed the applicable Water Quality Guidelines.

1.1.6. The location of the facilities from which the discharge is authorized to originate is 7TRI_Alberni (Lease Areas 135 & 135A) and Lot 3, Plan VIP72153.

1.1.7. The location of the point where the discharge is authorized to occur is Latitude 49.2397N and Longitude 124.8219 W.

1.1.8. The operational certificate holder must not discharge under this authorization unless the Authorized Works are complete and fully operational.

1.2. Port Alberni Wastewater Treatment Facility to Ground

This section applies to the non-point source discharge of municipal effluent from the City of Port Alberni wastewater treatment facility to ground and groundwater through infiltration.

1.2.1 The maximum rate of discharge is indeterminate.

1.2.2 The discharge must not cause both groundwater and surface water quality at or beyond the City of Port Alberni wastewater treatment facility property boundary to exceed the applicable Water Quality Guidelines.

1.2.3 The authorized discharge period is continuous.

Date issued: March 7, 2022

Liz Archibald, P.Ag.
for Director, *Environmental Management Act*
Authorizations - South Region

1.2.4 The discharge is authorized from a fine screen and two-cell aerated lagoon run in parallel and related appurtenances approximately located as shown on Site Plan A.

1.2.5 The location of the facilities from which the discharge is authorized to originate and the discharge is 7TRI_Alberni (Lease Areas 135 & 135A) and Lot 3, Plan VIP72153.

2. GENERAL REQUIREMENTS

2.1. Maintenance of Works and Emergency Procedures

2.1.1 The operational certificate holder must regularly inspect the Authorized Works (except the submerged section of the outfall addressed in section 2.12.) and maintain them in good working order.

2.1.2 If components of the Authorized Works have a manufacturer's recommended maintenance schedule, then those components must, at a minimum, be maintained in accordance with that schedule.

2.1.3 The operational certificate holder must maintain a record of inspections and maintenance of the Authorized Works and make the record available to an officer upon request.

2.1.4 In the event of an emergency or other condition which prevents normal operation of the Authorized Works or leads to an unauthorized discharge, the operational certificate holder must take remedial action immediately to restore the normal operation of the Authorized Works and to prevent any unauthorized discharges. The operational certificate holder must immediately report the emergency or other condition and the remedial action that has and will be taken to the EnvironmentalCompliance@gov.bc.ca email address and the Indigenous Nations or as otherwise instructed by the director.

2.2. Bypasses

The operational certificate holder must not allow any discharge authorized by this authorization to bypass the Authorized Works, except with the prior written approval of the director.

Date issued: March 7, 2022

Liz Archibald, P.Ag.
for Director, *Environmental Management Act*
Authorizations - South Region

2.3. Standby Power

The operational certificate holder must provide auxiliary power facilities to ensure continuous operation of the Authorized Works during power outages.

2.4. Process Modifications

The operational certificate holder must notify the director in writing prior to implementing changes to any process that may adversely affect the quality and/or quantity of the discharge.

2.5. Lagoon Berm Assessment

The operational certificate holder must retain a qualified engineer to assess and make recommendations concerning the integrity of the lagoon berms, particularly with respect to protection against earthquakes, tsunamis, storm surges and sea level rise, including recommending an ongoing inspection frequency. The Lagoon Berm Assessment Report prepared by Qualified Professional must be submitted to the director by **September 30, 2021**.

2.6. Lagoon Berm Inspection

The operational certificate holder must retain a qualified engineer to inspect the lagoon berms to assess and make recommendations on their integrity at a frequency recommended in the Lagoon Berm Assessment report required under section 2.5.

2.7. Operating Plan

2.7.1. The operational certificate holder must maintain and implement an Operating Plan prepared by a Qualified Professional for the lift stations, wastewater treatment facility and effluent disposal works.

2.7.2. The Operating Plan must detail the proper operation, maintenance, and monitoring of the lift stations, wastewater treatment facility, and effluent disposal works. The Operating Plan is to be continually updated, as necessary, to reflect the current operation.

Date issued: March 7, 2022

Liz Archibald, P.Ag.
for Director, *Environmental Management Act*
Authorizations - South Region

2.7.3. The Operating Plan must include standard operating procedures for the Trigger Response Plan and the Managed Release Scenario outlined in the Receiving Environment Monitoring Program (section 3.4.) that include variable-specific triggers and responses including decision-tree flow charts.

2.7.4. The operational certificate holder must submit a copy of the Operating Plan to the director and Indigenous Nations. Any revisions to the Operating Plan must be submitted to the director and Indigenous Nations with the Annual Report (see section 4.5.). A copy of the Operating Plan must be retained at the City of Port Alberni wastewater treatment facility and made available for inspection by an officer upon request.

2.8. Contingency Plan

2.8.1. The operational certificate holder must maintain and implement a Contingency Plan for the lift stations, City of Port Alberni wastewater treatment facility, and effluent disposal works prepared by a Qualified Professional that will address the appropriate course of action to be taken in any preconceived emergency situation, including, but not limited to the following:

a) An action plan for mitigating the impacts of tsunamis, earthquakes and storm surges.
b) Site specific spill response procedures, including the required training and resources to implement those procedures for each of the identified materials or risks during an emergency event.
c) Requirements and procedures for spill reporting and/or emergency notification to various levels of government including Indigenous Nations.
d) Procedure for establishing formal interagency communication for the duration of the emergency and clean-up as necessary.
e) Invite the Indigenous Nations to participate with the operational certificate holder in conducting scheduled emergency response drills and exercises to test and refine the Contingency Plan.

2.8.2. The operational certificate holder must submit a copy of the Contingency Plan to the director and Indigenous Nations. Any revisions to the Contingency Plan must be submitted to the director and

Indigenous Nations with the Annual Report (see section 4.5.). A copy of the Contingency Plan must be retained at the City of Port Alberni wastewater treatment facility and made available for inspection by an officer upon request.

2.9. Liquid Waste Management Plan Monitoring Committee

2.9.1. The operational certificate holder must maintain a Liquid Waste Management Plan Monitoring Committee (PMC) to provide advice to the City of Port Alberni on Liquid Waste Management Plan commitments and the receiving environment monitoring program (section 3.4.) including the managed release of effluent and trigger response plan.

2.9.2. Indigenous Nations must be invited to participate in the PMC.

2.9.3. The operational certificate holder must establish terms of reference for the PMC that define the purpose, mandate, membership, structure, meeting frequency, procedures, and reporting structure.

2.9.4. The operational certificate holder must seek endorsement on the Terms of Reference, and any revisions to the terms of reference, from the PMC and Indigenous Nations and submit a copy of the terms of reference to the director. Any revisions to the terms of reference must be submitted to the director with the Annual Report.

2.10. Facility Classification and Operator Certification

2.10.1. The operational certificate holder must have the Authorized Works classified, and the classification must be maintained with the Environmental Operators Certification Program (EOCP); and

2.10.2. The operational certificate holder must cause the Authorized Works to be operated and maintained by persons certified within and according to the program provided by the EOCP; and

2.10.3. The operational certificate holder must notify the director of the classification level of the wastewater treatment facility and certification levels of the operators, and changes of operators and/or operator certification levels within 30 days of any change.

Date issued: March 7, 2022

Liz Archibald, P.Ag.
for Director, *Environmental Management Act*
Authorizations - South Region

2.11. Posting of Outfalls

The operational certificate holder must erect and maintain a sign above the high-water mark along the alignment of the outfall and all overflow locations. The operational certificate holder must ensure that the sign meets the following criteria:

(i) identifies the nature of the works including the risks to public health;
(ii) indicates the length and depth of the outfall;
(iii) has a surface area of at least $1m^2$;
(iv) the colours of the lettering and the background of the sign contrast sufficiently with each other; and,
(v) is located such that the wording is clearly visible from both land and water.

2.12. Outfall Inspection

The operational certificate holder must cause the outfall to be inspected once every five years under the direction of a qualified person to ensure it is in good working order. The operational certificate holder must submit an inspection report prepared by a Qualified Professional to the director and Indigenous Nations within 30 days after the inspection date. The first inspection report must be submitted by **October 31, 2022**.

2.13. Treatment Plant Sludge Wasting and Disposal

The operational certificate holder must dispose of sludge wasted from the treatment plant at a site and in a manner approved by the director, or as authorized by regulation under the *Environmental Management Act*.

2.14. Dilution Modelling Update

2.14.1. Estimate the minimum dilution on a quarterly basis in 2023 using concurrent effluent and receiving environment water quality samples at the edge of the initial dilution zone (IDZ). Include a discussion of how the calculated minimum dilution based on monitoring data compares to the predicted dilution from the model in the Annual Report for that year.

Date issued: March 7, 2022

Liz Archibald, P.Ag.
for Director, *Environmental Management Act*
Authorizations - South Region

2.14.2. The operational certificate holder must update dilution modelling if monitoring data for effluent flow rate, effluent density and ambient density (at point of discharge) are +/- 20% of the assumed model inputs for these variables. If updated dilution modelling is not completed, then sufficient rationale should be provided by the operational certificate holder to demonstrate how the current monitoring program provides a reasonable validation of the original model results.

2.15. Closure Plan for Old Lagoon

2.15.1. The operational certificate holder must have a Closure Plan prepared by a Qualified Professional that describes procedures for decommissioning the old wastewater treatment lagoon.

2.15.2. The operational certificate holder must submit a copy of the Closure Plan to the director and Indigenous Nations by **March 7, 2023**.

2.15.3. The operational certificate holder must decommission the old wastewater treatment lagoon in accordance with the Closure Plan.

2.16. Restoration Plan for Old Lagoon

2.16.1. The operational certificate holder must have a Restoration Plan prepared by a Qualified Professional for the old wastewater treatment lagoon that will restore the lagoon to natural habitat including a monitoring program to evaluate the restoration efforts, timelines and costs.

2.16.2. The operational certificate holder must seek input from the Plan Monitoring Committee, Indigenous Nations, and the public on the Restoration Plan.

2.16.3. The Restoration Plan must be submitted to the director by **March 7, 2024.**

2.16.4. The operational certificate holder must restore the old lagoon in accordance with the Restoration Plan and within the timelines stipulated within.

Date issued: March 7, 2022

Liz Archibald, P.Ag.
for Director, *Environmental Management Act*
Authorizations - South Region

2.17. Liquid Waste Management Plan Review

2.17.1. The operational certificate holder must review their Liquid Waste Management Plan every five (5) years. The review must include an assessment of:

a) Cost estimates;
b) Objectives and outcomes;
c) Approach and technologies;
d) Regulations and standards;
e) Official community plan and regional growth strategy;
f) Public support for the plan.

The review must determine whether an amendment or update is required and ensure that the LWMP is still relevant and current and be carried out in accordance with the procedures described in the most recent edition of the "Interim Guidelines for Preparing Liquid Waste Management Plans".

A copy of the above guidelines is available on the Ministry web page at https://www2.gov.bc.ca/gov/content/environment/waste-management/sewage/liquid-waste-management-plans

2.17.2. The first review must occur in 2026 and include a feasibility study of alternate locations for the wastewater treatment facility, alternate treatment methodologies and alternate receiving environments for the discharge.

2.18. Stormwater Management Plan

The operational certificate holder must develop a stormwater management plan prepared by a Qualified Professional by **December 31, 2028**, that includes an action plan with timelines and costs for addressing stormwater quality issues.

2.19. Overflow, and Inflow and Infiltration Requirements

2.19.1. The operational certificate holder must notify the public and Indigenous Nations within 12 hours of every overflow of untreated municipal effluent in addition to the requirements under the Spill Reporting Regulation.

Date issued: March 7, 2022

Liz Archibald, P.Ag.
for Director, *Environmental Management Act*
Authorizations - South Region

2.19.2. Every 5-years, with the first report due on **March 31, 2026**, provide a report on progress towards the elimination of combined sewer overflows that includes the following:

(i) The volume, frequency, and number of overflow occurrences for each overflow location.

(ii) An assessment of the potential impact of overflow occurrences on the receiving environment at each overflow location.

(iii) Overflow of storm and sewer upgrades undertaken during the period and an assessment of the impacts of those actions on overflows.

(iv) Based on items (i-iii), provide a plan designed by a Qualified Professional with cost estimates over the following 5-years to reduce the volume, frequency, and the number of overflow occurrences. This plan must be approved by the director.

3. MONITORING REQUIREMENTS

The director may alter the monitoring and reporting requirements in this operational Certificate as needed. The need for changes to the programs will be based on results submitted to the director as well as any other information obtained by the Ministry in connection with the discharges.

3.1. Flow Measurement

The operational certificate holder must install an effluent flow measuring device and record once per day the effluent volume discharged through the outfall under section 1.1 over a 24-hour period.

3.2. Non-Point Source Discharge to Ground

The operational certificate holder must provide a water balance prepared by a Qualified Professional to assess and estimate the average monthly volume of seepage to ground using influent and effluent flow data, precipitation, and evaporation rates.

Date issued: March 7, 2022

Liz Archibald, P.Ag.
for Director, *Environmental Management Act*
Authorizations - South Region

3.3. Effluent Quality

The operational certificate holder must assess the quality of the effluent authorized in section 1.1 as follows:

Parameter	Sample Type	Sample Frequency
$CBOD_5$ (mg/L)	Composite	Twice/week
TSS (mg/L)	Composite	Twice/week
Ammonia-N (mg/L)	Composite	Twice/month
Total Phosphorus (mg/L)	Composite	Twice/month
Orthophosphorus (mg/L)	Composite	Twice/month
Total and dissolved metals (mg/L)	Composite	Monthly
Fecal coliform (unit/100mL)	Grab	Twice/month
E.coli (unit/100mL)	Grab	Twice/month
Enterococci (unit/100mL)	Grab	Twice/month
Toxicity (96-Hr RBT single concentration)	Grab	Twice/year (February and September)

3.4. Receiving Environment Monitoring

3.4.1. The operational certificate holder must undertake a comprehensive receiving environment monitoring program ("REMP") in accordance with the approved Wastewater Treatment System Upgrades Pre-discharge and Operational Receiving Environment Monitoring Program (Associated Engineering, July 2021).

3.4.2. The REMP must include a trigger response plan for the managed release of effluent only on ebb tides if dissolved oxygen levels in the receiving environment have the potential to have an adverse effect on fish.

3.4.3. The REMP must include trigger response plan to implement planned contingency measures to address uncertainties associated with the non-point source discharges from the lagoon (section 1.2.). The trigger response plan must include escalating monitoring activities and management actions including reporting to the director and Indigenous Nations that will be triggered if water quality parameters measured at the groundwater and surface water monitoring sites and vegetation associated with monitoring the effects of seepage exceed triggers specified in the Plan.

Date issued: March 7, 2022

Liz Archibald, P.Ag.
for Director, *Environmental Management Act*
Authorizations - South Region

3.4.4. Where changes are proposed to the REMP, the operational certificate holder must obtain written approval from the director. Any revisions to the REMP must be discussed with the Plan Monitoring Committee and Indigenous Nations prior to submission to the director for written approval.

3.5. Sampling facilities

The operational certificate holder must install and maintain sampling facilities for the discharge and receiving environment monitoring locations as described in Section 3.

3.6. Sampling Procedures

3.6.1. The operational certificate holder must take due care in sampling, storing and transporting the samples to control temperature and avoid contaminations, breakage, and any other factor or influence that may compromise the integrity of the samples.

3.6.2. The operational certificate holder must carry out sampling in accordance with the procedures described in the most recent edition of the "British Columbia Field Sampling Manual for Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples " or by alternative procedures as authorized by the director.

A copy of the above manual is available on the Ministry web page at https://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/laboratory-standards-quality-assurance/bc-field-sampling-manual

3.7. Analytical Procedures

The operational certificate holder must carry out analyses in accordance with procedures described in the most recent edition of the "British Columbia Laboratory Manual", or by alternative procedures as authorized by the director. A copy of the above manual is available on the Ministry web page at https://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/laboratory-standards-quality-assurance/bc-field-sampling-manual

Date issued: March 7, 2022

Liz Archibald, P.Ag.
for Director, *Environmental Management Act*
Authorizations - South Region

3.8. Quality Assurance

3.8.1. The operational certificate holder must obtain from the analytical laboratory(ies) their precision, accuracy and blank data for each sample set submitted by the operational certificate holder and an evaluation of the data acceptability, based on criteria set by such laboratory.

3.8.2. The operational certificate holder must prepare and submit for analysis by the analytical laboratory(ies) duplicates of at least ten percent of the samples collected at each monitoring location sampling event to provide for quality assurance.

3.8.3. The operational certificate holder must submit samples to the analytical laboratory(ies) that meet the definition of a qualified laboratory under the Environmental Data Quality Assurance Regulation.

4. REPORTING REQUIREMENTS

4.1. EMS Reporting

The operational certificate holder must ensure all monitoring data analyzed by a qualified laboratory is uploaded to the EMS database within 30 days of the date of sample collection.

The following EMS ID's are assigned to the effluent and receiving environment monitoring sites:

Site	EMS ID	Description
Effluent	E325851	After treatment prior to discharge
A	E317671	100m north of diffuser
B	E317672	100m south of diffuser
C	E317673	400m southwest of diffuser
D	E317674	400m south of diffuser
E	E317675	Reference site 660 m southwest of diffuser
F	E317676	Reference site 760 southwest of diffuser
Z	E317670	400m north of the diffuser
H	E327680	Hupačasath wharf

Date issued: March 7, 2022

Liz Archibald, P.Ag.
for Director, *Environmental Management Act*
Authorizations - South Region

I	E327681	Marina reference
T1	E327671	Tidal channel
T2	E327672	Tidal channel
T3	E327673	Tidal channel
P1	E327674	Piezometer on east side of lagoon
P4	E327675	Piezometer on south-east side of lagoon on beach
MW21-1	E327676	Reference well
MW21-2	E327677	Monitoring well on south side of lagoon
MW21-3a	E327678	Monitoring well on west side of lagoon - shallow
MW21-3b	E327679	Monitoring well on west side of lagoon - deep

4.2. Routine Submission of Reports

The operational certificate holder must submit all reports required to be submitted under this section by email to the Ministry's Routine Environmental Reporting Submission Mailbox (RERSM) at envauthorizationsreporting@gov.bc.ca or as otherwise instructed by the director.

For guidelines on how to properly name the files and email subject lines or for more information visit the Ministry website: https://www2.gov.bc.ca/gov/content/environment/waste-management/waste-discharge-authorization/data-and-report-submissions/routine-environmental-reporting-submission-mailbox

4.3. Non-compliance Notification

The operational certificate holder must immediately notify the director by email at EnvironmentalCompliance@gov.bc.ca, or as otherwise instructed by the director, of any non-compliance with the requirements of this authorization and must immediately take remedial action to remedy any effects of such non-compliance.

Date issued: March 7, 2022

Liz Archibald, P.Ag.
for Director, *Environmental Management Act*
Authorizations - South Region

4.4. Non-compliance Reporting

4.4.1. The operational certificate holder must, within 30 days of any non-compliance event, submit to the director a written report that includes, but is not necessarily limited to, the following:

a) all relevant test results obtained by the operational certificate holder related to the non-compliance,
b) an explanation of the most probable cause(s) of the non-compliance, and
c) a description of remedial action planned and/or taken by the operational certificate holder to prevent similar non-compliance(s) in the future.

4.4.2. The operational certificate holder must submit all non-compliance reporting required to be submitted under this section by email to the Ministry's Compliance Reporting Submission Mailbox (CRSM) at EnvironmentalCompliance@gov.bc.ca or as otherwise instructed by the director.

For guidelines on how to report a non-compliance or for more information visit the Ministry website:
https://www2.gov.bc.ca/gov/content?id=076C5CA3ABD342A784CC49EC78CBAE12

4.5. Annual Report

The operational certificate holder must, by March 31st of each year, submit to the director an Annual Report that includes, but is not limited to:

a) A compendium of the municipal effluent flow, municipal effluent quality and receiving environment monitoring data.
b) A discussion of the impact of landfill leachate on effluent quality;
c) A statement outlining the number of non-compliance with the authorization requirements that occurred during the reporting period, the dates of each such non-compliances, an explanation as to the cause of the non-compliance, and a description of the measures taken by the operational certificate holder to rectify the cause of each such non-compliance. If compliance occurred over the reporting period, the required statement must indicate that no non-compliances of the authorization occurred during the reporting period;

Date issued: March 7, 2022

Liz Archibald, P.Ag.
for Director, *Environmental Management Act*
Authorizations - South Region

d) A comparison of receiving environment monitoring results to the appropriate Water Quality Guidelines and a discussion of the effect of any exceedances on the quality of the receiving environment, using appropriate statistical and graphical analysis.
e) Include summary tables of parameters discussed to relate data spatially and to data compare between sites and over time for parameters discussed;
f) Any trends in environmental quality in the receiving environments affected by the discharge, using background and pre-discharge data and all the years of record in which the discharge has taken place;
g) All laboratory reports of data collected under this authorization;
h) A summary of all quality assurance/quality control (QA/QC) issues during the calendar year;
i) Include recommendations from the Plan Monitoring Committee and how they have been addressed including copies of the Plan Monitoring Committee minutes;
j) An evaluation of the performance of the authorized works and any planned improvements of wastewater facilities for the coming year;
k) Discuss any implementation of managed release of effluent during ebb tides (section 3.4.2) for the previous year;
l) Discuss any implementation of the trigger response plan for the non-point source discharge (section 3.4.3.) for the previous year;
m) Outfall inspection report (section 2.12.), when applicable;
n) Updated dilution modelling, when applicable (section 2.14);
o) Stormwater management plan, when applicable (section 2.18);
p) Combined sewer overflow elimination report, when applicable (section 2.19);
q) A revised Operating Plan and/or Contingency Plan and/or Plan Monitoring Committee Terms of Reference, when applicable.

4.6. Reporting to Indigenous Nations

The operational certificate holder must submit copies of the Annual Report to the following Indigenous Nations, Hupačasath First Nation and Tseshaht First Nation, unless otherwise agreed to by the Indigenous Nations by email, unless otherwise agreed to by the Indigenous Nations.

The operational certificate holder may not omit any information from the original version of the document, as submitted to the director, without the prior approval of the director.

Date issued: March 7, 2022

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for Director, *Environmental Management Act*
Authorizations - South Region

5. GLOSSARY

Capitalized terms referred to in this authorization are defined in the attached Glossary. Other terms used in this authorization have the same meaning as those defined in the Environmental Management Act and applicable regulations.

5.1. "Authorized Works"

"Authorized Works" means [[Authorized Works]] as stated in Section 1.1.4.

5.2. "Indigenous Nations"

"Indigenous Nations" refers to the Tseshaht First Nation and the Hupačasath First Nation.

5.3. "Initial Dilution Zone"

"Initial Dilution Zone" is the 3-dimensional zone around the point of discharge where mixing of the municipal effluent and the receiving water occurs.

For the purpose of calculating the initial dilution zone for an estuary, all of the following, measured from the point of discharge and from mean low water apply:

(i) The height is the distance from the bed to the water surface;
(ii) The width, perpendicular to the path of the stream, is the lesser of
   a. 100m, and
   b. 25% of the width of the estuary;
(iii) The length, parallel to the path of the stream, is the distance between a point 100 m upstream and a point that is the lesser of
   a. 100 m downstream, and
   b. A distance downstream at which the width of the municipal effluent plume equals the width determined under paragraph (ii).

5.4. "Province"

"Province" means Her Majesty the Queen in right of British Columbia;

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Authorizations - South Region

5.5. "Qualified Professional"

"Qualified Professional" means an applied scientist or technologist specializing in an applied science or technology applicable to the duty or function, including, if applicable and without limiting this, agrology, biology, chemistry, engineering, geology or hydrogeology and who:

(i) is registered with the appropriate professional organization, is acting under that organization's code of ethics and is subject to disciplinary action by that organization, and

(ii) through suitable education, experience, accreditation and/or knowledge, may be reasonably relied on to provide advice within their area of expertise.

All documents submitted to the Director by a Qualified Professional must be signed by the author(s).

5.6. "Regulatory Document"

"Regulatory Document" means any document that the operational certificate holder is required to provide to the director or the Province pursuant to:

(i) this Authorization;

(ii) any regulation made under the *Environmental Management Act* that regulates the facility described in this Authorization or the discharge of waste from that facility; or

(iii) any order issued under the Environmental Management Act directed against the operational certificate holder that is related to the facility described in this authorization or the discharge of waste from that facility.

Date issued: March 7, 2022

Liz Archibald, P.Ag.
for Director, *Environmental Management Act*
Authorizations - South Region

5.7. "Toxicity"

"Toxicity" means a 96-Hr rainbow trout single concentration test. Effluent is acutely toxic if there is greater than 50% mortality during a 96-hour Rainbow Trout (*Oncorhynchus mykiss*) single concentration acute toxicity test in a 100% effluent concentration using " Biological Test Method: Reference Method for Determining Acute Lethality of Effluent to Rainbow Trout, EPS 1/RM/13 "Second Edition December 2000" and if applicable, Procedure for pH Stabilization During the Testing of Acute Lethality of Wastewater Effluent to Rainbow Trout, EPS 1/RM/50 . For the Pass/Fail of a single concentration test an effluent sample is considered to have passed (Pass) if at 100% effluent concentration ≤ 50% of the test fish die after 96-hours of exposure, the test is considered to have failed (Fail) if > 50% of the test fish die after 96-hours. Test results must be reported in percent (%) mortality.

5.8. "Water Quality Guidelines"

"Water Quality Guidelines" means, as published under the authority of the minister,

(i) The water quality guidelines that, by approval of the minister, apply in British Columbia to groundwater and surface water;

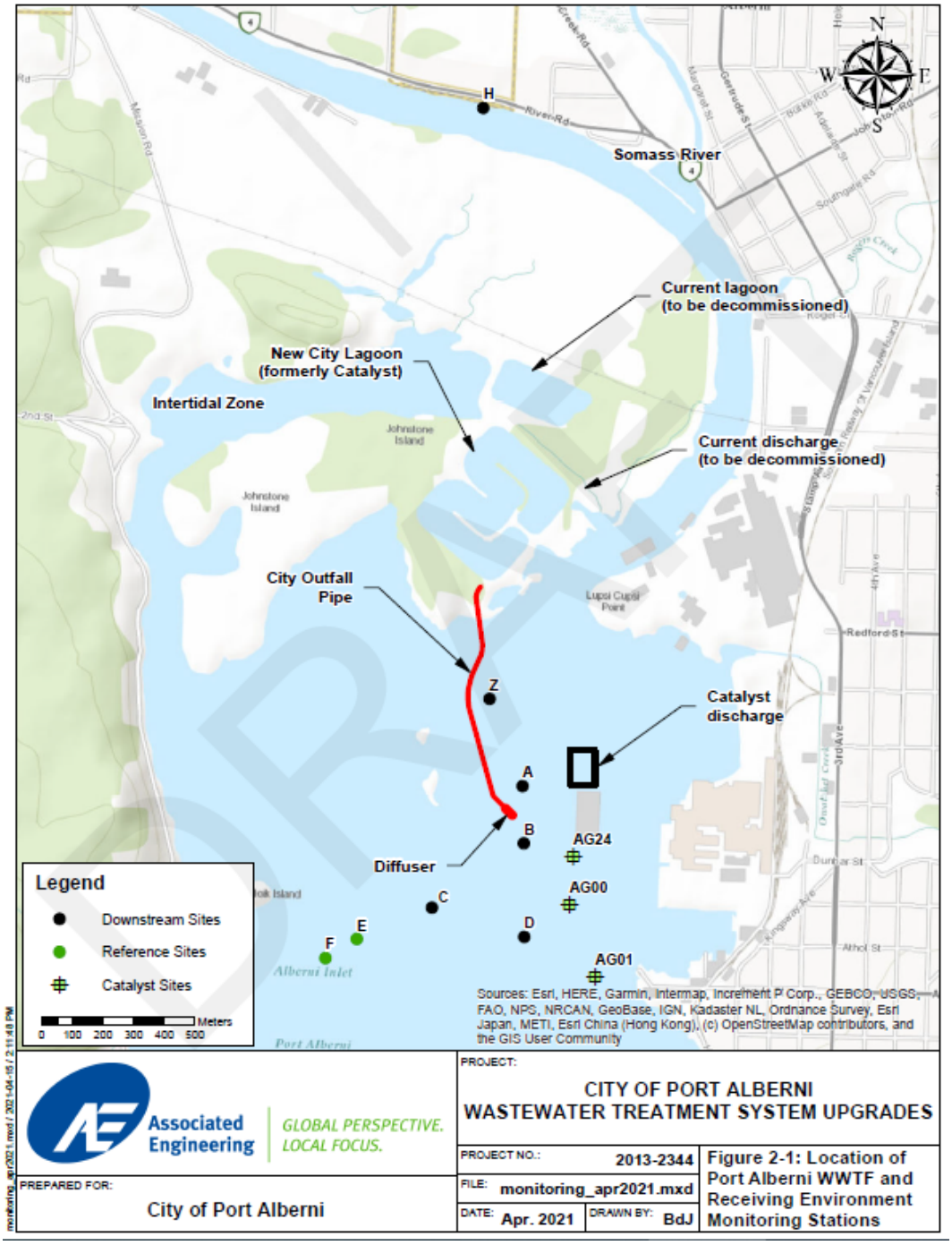
(ii) In relation to a body of water for which water quality objectives have been established, the most recent water quality objectives,

(iii) If neither of paragraphs (a) or (b) applies, any other quality standard acceptable to the minister such as the Contaminated Sites Regulation Schedule 3.2 and the Canadian Council of Ministers of the Environment Canadian Environmental Quality Guidelines.

Date issued: March 7, 2022

Liz Archibald, P.Ag.
for Director, *Environmental Management Act*
Authorizations - South Region

SITE PLAN A



Date issued: March 7, 2022

Liz Archibald, P.Ag.
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Authorizations - South Region

APPENDIX B: BIOLOGICA INVERTEBRATE SAMPLING METHODS

Marine Benthic Enumeration and Identification Methods
Client: Roe Environmental
Project: Port Alberni
Protocol: EEM

Sample Inventory

Sample arrival: 18-Sept-24
Number of samples: 18
Number of jars: 63
Field screen size: 1000 µm
Lab screen size: 500 µm
Biologica project number: mb24-139

The chain of custody documents were checked and approved with the client. Samples were transferred from formalin into 70% ethanol and stained with Rose Bengal to aid in sorting. Each sample was provided a unique identification number and placed in the queue for analysis.

Table 1. Summary of benthic samples processed for Roe Environmental Port Alberni, 2024.

Client Sample ID	Date Sampled	Biologica Sample ID	# of Jars	Sub-sample	Organisms Counted
A1	23-Sep-24	mb24-139-001	3	1/4	472
				Whole	14
A2	23-Sep-24	mb24-139-002	5	1/4	501
				Whole	30
A3	23-Sep-24	mb24-139-003	7	1/4	765
				Whole	9
B1	23-Sep-24	mb24-139-004	3	1/2	263
				Whole	0
B2	23-Sep-24	mb24-139-005	4	1/2	141
				Whole	18
B3	23-Sep-24	mb24-139-006	3	1/2	95
				Whole	3
C1	23-Sep-24	mb24-139-007	2	1/2	126
				Whole	0
C2	23-Sep-24	mb24-139-008	3	1/2	204
				Whole	0
C3	23-Sep-24	mb24-139-009	2	1/2	120
				Whole	1
D1	23-Sep-24	mb24-139-010	4	1/2	90
				Whole	8
D2	23-Sep-24	mb24-139-011	5	1/2	370
				Whole	6

Client Sample ID	Date Sampled	Biologica Sample ID	# of Jars	Sub-sample	Organisms Counted
D3	23-Sep-24	mb24-139-012	3	1/2	86
E1	24-Sep-24	mb24-139-013		1/2	156
			4	Whole	1
E2	24-Sep-24	mb24-139-014		1/2	54
			4	Whole	0
E3	24-Sep-24	mb24-139-015		1/2	490
			3	Whole	2
F1	24-Sep-24	mb24-139-016		1/2	18
			2	Whole	0
F2	24-Sep-24	mb24-139-017		1/2	56
			3	Whole	1
F3	24-Sep-24	mb24-139-018		1/2	39
			3	Whole	0

Sample Processing

Sorting:

All samples were sorted using dissecting microscopes at 10–40x magnification by trained personnel. All debris in each sample was checked microscopically, including leaves, elutriated gravel, and other large debris. To minimize potential sorter bias, samples were distributed among technicians such that no one person sorted all the replicates of a given sample or station.

Due to large debris volumes and low abundances samples were subsampled using a Caton tray (Caton, 1991). A minimum ¼ split is the recommended acceptable split for marine benthos samples (EEM 2002, 2010, 2012). 3 of the total 18 samples were subsampled to a 1/4 split and 15 of 18 samples were subsampled to a 1/2 split. Prior to subsampling with a Caton tray, all samples underwent a preliminary whole-sample sort in which all large, unique and rare organisms (>1.0 cm) were removed from the debris. These large organisms were identified and enumerated as a whole count and stored and recorded separately from the rest of the sample. This procedure is meant to increase the detection of rare taxa and capture the abundance of large organisms accurately. Following the preliminary whole sort, all sample debris was then spread evenly over a Caton grid, and ¼ or ½ of the sample was randomly selected and removed for microscopic sorting.

Sub-sampling accuracy was assessed by sorting the remaining sample for 10% of all sub-sampled samples and comparing the fractions to one another. Refer to Table 2 for sub-sampling accuracy results.

Sorting QA/QC:

To ensure sorting efficiency was >95%, whole and/or partial sub-samples were re-sorted. Sorting efficiency was calculated using the following equation (where total count = final total number of organisms in sample):

Sorting efficiency = [1−(# of organisms in spot check or re-sort / total organisms)] x 100

*Total organisms includes the original count and the number found from the re-sort

All samples checked must meet or exceed 95% sorting efficiency. Any samples falling below 95% sorting efficiency are re-sorted in their entirety, and additional checks are undertaken as necessary. For quality assurance, QA re-sorts were performed on 10% of samples. one sample was randomly selected and re-sorted in its entirety. Refer to Table 2 for sorting efficiency results.

Table 2. Summary of sorting QA/QC results for Roe Environmental Port Alberni, 2024.

Client Sample ID	Biologica Sample ID	Sorting Efficiency QA Whole Resorts	Sub-sampling Accuracy
A1	mb24-139-001		
A2	mb24-139-002		
A3	mb24-139-003		
B1	mb24-139-004		94.26%
B2	mb24-139-005		
B3	mb24-139-006		
C1	mb24-139-007		95.74%
C2	mb24-139-008		
C3	mb24-139-009		
D1	mb24-139-010		
D2	mb24-139-011		
D3	mb24-139-012		
E1	mb24-139-013		
E2	mb24-139-014		
E3	mb24-139-015		
F1	mb24-139-016	95.00%	
F2	mb24-139-017		
F3	mb24-139-018		
Average:		**95.00%**	**95.00%**

Identification:

All organisms were identified using a combination of dissecting (10–40x) and compound (100–1000x) microscopes and standard taxonomic keys (see methodological and taxonomic references) to the level specified by the client: species or LPL (lowest practicable level). All specimens were archived in air-tight glass vials with glycerin and 70% ethanol for long-term storage. Taxonomic data were recorded in Biologica's custom database.

Any species new to Biologica's verified reference collections are confirmed by one of Biologica's secondary trained taxonomists.

Data

All data were recorded in Biologica's custom database. Results were provided to the Roe Environmental project manager in Excel spreadsheets via email.

Selected Methodological and Taxonomic References

Carlton JT. 2007. Light's Manual, Intertidal Invertebrates of the Central California Coast. 4th ed. Berkley (CA): University of California Press. 964pp.

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Coan EV, Scott PV, Bernard FR. 2000. Bivalve Seashells of Western North America: Marine Bivalve Molluscs from Arctic Alaska to Baja California. Santa Barbara Museum of Natural History Monographs No. 2. 764pp.

Environment Canada. 2010. Pulp and Paper Environmental Effects Monitoring (EEM) Technical Guidance Document.

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Environmental Protection Agency. 1987. Recommended Protocols for Sampling and Analyzing Macroinvertebrate Assemblages in Puget Sound. http://www.psparchives.com/our_work/science/protocols.htm. Accessed January 2014.

Kozloff EN. 1987. Marine Invertebrates of the Pacific Northwest. Seattle (WA): University of Washington Press. 511pp.

Scott PV, Blake, JA. 1998. Taxonomic Atlas of the Benthic Fauna of the Santa Maria Basin and Western Santa Barbara Channel, Vols 1–14. Santa Barbara (CA): Santa Barbara Museum of Natural History.

Staude CP, Armstrong JW, Thom RM, Chew KK. 1977. An illustrated key to the intertidal Gammaridean Amphipoda of central Puget Sound. Contribution 466, College of Fisheries. University of Washington. 27pp.

Watling L. 1979. Marine Flora and Fauna of the Northeastern United States, Crustacea: Cumacea. NOAA Technical Report NMFS Circular 423, U.S. Dept. of Commerce National Marine Fisheries Service.

APPENDIX C: PHOTOGRAPHIC DOCUMENTATION

Photo 3. Groundwater sampling at monitoring well MW21-3a/3b (July 3, 2024).

Photo 4. Piezometer sampling at sample site P-1 near tidal channel and sample site T-1 (July 3, 2024).

Photo 5. Marine receiving environment sampling at sample site C (September 3, 2024).

Photo 6. Van Dorn grab sampler used for marine receiving environment sampling (September 3, 2024).

Photo 7. Water sampling in progress at sample site H on Hupačasath First Nation wharf (September 3, 2024).

Photo 8. Conditions in tidal channel during sampling at site T1 (September 3, 2024).

Photo 9. Marine receiving environment water sample collected with Van Dorn grab sampler (September 9, 2024).

Photo 10. Bottle sets prepared for marine receiving environment sampling (September 9, 2024).

Photo 11. Groundwater sampling in progress at monitoring well MW21-2 (September 9, 2024).

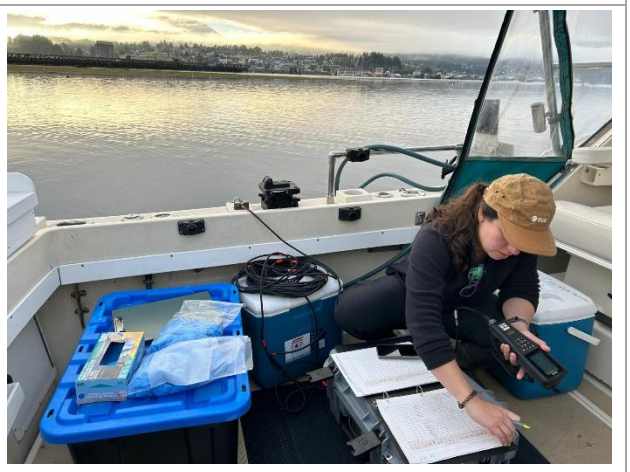

Photo 12. In-situ marine water quality data collected with YSI multi-parameter unit (September 16, 2024).

Photo 13. Conditions in tidal channel during sampling at site T3 (September 16, 2024).

Photo 14. Groundwater sampling at monitoring well MW21-3a/3b (September 16, 2024).

Photo 15. Standard ponar grab sampler used for sediment sampling (September 23, 2024).

Photo 16. Sediment collected in tote for benthic invertebrate sampling (September 23, 2024).

Photo 17. Benthic invertebrate processing in progress at dock (September 23, 2024).

Photo 18. Sediment collected at site F1 (September 24, 2024).

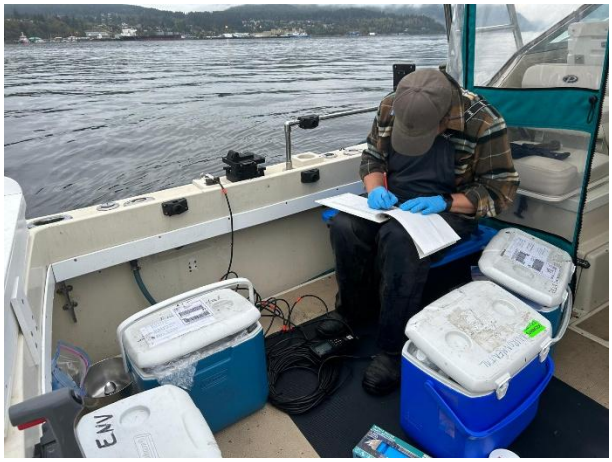

Photo 19. Marine receiving environment in-situ data collection at sample site (September 24, 2024).

Photo 20. Groundwater sampling at monitoring well MW21-1 (December 18, 2024).

APPENDIX D: QUALITY ASSURANCE/QUALITY CONTROL

Throughout 2024, field methods followed standard procedures and QA/QC. A minimum of one lab provided trip blank and one lab provided field blank were submitted for lab analysis for each sampling event, which were pre-filled by the laboratory with distilled or deionized water. Trip blank samples were left sealed, and field blank samples were opened for a short period of time to expose the contents to atmospheric conditions at a sampling site during sampling and then sealed again. With the exception of these differences, trip and field blank samples were handled and analyzed the same as the other samples throughout the sampling events (i.e. stored in the sample coolers). Trip and field blank sample results were less than laboratory detection limits.

Field duplicate samples were collected at a minimum of 11% of the total number of samples, meeting the BC Field Sampling Manual minimum requirement of 10% of the total number of samples. The field duplicate samples were compared to the parent samples by calculating the relative percent difference (RPD) in parameter concentrations; the objective being an RPD of 20% or less for each parameter, where both the parent and duplicate samples have concentrations that are at least 5 times the laboratory detection limits. The RPD calculation from the BC Field Sampling Manual – Part E1 Surface Water is defined as:

$$\textbf{RPD (\%) = ((parent – duplicate) / ((parent + duplicate)/2)) * 100}$$

Overall, the RPDs of all field duplicates met the 20% objective in samples with concentrations equal to or greater than 5 times the detection limit. There was a total of 40 RPD values calculated which exceeded the 20% objective. Of that total, 6 were under 25%, 14 were between 25-30%, and 16 were between 30-50%. The remaining 4 RPD values were greater than 50%, and 3 out of the 4 were from Enterococci.

On September 3rd, 2024, there was a sampling issue with the duplicate sample for site I2 (DUP-B), and on September 9th, 2024, there was a sampling issue with the duplicate sample for site T2 (DUP-C). The RPD values for these duplicate samples on these dates were discounted from the RPD evaluation due to sampling error.

APPENDIX E: MARINE SAMPLING SITE DEPTH TABLES

Table 1: June 26th, 2024, Quarterly Marine Sample Collection Depth and Halocline Details

Site	Sample ID	Depth (m)	Salinity	Position Relative to Halocline	Comments
A	A1	0.75	2.4	N/A	Freshwater (no halocline)
	A2	1.5	2.42	N/A	Freshwater (no halocline)
B	B1	1.4	2.2	N/A	Freshwater (no halocline)
	B2	2.8	3.04	N/A	Freshwater (no halocline)
C	C1	3.5	15.81	Within	Depth 3m used in graphs
	C2	3.75	n.s.	Below	Depth 3.5m used in graphs (no field data was taken at 3.75m)
D	D1	4.0	11.2	Within	Depth 3.5m used for graphs (and salinity)
	D2	6.0	32.15	Below	Depth 6.5m used for graphs (and salinity)
	D3	-	n.s.	N/A	No third sample taken due to low tide
E	E1	3.0	10.54	Within	Depth 2.5m used in graphs (salinity from 3.0m)
	E2	3.5	n.s.	Below	Depth 3.0m used in graphs (no field data was taken at 3.5m)
F	F1	3.5	21.62	Within	Depth 3.0m used in graphs (salinity from 3.5m)
	F2	4.0	n.s.	Below	Depth 3.5m used in graphs (no field data was taken at 4.0m)
H	H1	0.5	0.03	N/A	Freshwater (no halocline)
	H2	1.0	n.s.	N/A	Freshwater (no halocline). No field data was taken at 1.0m
I	I1	2.0	0.04	N/A	Freshwater (no halocline)
	I2	2.5	0.04	N/A	Freshwater (no halocline)
Z	Z1	0.75	2.11	N/A	Freshwater (no halocline)
	Z2	1.6	2.17	N/A	Freshwater (no halocline)

Table 2: September 16th, 2024, Quarterly/5-in-30 Marine Sample Collection Depth and Halocline Details

Site	Sample ID	Depth (m)	Salinity	Position Relative to Halocline	Comments
A	A1	1.0	18.83	Within	
	A2	2.0	22.13	Below	
B	B1	1.0	18.92	Within	
	B2	3.5	25.63	Below	
C	C1	1.0	22.41	Within	
	C2	3.5	28.45	Below	
D	D1	0.5	19.3	Surface (above)	
	D2	1.5	22.24	Within	
	D3	10	31.66	Below	
E	E1	1.0	22.62	Within	
	E2	4.0	30.54	Below	
F	F1	1.0	22.65	Within	
	F2	4.5	30.71	Below	
H	H1	0.5	13.67	Within	
	H2	2.5	21.7	Below	
I	I1	0.7	10.17	Surface (above)	Shallow, little to no halocline
	I2	1.7	15.78	Below	Shallow, little to no halocline
Z	Z1	1.0	17.1	Within	
	Z2	2.0	22.29	Below	

Table 3: December 17th, 2024, Quarterly Marine Sample Collection Depth and Halocline Details

Site	Sample ID	Depth (m)	Salinity	Position Relative to Halocline	Comments
A	A1	1.0	6.73	Within	
	A2	2.5	14.4	Below	
B	B1	1.0	5.91	Within	
	B2	2.5	22.29	Below	
C	C1	1.0	3.84	Within	
	C2	1.5	10.58	Below	
D	D1	1.0	7.18	Surface (above)	
	D2	2.5	22.16	Within	
	D3	3.5	26.15	Below	
E	E1	1.0	3.86	Within	
	E2	2.5	21.21	Below	
F	F1	1.5	7.42	Within	
	F2	3.0	25.94	Below	
H	H1	1.5	0.02	N/A	Freshwater (no halocline)
	H2	3.0	0.02	N/A	Freshwater (no halocline)
I	I1	1.0	0.03	N/A	Freshwater (no halocline)
	I2	4.5	n.s.	N/A	Freshwater (no halocline), depth 3.0m used in graphs due to the current being too strong to deploy YSI deeper on day of sampling
Z	Z1	1.5	5.99	Within	
	Z2	3.0	25.23	Below	

Table 4: September 3rd, 2024, 5-in-30 Marine Sample Collection Depth and Halocline Details

Site	Sample ID	Depth (m)	Salinity	Position Relative to Halocline	Comments
A	A1	0.5	7.16	Within	
	A2	1.5	20.39	Below	
B	B1	0.5	8.87	Within	
	B2	1.5	19.14	Below	
C	C1	2.0	19.66	Within	
	C2	2.5	20.55	Below	
D	D1	1.0	13.85	Surface (above)	
	D2	3.5	22.30	Within	
	D3	6.5	30.62	Below	
E	E1	1.5	14.89	Within	
	E2	2.0	19.07	Below	
F	F1	2.5	20.23	Within	
	F2	3.0	21.39	Below	
H	H1	0.5	2.02	N/A	Freshwater
	H2	1.0	15.22	N/A	Saltwater
I	I1	1.0	5.11	N/A	Freshwater/saltwater mix
	I2	2.0	17.81	N/A	Saltwater
Z	Z1	1.0	12.0	Within	
	Z2	2.0	21.42	Below	

Table 5: September 9th, 2024, 5-in-30 Marine Sample Collection Depth and Halocline Details

Site	Sample ID	Depth (m)	Salinity	Position Relative to Halocline	Comments
A	A1	0.5	7.6	Within	
	A2	1.5	17.74	Below	
B	B1	0.5	11.93	Within	
	B2	1.5	15.83	Below	
C	C1	2.0	20.67	Within	
	C2	2.5	22.51	Below	
D	D1	1.0	17.48	Surface (above)	
	D2	3.5	23.25	Within	
	D3	6.5	27.91	Below	
E	E1	1.5	19.08	Within	
	E2	2.0	20.93	Below	
F	F1	2.5	22.38	Within	
	F2	3.0	23.16	Below	
H	H1	0.5	0.17	N/A	Freshwater (no halocline)
	H2	1.0	0.18	N/A	Freshwater (no halocline)
I	I1	1.0	3.83	N/A	Freshwater/saltwater mix
	I2	2.0	21.3	N/A	Saltwater
Z	Z1	1.0	13.49	Within	
	Z2	2.0	17.33	Below	

Table 6: September 23rd/24th, 2024, 5-in-30 Marine Sample Collection Depth and Halocline Details

Site	Sample ID	Depth (m)	Salinity	Position Relative to Halocline	Comments
A	A1	1.0	15.99	Within	
	A2	2.0	16.82	Below	
B	B1	1.0	15.75	Within	
	B2	3.5	20.83	Below	
C	C1	1.0	14.06	Within	
	C2	3.5	20.19	Below	
D	D1	1.0	16.0	Surface (above)	
	D2	3.0	21.19	Within	
	D3	10.0	31.55	Below	
E	E1	1.0	14.6	Within	
	E2	4.0	24.54	Below	
F	F1	1.0	15.69	Within	
	F2	4.5	28.16	Below	
H	H1	0.5	9.14	N/A	Freshwater/saltwater mix (no halocline)
	H2	1.0	n.s.	N/A	Freshwater/saltwater mix (no halocline)
I	I1	0.5	5.54	N/A	Freshwater/saltwater mix
	I2	3.0	23.27	N/A	Saltwater
Z	Z1	1.0	15.15	Within	
	Z2	2.5	17.62	Below	

Table 7: September 30th, 2024, 5-in-30 Marine Sample Collection Depth and Halocline Details

Site	Sample ID	Depth (m)	Salinity	Position Relative to Halocline	Comments
A	A1	1.0	14.83	Within	
	A2	2.5	18.41	Below	
B	B1	1.0	14.98	Within	
	B2	3.5	20.65	Below	
C	C1	1.0	15.82	Within	
	C2	3.5	26.3	Below	
D	D1	1.0	16.14	Surface (above)	
	D2	3.0	22.69	Within	
	D3	9.0	31.66	Below	
E	E1	1.0	16.87	Within	
	E2	4.0	28.73	Below	
F	F1	1.0	14.07	Within	
	F2	4.5	29.93	Below	
H	H1	0.5	0.07	N/A	Freshwater (no halocline)
	H2	2.5	n.s.	N/A	Freshwater (no halocline)
I	I1	0.5	6.92	N/A	Freshwater/saltwater mix
	I2	3.0	16.55	N/A	Saltwater
Z	Z1	1.0	14.68	Within	
	Z2	2.5	17.57	Below	

APPENDIX F: WATER SAMPLING LAB RESULTS

A link is provided for 2024 lab sampling results from ALS Laboratories:

https://drive.google.com/drive/folders/1M7WILb8yBrwrKbRTc9568fM3ZnXos0sV?usp=sharing