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ALBERNI-CLAYOQUOT REGIONAL DISTRICT

2023 MONITORING REPORT
WEST COAST LANDFILL

Prepared for

ALBERNI-CLAYOQUOT REGIONAL DISTRICT

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EXECUTIVE SUMMARY

This report provides the 2023 annual summary for a surface water monitoring program at the West Coast Landfill (WCL) near Ucluelet, BC. The monitoring program, ongoing since 1996, included 15 surface water sampling sites in 2023. Sites were sampled on a quarterly to annual basis, except when dry conditions precluded sample collection.

Leachate is collected in two ditches on the east and west sides of the landfill and directed to the leachate storage lagoon. Leachate indicator data for the concentrated leachate display a consistent seasonal variation with monthly precipitation and temperature. Chloride concentrations generally increase when precipitation decreases due to the naturally brackish chemistry of the groundwater in the clay sediments underlying WCL. Ammonia generally decreases when precipitation decreases, due to less leachate flushing and greater residence time (and renovation) along seepage pathways.

Leachate is pumped from the leachate storage lagoon to the spray irrigation area north of the landfill, then flows west overland towards Sandhill Creek. The monitoring record demonstrates a consistent reduction in ammonia concentrations on the overland flow pathway towards Sandhill Creek relative to the leachate lagoon, indicating that the irrigation system mitigates ammonia effects during the dry months, when receiving water dilution is lowest and ammonia concentrations present the highest level of risk.

Sampling results at the southwest corner of the site, exhibit a slight leachate effect, with aluminum, iron and chromium exceeding the working and approved guideline criteria for freshwater aquatic life (FWAL) in BC.

Water quality in Sandhill Creek (SW-1) has generally been within the allowable envelope defined by the FWAL guidelines, and/or typical background concentrations for the area. Monitoring data for the lower reach of Sandhill Creek at Highway 4 do not exhibit any indication of leachate effect.

Seven overflow events from the leachate storage lagoon were recorded at WCL in 2023 following periods of rainfall. Water quality results from the two overflow events when samples were collected indicate that there was no measurable effect to Sandhill Creek at SW-1.

The current surface water monitoring program should continue in 2024, and overflow samples should continue to be collected during overflow events. A cumulative flow meter should be installed on the leachate irrigation system to track pumping rates, and the water level in the leachate storage lagoon should be maintained at a low level during the winter months to limit overflow events following heavy rainfall and snowmelt events. The potential for ammonia concentrations to increase with the volume and age of waste presents the most significant risk to Sandhill Creek, so it is important to continue to monitor and properly manage the irrigation system. Partial capping of the landfill and diversion of clean runoff should also be considered to reduce leachate quantity.

RECORD OF AMENDMENTS

This report has been issued and amended as follows:

Issue	Version	Date	Prepared by	Reviewed by
1	Draft	February 5, 2024	Jennifer Mancer, P.Eng. Senior Hydrogeologist Rebekah Manning, EIT Junior Hydrogeologist	David Tiplady, P.Eng. Principal Hydrogeologist
2	2nd Draft	March 13, 2024	Jennifer Mancer, P.Eng. Senior Hydrogeologist Rebekah Manning, EIT Junior Hydrogeologist	David Tiplady, P.Eng. Principal Hydrogeologist
3	Final	March 22, 2024	Jennifer Mancer, P.Eng. Senior Hydrogeologist Rebekah Manning, P.Eng. Intermediate Hydrogeologist	David Tiplady, P.Eng. Principal Hydrogeologist

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1 INTRODUCTION AND BACKGROUND

The West Coast Landfill (WCL) is situated 1 km north of the Pacific-Rim Highway, approximately 9 km northwest of the Tofino-Ucluelet junction, and 7 km southeast from the Tofino Airport. It is located in a previously clearcut area leased from Weyerhaeuser, and borders the Pacific Rim National Park to the south and west (Figure 1).

The WCL is owned by the Alberni-Clayoquot Regional District (ACRD) and operates under Operational Certificate MR-05634 issued by the Ministry of Water, Land and Air Protection on April 12, 2005. It accepts municipal solid waste from the surrounding area, including Ucluelet and Tofino. Berry & Vale Contracting Ltd. operated the landfill for the ACRD through 2023 and Piteau Associates Engineering Ltd. (Piteau) oversaw the water quality monitoring program. Water quality results from the 2023 sampling period, along with relevant results from previous years, have been compiled and are presented and assessed in this report.

A description of the landfill geology, the history of the landfill and water quality program, and descriptions of the monitoring wells and surface water sampling locations, are included in the 2019 monitoring report (Piteau, 2020).

2 MONITORING PROGRAM

2.1 DESCRIPTION OF 2023 MONITORING PROGRAM

The 2023 monitoring program included analysis of surface water samples collected at 15 sites at or close to the West Coast Landfill. The frequency of sample collection, and analyses performed, are summarized on Table 1.

All samples were collected by ACRD personnel in accordance with methods described in the document entitled “Field Procedures for West Coast Landfill” by Piteau (2021). Electrical conductance (EC), pH, and temperature were measured at the time of sample collection, and water samples were collected using a low-flow peristaltic pump or by grab-sampling. Samples for ammonia were preserved with sulphuric acid (H_2SO_4) at the time of collection. All samples were stored with ice in a cooler and shipped to ALS Laboratories in Burnaby, BC.

Average concentrations of key leachate indicator parameters at each site in 2023 are presented in Table 2, along with working and approved guideline criteria for freshwater aquatic life (FWAL) in BC (MOE, 2021), and standards from the Contaminated Sites Regulation (CSR) for aquatic water (AW) and drinking water (DW). As the CSR AW standards are for groundwater, and assume 10 times dilution before entering surface water, analytic water quality data for natural surface watercourses have been compared to one tenth of the AW standard (“CSR AW/10”). Table 3 summarizes all sample locations with concentrations of one or more analytes exceeding FWAL guidelines and/or the CSR standards on one or more occasions during 2023. With the exception of pH, these occurrences are discussed in Section 3.

The dissolved copper FWAL guideline approved in 2019 is dependent on sample pH, temperature, dissolved organic carbon (DOC), humic acid (HA) content, alkalinity, and major cation and anion concentrations. A site-specific dissolved copper guideline was developed for each monitoring location based on the average of sample-specific guidelines calculated using the BC BLM software from 2020 through 2022. Similarly, updated guidelines for total aluminum and dissolved zinc approved in 2023 vary with hardness, pH and DOC. Site-specific guidelines were developed for each monitoring location based on parameters measured in 2020 through 2022. Site-specific hardness, pH, DOC and temperature used to calculate guidelines and standards are indicated in the tables in Appendix A.

Total phosphorus results were also compared to the May to September average phosphorus objective developed for Vancouver Island streams (MOE, 2014). This objective was developed to protect streams from the effects of development, and in particular sewage discharge. The focus of this objective is on southern and eastern Vancouver Island where development pressure is greatest.

Results of the field measurements and laboratory analyses for each of the sampling events in 2023 are summarized in Tables A-1 through A-19 in Appendix A. Key leachate indicator parameters are plotted spatially on Figure 1, and time-series graphs are included with Figures B-1 through B-18 in Appendix B.

2.2 QUALITY ASSURANCE/QUALITY CONTROL

Quality assurance/quality control (QA/QC) processes incorporated in the monitoring program included measures by both the analytic laboratory and by field personnel collecting surface water and groundwater samples. The laboratory component includes analysis of quality control samples to define precision and accuracy, and to demonstrate contamination control for the type of samples and parameters under investigation. These measures include analysis of laboratory replicates, method blanks, and certified reference materials.

QA/QC inherent in the field program included the following measures to ensure sample integrity. Prevention of cross contamination or introduction of foreign contaminants during sampling included use of new latex or nitrile gloves and dedicated sampling equipment at each sample location, and use of unused sample containers provided by the project laboratory.

The field program also included collection and analysis of duplicate samples to verify analytical precision (i.e., repeatability). In 2023, 37 samples and two duplicate samples were collected for analysis. The relative percent difference (RPD) between the sample and the duplicate was calculated in accordance with the following equation:

$$RPD = \frac{(C_1 - C_2)}{(C_1 + C_2)/2} \times 100\%$$

where:

- RPD is relative percent difference;
- C_1 is the larger of the two observed values; and
- C_2 is the smaller of the two observed values.

RPD values below about 35% are generally desirable, and values of up to about 65% are considered acceptable. For the three field duplicate samples collected in 2023 all calculated RPDs were below 35%, except for the 42% RPD for total titanium and 47% RPD for total zinc at SW-10 in November (Appendix C). Both the primary (0.0081 mg/L) and duplicate (0.0131 mg/L) total zinc concentrations exceed one tenth of the CSR AW standard (0.075 mg/L). The maximum titanium concentration was 0.0141 mg/L and is well below one tenth of the 1.0 mg/L CSR AW standard.

The elevated RPD in the above-noted samples can be attributed to inclusion of sediment in the samples, which often leads to positive bias and increases the degree of variability in analytical results. Due to the low reported concentrations close to the detection limits, these elevated RPD values are not considered to be of concern.

3 SAMPLING RESULTS

3.1 COLLECTED LEACHATE QUALITY

3.1.1 SW-2, SW-3 and SW-4

Sample collection sites SW-2 and SW-4 are located where Leachate Ditch #2 and Leachate Ditch #1 drain into the leachate storage lagoon. SW-3 is located at the pump intake in the lagoon. Four samples were collected at SW-3 in 2023, but only three samples were collected from SW-2 and only two from SW-4 due to dry conditions in the spring and summer.

Analysis results for SW-2, SW-3, and SW-4 indicated elevated concentrations of total dissolved solids (TDS) and chloride (Tables A-2, A-3 and A-4, Figures B-1 and B-3), and are indicative of concentrated leachate. Hardness and alkalinity were also elevated, with 2023 average results for total hardness ranging from 287 to 382 mg/L as $CaCO_3$ and average alkalinity ranging from 391 to 496 mg/L as $CaCO_3$ (Table 2).

Long-term trends indicate that leachate indicator concentrations dropped after the implementation of the leachate interception measures in 2004, and began to rise in 2013 (Appendix B). The rise since 2013 is attributed to the drying trend seen in the local weather, and thus reduced dilution and in some instances waste composition and/or extent exposed to leaching. Although 2023 was a second consecutive drier than average year, overall concentrations of analyzed parameters concentrations were within the range of values reported since 2013.

Seasonally, leachate indicator concentrations typically peak in the late summer/early fall when dilution is minimal. Accordingly, concentrations at SW-3 were highest in June and August 2023. SW-2 and SW-4 were dry when concentrations are typically highest.

In 2023, the SW-2 samples displayed higher leachate concentrations than SW-4. The difference in TDS, chloride and nitrate concentrations between the two sites is typically more pronounced during the summer (drier) months. This may indicate that as the region becomes drier flows in Leachate Ditch #1 receive more dilution than that in Leachate Ditch #2.

Ammonia concentrations are typically higher at SW-4 and SW-2 than at SW-3 (Tables A-2, A-3 and A-4 and Figure B-5). This indicates that nitrification is occurring in the leachate storage lagoon. All ammonia concentrations measured in leachate in 2023 were above the FWAL guideline (1.84 mg/L-N) and concentrations in about half of the samples also exceeded the CSR AW standard (18.5 mg/L-N).

Nitrate concentrations in the leachate collection system reported in 2023 were consistent with results from the previous eight years. The only exceedance of the FWAL guideline (3 mg/L-N) was measured at SW-2 (5.31 mg/L-N) in February (Table A-2 and Figure B-7). Nitrate concentrations were generally lower at SW-3 and SW-4.

Total phosphorus concentrations measured in the leachate system have remained within previously observed ranges. The three samples collected between May and September exceeded the May to September average Vancouver Island phosphorous objective for streams (0.005 mg/L; MOE, 2014) by multiples of between eight and ten (Tables B-2, B-3, B-4 and 3).

Chemical oxygen demand (COD) has declined since the highs measured in 2013, with a maximum concentration of 130 mg/L measured at SW-2 in 2023 (Table A-2, Figure B-9). The relative values for reflect the mixing ratio of the SW-2 and SW-4 waters in the storage lagoon, evaporation in the summer months, and renovation from residence time in the leachate storage lagoon.

Historical five-day biochemical oxygen demand (BOD_5) in samples collected at SW-2, SW-3 and SW-4 are typically less than 40 mg/L-O (Figure B-11), reflecting the low strength of the leachate. Levels in 2023 were lower than for previous years, with the majority of the reported values close to or below the laboratory's detection limit of 2 mg/L-O. The highest BOD_5 (32.4 mg/L-O) was reported for SW-3 in August (Table A-3).

Similar to the 2022 results, total aluminum concentrations in leachate in 2023 were lower than in previous years (Figure B-13). There were no exceedances of the updated FWAL guideline for total aluminum.

Since the implementation of the leachate collection system in 2004, total iron concentrations in the leachate have remained below 40 mg/L, with exceptions in 2013, 2014 and 2023. Concentrations in 2023 ranged from 0.362 mg/L to 59.3 mg/L, exceeding the FWAL guideline (1 mg/L) in seven of nine samples. Total iron also exceeded the CSR DW standard at SW-2 in June, and at SW-3 and SW-4 in November (Tables 3, A-2, A-3, and A-4, and Figure B-15).

In 2023, total manganese concentrations in leachate were within the range of values measured since 2005 (Figure B-17). The highest concentration (5.8 mg/L) was recorded at SW-2 in June. Three of nine samples exceeded the hardness-dependent FWAL guideline (1.57 to 2.37 mg/L), and four samples exceeded the 1.5 mg/L CSR DW standard (Tables A-2, A-3, and A-4).

Samples from SW-3 were submitted for analysis of the complete metals package. Other than the total iron noted above, only boron, chromium, and cobalt had slight exceedances of FWAL guidelines or CSR standards (Tables 3 and A-3).

All samples collected from SW-3 in 2023 were analyzed for volatile organic compounds (VOCs). Results indicated concentrations of all analytes were below the applicable reporting limits (Tables A-15 and A-16). The August sample from SW-3 was also submitted for analysis of a broad spectrum of potential organic contaminants, including: chlorinated phenolics, non-chlorinated phenolics, hydrocarbons, polycyclic aromatic hydrocarbons, semi-volatile organics, and pesticides (Tables A-17 and A-18). Concentrations of all parameters analyzed were below reporting limits.

No samples collected in 2023 were analyzed for per- and polyfluoroalkyl substances (PFAS). However, samples analyzed for these substances in 2021 had concentrations below the laboratory's detection limit and/or far below application guidelines or standards.

3.1.2 SW-14

SW-14 is sampled where the pipe collecting the runoff from the composting facility discharges into Leachate Ditch #1 (Figure 1). It was first sampled in April 2020, shortly after composting commenced at the trial facility. Samples were only collected here in February and November 2023, as it was dry in June and August.

In 2023, TDS, chloride, ammonia, nitrate, BOD_5 and COD were generally lower than levels measured in samples from SW-2, SW-3 and SW-4 (Table 2, Figures B-1, B-3, B-5, B-7, B-9 and B-11). Chloride and COD were significantly lower in 2023 samples than in samples collected in 2020 and 2021.

Both samples from SW-14 in 2023 exceeded the FWAL guidelines for aluminum (factors of 2.3 and 1.4) and iron (factors of 1.3 to 2). The February sample (0.0016 mg/L) also slightly exceeded the FWAL guideline for chromium (0.001 mg/L), and the November sample had chromium results at the CSR DW standard (0.001 mg/L). No other exceedances were reported for SW-14 (Table A-14 and 3).

3.2 LEACHATE IRRIGATION WATER RECEIVING AREA AND WEST LANDFILL BOUNDARY

3.2.1 SW-8 and SW-9

SW-8 and SW-9 are located in the spray irrigation water receiving area in the northern part of the facility. Both locations were dry for the June and August 2023 sampling events, and were therefore sampled only in February and November. The analytic results for these locations indicate significant leachate effect due to the upslope application of irrigation water (Table 2). However, concentrations of TDS and chloride remained within previously observed bounds, with concentrations at SW-9 generally higher than at SW-8 (Table 2, Figures B-1 and B-3). Peak concentrations at SW-8 and SW-9 are typically observed in the summer months when conditions are driest.

All ammonia concentrations measured in 2023 were below the 30-day average FWAL guideline (1.84 mg/L-N) and the CSR AW standard (3.7 mg/L-N) (Figure B-5). The maximum ammonia concentration of 1.24 mg/L-N was reported for SW-8 in February (Tables A-8 and A-9). Nitrate concentrations for the four 2023 samples ranged from 8.59 to 10.9 mg/L-N. All nitrate concentrations exceeded the FWAL guideline (3 mg/L-N) and the November results also exceeded the CSR DW standard (10 mg/L-N) (Figure B-7).

COD and BOD_5 in 2023 samples from SW-8 and SW-9 remained on the lower end of the previously observed range (Figures B-9 and B-11).

Total aluminum concentrations were lower than in previous years, in part due to dry conditions that precluded sample collection in summer when concentrations are typically highest. All total aluminum results at SW-8 and SW-9 for 2023 were below the updated site-specific total aluminum FWAL guideline (Figure B-13 and Tables B-8 and B-9). Total iron and manganese concentrations remained low, with all results below the FWAL guidelines (Figures B-15 and B-17).

The 2023 monitoring results for sites SW-8 and SW-9 continued to show varying leachate effect in response to the irrigation of water over the upland area. The sampling results also indicate that:

- the irrigation system promotes significant nitrification year-round;
- irrigation promotes plant uptake of nutrients and increases evapotranspiration losses of leachate in the summer months; and
- irrigation increases leachate dilution prior to discharge to Sandhill Creek in the winter months.

Overall, the results indicate the lagoon/irrigation system promotes oxidation and precipitation of iron. Some instances of higher total iron concentrations measured from 2013 to 2015 suggest this may not always be the case; however, concentrations were mostly lower than in the leachate samples from SW-2, SW-3 and SW-4, indicating iron concentrations are reduced relative to typical leachate. The irrigation system does appear to reduce iron and ammonia loading to Sandhill Creek, particularly during the growing season, when ammonia effects on Sandhill Creek are expected to be the most significant.

3.2.2 SW-6

SW-6 is located in an area of ephemeral ponding in the buffer zone along the west edge of the landfill (Figure 1) where water from the spray irrigation area passes before leaving the property. It was dry during the June and August sampling events and was thus sampled only twice in 2023.

Concentrations of TDS and chloride in 2023 samples from SW-6 were within the range of previously observed data and were similar to or lower than concentrations measured at SW-8 and SW-9 (Figures B-1 and B-3). At 0.0637 mg/L-N, the maximum ammonia concentration in 2023 is on the lower end of the range for recent years (Table A-6 and Figure B-5). Lower ammonia concentrations are balanced by higher nitrate concentrations, with both concentrations exceeding the FWAL guideline (3 mg/L) and higher than typically observed at this site (Figure B-7). Elevated nitrate concentrations may be associated with higher levels of nitrification and drier-than-average conditions.

Total aluminum concentrations at SW-6 in 2023 were higher than those measured at SW-8 and SW-9, but remained below the updated FWAL guideline for both sampling events (Tables 2 and A-6, Figure B-13). Iron and manganese concentrations in the two samples were below FWAL guidelines (Figures B-15 and B-17).

Overall, historical TDS, chloride, ammonia and nitrate data suggest water quality at SW-6 has a slight leachate effect. Compared to SW-8 and SW-9, samples from SW-6 generally show improvement for leachate indicators (Table 2). In 2022 and 2023, relative concentrations of nitrate and ammonia indicated high nitrification rates. Chloride concentrations closely track those measured at SW-8 and SW-9 (Figure B-3), suggesting the reduced nutrient loading is not solely attributable to dilution.

3.3 SOUTHWEST AND SOUTH LANDFILL BOUNDARIES

3.3.1 SW-11

SW-11 is located west of the landfill in a natural gulley that exhibits perennial flow and appears to be receiving leachate that seeps past Leachate Ditch #2 or overflows from the leachate pond after periods of heavy rain. This location was noted to be dry in June and September so only two samples were collected in 2023.

TDS and chloride have historically been elevated at SW-11. Concentrations measured in 2023 were typical of recent years, averaging 108 and 26 mg/L, respectively (Table 2, Figures B-2 and B-4).

Ammonia concentrations at SW-11 have dropped since 2018, with all results for 2023 below 0.1 mg/L-N, which is well below the 1.84 mg/L-N FWAL guideline (Table A-11 and Figure B-6). Nitrate concentrations ranged from 0.116 and 0.409 mg/L-N in 2023 (Table A-11 and Figure B-8). The concentration trends for SW-11 do not correlate with results for SW-2 (Leachate Ditch #2). This suggests a localized source within the landfill, and hence a discrete seepage path beneath Leachate Ditch #2 (Piteau, 2020).

COD at SW-11 was relatively low in 2023, and reached a maximum reported value of 30 mg/L-O in November (Table A-11 and Figure B-10). BOD_5 was at or less than the 2 mg/L-O detection limit in all samples analyzed (Figure B-12).

Total aluminum concentrations were 0.775 and 0.832 mg/L in 2023, with both samples exceeding the updated site-specific FWAL guideline of 0.17 mg/L (Table A-11 and B-14). The aluminum concentrations were historically similar to the background values (Section 3.4) but increased relative to background values between 2015 and 2021. Concentrations measured in 2022 and 2023 were at background values.

In 2023 total iron concentrations at SW-11 ranged from 1.46 to 2.73 mg/L. Although lower than measured in previous years (Table A-11 and Figure B-16), this range is above the FWAL guideline. The highest concentrations are typically observed in the summer months (Figure B-16). Summer peaks above 10 mg/L have not been recorded since sample collection with a low-flow method (peristaltic pump) began in April 2018.

Manganese concentrations in samples collected from SW-11 in 2023 remained below the FWAL guideline (Table A-11; Figure B-18) and were consistent with results from previous years.

Also consistent with results from previous years, total chromium concentrations at SW-11 measured 0.00131 and 0.00133 mg/L in 2023. The results exceeded the Cr(VI) FWAL guideline of 0.001 mg/L by a factor of 1.3 (Table A-11).

Copper concentrations reported for samples collected at SW-11 during 2023 exceeded the site-specific calculated dissolved copper guideline (0.0014 mg/L) by factors of 1.3 and 1.7 (Table A-11).

Consistent with results from previous years, total zinc ranged from 0.0083 to 0.0147 mg/L (Table A-11). Both results were below the updated site-specific FWAL guideline (0.019 mg/L).

The only other metals exceedance at SW-11 was cobalt in the November 2023 sample (0.00278 mg/L), which was greater than the CSR DW standard (0.001 mg/L).

The monitoring results indicate the small gulley at SW-11 is a pathway for movement of leachate towards Sandhill Creek. Leachate effects (primarily nitrate and ammonia) appeared to drop in 2009, likely as a result of deepening of Leachate Ditch #2 (Piteau, 2010 and 2020). The ammonia results are highly variable, but overall, appear to correlate with concentrations in the leachate. SW-11 continues to exhibit a moderate leachate effect, with iron, chromium and copper concentrations regularly exceeding their respective 30-day FWAL guidelines.

3.3.2 SW-12

SW-12 is located near the park boundary in the southwest corner of the property, down gradient from the leachate lagoon, and represents the south landfill effect on Sandhill Creek. During 2023 samples were collected at SW-12 in February and November. None were collected in June and August due to dry conditions.

TDS and chloride concentrations at SW-12 remained within previously observed bounds in 2023 (Figures B-2 and B-4). Both analytes vary seasonally, but to a much lesser extent than in leachate (Tables 2 and A-12).

Ammonia concentrations at SW-12 are relatively low, but since 2015 have increased slightly with exceedances of the FWAL guideline in 2015 and 2018 (Figure B-6). Ammonia was at or below 1.2 mg/L-N in both samples in 2023, and below the 1.84 mg/L-N FWAL guideline (Table A-12).

Nitrate concentrations at SW-12 were 0.282 and 0.698 mg/L-N in November and February, and were below the 3 mg/L-N 30-day average FWAL guideline as in previous years (Table A-12 and Figure B-8).

Total aluminum concentrations in 2023 ranged from 0.893 to 1.28 mg/L, and both exceeded the updated site-specific FWAL guideline of 0.29 mg/L (Table A-12 and Figure B-14). Aluminum concentrations were historically similar to the background values, but like those at SW-11, increased relative to background values after 2015.

Total iron concentrations at SW-12 up to May 2015 ranged between 0.19 and 2.9 mg/L, with approximately 10% of the results exceeding the current FWAL guideline (1 mg/L). Since 2015, total iron has routinely exceeded the FWAL guideline. Both 2023 samples exceeded the FWAL guideline by factors of 1.1 and 1.7 (Table A-12 and Figure B-16).

Results for SW-12 suggest only a very slight leachate effect in relation to the SW-7 background data. Leakage from the leachate lagoon, and southward seepage from the landfill in general, are therefore interpreted to be minimal, indicating effective containment is provided by Leachate Ditch #1 and the storage lagoon.

3.4 BACKGROUND CREEKS

3.4.1 SW-7

SW-7 drains the northeastern portion of the landfill property and is separated from the landfill area by a surface water divide. It is included in the monitoring program to provide background water quality data for the site. This location was sampled in February and November 2023, and was noted to be dry in June and August.

Alkalinity and hardness are typically low at SW-7, with the record to date exhibiting a typical range of 4 to 69 mg/L as $CaCO_3$. Average alkalinity and hardness values were 30.8 and 31.5 mg/L as $CaCO_3$, respectively, in 2023 (Table 2).

Water quality for SW-7 during 2023 was characterized by a TDS of 95 mg/L (Table A-7 and Figure B-2). Chloride concentrations were consistently about 20 mg/L (Figure B-4). Chloride concentrations in recent years have consistently been higher than in 2012, and likely reflect the drier-than-average summers and autumns of recent years.

Ammonia concentrations in samples collected at SW-7 in 2023 were below 0.2 mg/L-N, and were typical for this background site (Figure B-6). Corresponding nitrate concentrations ranged from 0.0143 to 0.811 mg/L-N, and remained well below the FWAL guideline of 3 mg/L-N (Figure B-8).

Total phosphorus at SW-7 typically exceeds the May to September average Vancouver Island phosphorous objective for streams (0.005 mg/L; MOE, 2014) in the summer samples. The site was dry for the June and August sample events in 2023.

Prior to 2006, samples from SW-7 had pH typically ranging between 5 and 6.4. Both field and lab pH values have exhibited a slight increasing trend since 2006, with 2023 field and lab pH values averaging 6.4 and 7.1, respectively. Low pH is characteristic of peat bogs.

In 2023, COD at SW-7 ranged between 16 and 45 mg/L-O and BOD_5 range from below the detection limit of 2 mg/L-O to 2.4 mg/L-O (Table A-7). Elevated values measured in 2021 were not repeated in 2022 or 2023 (Figures B-10 and B-12).

Total metal concentrations at SW-7 in 2023 were below the FWAL guidelines and CSR AW/10 and DW standards, with the following exceptions (Tables 3 and A-7):

- Aluminum concentrations exceeded the updated site-specific guideline (0.10 mg/L) by factors of 4 to 6 (Figure B-14);
- Chromium measured in November exceeded the FWAL guideline and CSR AW/10 standard (0.001 mg/L) by a factor of 1.2;
- Cobalt exceeded the CSR DW standard (0.001 mg/L) by a factor of 1.6 in November;
- Total copper was evaluated against site-specific dissolved copper FWAL guidelines. The November result (0.00155 mg/L) slightly exceeded the FWAL guideline (0.0013 mg/L) but remained below the CSR AW/10 standard (0.002 mg/L); and
- Iron exceeded the FWAL guideline (1 mg/L) by a factor of 2 in November.

Other metals that have exceeded FWAL guidelines at this background site in previous years include arsenic, manganese, mercury, silver and zinc. Most exceedances are attributed to low creek water levels leading to elevated amounts of sediment in the samples.

Since the leachate interception system was commissioned in 2004, elevated concentrations of iron and manganese have been encountered more frequently (Figures B-16 and B-18). As the elevated concentrations typically occur in the summer, they are at least partially attributed to the drier than average weather experienced over the past decade. However, although exceedances of nitrate and ammonia at SW-7 are rare, these nutrients have been detected more frequently at higher concentrations in recent years. In light of these results, it is possible that the SW-7 background site is receiving some landfill effect. However, as previously reported, no flow toward SW-7 from the landfill or the spray irrigation area was visually observable in November 2020 following an interval of heavy rain (Piteau, 2021). This site will continue to be monitored for any indications of leachate effect.

3.4.2 SHC East Tributary

The SHC East Tributary sample collection site is near the southeast corner of the facility and was added to the landfill monitoring program in 2018. It is intended to further characterize background chemistry during summer low flow periods in a tributary of Sandhill Creek that is unlikely to receive any effect from the landfill. Due to dry conditions in the summer of 2023, collection of the annual sample was delayed to November.

TDS, chloride, and alkalinity values in samples collected at the SHC East Tributary site were lower than the other creek sampling sites, indicating a lower proportion of groundwater from marine clay is present in this upper reach of Sandhill Creek (Tables A-13 and 2 and Figures B-2 and B-4). BOD_5 and concentrations of total metals were close to those measured in SW-7 (Figures B-10, B-12, B-14, B-16 and B-18). The September 2021 ammonia concentration and COD were anomalously high compared to previous years and other sampling sites, but were not repeated in November 2023 (Figures B-6 and B-8). Since these anomalous results were not accompanied by elevated chloride, they are unlikely to have been associated with landfill leachate.

Exceedances of the FWAL guideline in 2023 were limited to (Tables 3 and A-13):

- Total aluminum (0.298 mg/L compared to the site-specific 0.06 mg/L guideline); and
- Total copper (0.00094 mg/L compared to the site-specific 0.0002 mg/L dissolved copper guideline).

There were no exceedances of the CSR AW/10 standard in 2023. In previous years total silver has exceeded the FWAL guideline and CSR AW/10 standard at this site.

Water quality at the East Tributary of Sandhill Creek is similar to the SHC site 1 km southwest of the landfill, and at SW-7. Samples collected to date do not exhibit any landfill effect. With the exception of one anomalous ammonia concentration in 2021, all results show negligible concentrations of nitrate and ammonia and low concentrations of chloride, TDS and alkalinity (Table A-13). Metals exceedances at this site are associated with a combination of background chemistry, low flow during sampling leading to increased sample turbidity, and/or concentrations close to the detection limit and FWAL guidelines.

3.5 RECEIVING CREEKS

3.5.1 SW-10 Upstream (SW-10US)

SW-10-US is immediately upstream of a culvert that directs water under an old logging road (Figure 1) and is sampled annually.

Although samples from SW-10US have previously had slightly elevated TDS, chloride, alkalinity, ammonia and nitrate relative to samples from SW-10 (located 180 m downstream), concentrations measured in 2023 were similar to or lower than those at SW-10 (Figures B-2, B-4, B-6, and B-8; Table A-10). Total aluminum results exceeded the site-specific FWAL guideline for aluminum (0.2 mg/L) in 2023, which is consistent with results since 2015 and the background sampling sites. Total phosphorus also exceeded the May to September average Vancouver Island phosphorous objective for streams (0.005 mg/L; MOE, 2014) in the August sample by a factor of five (Tables A-10 and 3). This result is consistent with previous monitoring results at SW-10US, as well as concentrations at background sampling sites (SW-7 and SHC East Tributary). No other exceedances were identified for the SW-10US sample.

The leachate indicator chemistry results for the SW-10US samples show minimal leachate effect, and a slight improvement compared to the upgradient SW-6 site (Tables 2, A-6 and A-10).

3.5.2 SW-10

SW-10 is upstream of the point where flow at SW-11 enters the Sandhill Creek tributary. Four samples were collected here in 2023.

At 30 mg/L, the average chloride concentration at SW-10 in 2023 was slightly elevated relative to concentrations prior to 2013 (Table 2 and Figure B-4). The increased concentrations are attributed to drought conditions when creek baseflow is virtually 100% discharging groundwater.

In 2023, ammonia concentrations at SW-10 ranged from <0.005 to 0.0191 mg/L-N (Table A-10 and Figure B-6). Nitrate concentrations increased slightly, ranging from 0.0052 to 0.956 mg/L-N, but remained well below the 3 mg/L-N FWAL guideline (Figure B-8). Total phosphorus was typical of previous years and background creeks. It exceeded the May to September average Vancouver Island phosphorous objective for streams (0.005 mg/L; MOE, 2014) in the June and August samples by factors of three and five, respectively (Tables A-10 and 3).

Total metal concentrations at SW-10 during 2023 were below the FWAL guidelines, CSR AW/10, and DW standards, with the following exceptions (Tables 3 and A-10):

- Aluminum exceeded the updated site-specific FWAL guideline (0.20 mg/L) for three of four sampling events by factors of 1.6 to 1.9 (Figure B-14);
- Cobalt (0.00103 mg/L) slightly exceeded the CSR DW standard (0.001 mg/L) in June;
- Total copper was evaluated against site-specific dissolved copper FWAL guidelines. The August and November results (0.00122 and 0.00135 mg/L) slightly exceeded the FWAL guideline (0.0012 mg/L) but remained below the CSR AW/10 standard (0.002 mg/L);
- Iron exceeded the FWAL guideline (1 mg/L) by a factor of 1.4 in August; and
- Zinc (0.0081 mg/L) slightly exceeded the CSR AW/10 standard (0.0075 mg/L) in November.

Water quality results at SW-10 are consistent with previous years. Chloride and nitrate concentrations are slightly above levels in background creeks, indicating this site may receive some leachate from the irrigation area, but concentrations of trace metals are similar to those at background creeks.

3.5.3 SW-1

Site SW-1 is located on Sandhill Creek downstream of the leachate irrigation area and leachate discharge at SW-11. All significant leachate effects should therefore be reflected in the results at this site. Three samples were collected from SW-1 in 2023; the site was dry in August.

Samples collected at SW-1 have historically displayed chloride concentrations up to 100 mg/L (Figure B-4). In 2023, chloride concentrations were mostly in the lower half of the historical range, with a peak value of 45.9 mg/L in June (Table A-1). TDS concentrations were also in the lower portion of the historical range, averaging 127 mg/L (Table 2 and Figure B-2). Hardness ranged between 24.4 and 65.3 mg/L as $CaCO_3$ during 2023, with the highest value occurring in June. Alkalinity ranged from 13 mg/L to 58 mg/L as $CaCO_3$.

Ammonia concentrations at SW-1 have ranged up to 7.7 mg/L-N (Figure B-6). The maximum concentration in 2023 (0.113 mg/L-N in June) was well below the FWAL guideline (1.84 mg/L-N).

Nitrate concentrations are typically low at SW-1. The maximum nitrate concentration in 2023 (0.91 mg/L) was measured in February. All nitrate concentrations have remained below the FWAL guideline of 3 mg/L-N, except for samples collected in August 2006 and February 2022 (Figure B-8).

Total phosphorus exceeded the May to September average Vancouver Island phosphorous objective for streams (0.005 mg/L; MOE, 2014) in the June sample by a factor of six (Tables A-1 and 3). Phosphorus concentrations are consistent with levels reported for SW-1 in previous years, as well as concentrations at background creek sampling sites SW-7 and the SHC East Tributary.

COD at SW-1 varied between 28 and 30 mg/L-O in 2023, and was comparable with the concentrations at background site SW-7 (Figure B-10). BOD_5 was below the detection limit for all 2023 samples (Figure B-12).

Consistent with the SW-7 and East Sandhill Creek background locations, total aluminum concentrations in two of the three samples collected at SW-1 in 2023 exceeded the updated site-specific FWAL guideline of 0.29 mg/L (Figure B-14). The elevated aluminum concentrations are attributed to the low pH of the water in the natural peaty environment.

Total iron at SW-1 (1.29 mg/L) exceeded the 1.0 mg/L FWAL guideline in June 2023 (Table A-1). Concentrations at SW-1 typically exceed the SW-10 concentrations (Figure B-16). The difference is attributed to iron loading from the drainage course at SW-11.

Manganese concentrations in all 2023 samples from SW-1 were below 0.5 mg/L (Table A-1). These low concentrations are consistent with results since 2019 (Figure B-18).

VOC analyses were performed on the February, June and November samples from SW-1. All results were below the laboratory reporting limits (Tables A-15, A-16).

Results for the creek sampling program indicate little to no leachate effect at SW-1; the concentrations of chloride, ammonia, nitrate, iron, and manganese are similar to those measured at background site SW-7. The alkalinity in the creek is greater than values recorded at SW-7, reflecting the contribution of natural groundwater to the SW-1 flow. Leachate effect is not considered to be significant in comparison to background water quality, especially considering the slightly brackish chemistry of the natural groundwater in the area. Elevated concentrations of iron and manganese were measured in the summers during periods of very low baseflow from 2010 to 2018. There are no apparent increasing trends apparent, but the high variability of the peak concentrations makes it difficult to identify any slight trends.

3.5.4 SHC (Sandhill Creek Upstream of Highway 4)

Monitoring of water quality at the SHC site located approximately 1 km southwest of the landfill commenced in 2003. Chloride concentrations have been similar to those at SW-7 (background) during most of the year, but have been elevated during low-flow periods in summer (Figure B-4). During the extended dry period starting in 2007, the summer chloride concentrations at SHC have often been higher than at SW-1 and SW-10 on the same dates. These results indicate that during dry baseflow conditions, the lower reaches of Sandhill Creek receive a greater component of groundwater from the marine clay than in the upper reaches.

Total aluminum concentrations are elevated at background and receiving creek sites, and have demonstrated similar response throughout the period of record (Figure B-14 and Table A-5). Aluminum concentrations in all four 2023 SHC samples exceed the updated site-specific FWAL guideline. Total iron concentrations have often exceeded the 1 mg/L FWAL guideline in the summers since 2010, including the maximum iron concentration in 2023 (1.55 mg/L in August) (Table A-5 and Figure B-16). Total manganese concentrations at SHC have remained below the updated FWAL guideline (Figure B-18).

Consistent with results from previous years and background sites, total phosphorus in samples collected at the SHC site also exceeded the May to September average Vancouver Island phosphorous objective for streams (0.005 mg/L; MOE, 2014) in the June and August samples by factors of five to six.

Water quality results for the SHC site are comparable to results from background sites SW-7 and SW-10, and thus do not exhibit any leachate effects. All exceedances at this location were slight and remain within the envelope of background chemistry for the area.

3.6 ADDITIONAL SAMPLING SITES

3.6.1 PW-SS (Scale Shack Tap)

The water at the Scale Shack Tap is supplied from a nearby shallow dug well for which no well log is available. It is not consumed as drinking water. Although this site is not part of the monitoring program to assess landfill effects, the ACRD plans to sample PW-SS annually.

A sample collected from the washroom tap in the scale shack in August 2023 was analyzed for physical parameters, anions, cations, nitrate, nitrite, selected total metals, total coliforms, and E.coli. All results were below GCDWQ and CSR DW, with the exception of the following (Table A-19):

- Total coliforms (200 MPN/100 mL) and e. coli (11 MPN/100mL) exceeded the maximum acceptable concentration (MAC) of 0 MPN/100mL;
- Total iron (0.399 mg/L) exceeded the aesthetic objective (AO) of 0.3 mg/L;
- Total lead (0.0128 mg/L) exceeded the MAC of 0.005 mg/L and the CSR DW of 0.01 mg/L; and
- Total manganese (0.0965 mg/) exceeded the AO (0.02 mg/L) but remained below the MAC (0.12 mg/L).

Groundwater from the scale shack tap also exceeded FWAL guidelines and CSR AW standards for total copper and zinc, and FWAL guidelines for lead and silver. No leachate effect is indicated at this site.

4 OVERFLOW EVENTS

Overflowing of the Leachate Storage Lagoon typically occurs after significant storm events in the winter months (October through April) when water decants through perforated overflow pipes at the northwest corner of the lagoon (Figure 1). The timing and duration of overflow events are inferred from the water levels measured in the overflow pipe and information provided by the landfill operator. Six overflow events were recorded between January and May 2023, with durations ranging from 28 hours to 35 days. An additional 3-day overflow event was recorded in October 2023. Unlike previous years, most overflow events resulted from less than 100 mm of precipitation over the preceding five days (Table D-1).

During overflow events on April 17 and October 19, water samples were collected at the pond (SW-3), in the leachate flow path (SW-11), and in the receiving creek (SW-1). Analysis results are tabulated with the FWAL maximum guidelines and the 30-day average guidelines (Tables D-2 through D-4). The 30-day average guidelines represent long-term sub-lethal and lethal effects for indefinite exposures, whereas the maximum guidelines represent short-term lethal effects to aquatic life.

Relative to routine sampling events, water quality analyses results for samples collected during overflow events typically indicate diluted leachate (Figure D-1 and Table D-2). Exceptions include total aluminum, BOD_5 and total phosphorus, which are likely associated with high turbidity in the lagoon during periods of high precipitation (Piteau, 2020). Dilution factors between SW-3 and SW-1 have previously ranged from 1 to 50, and average about 10 for metals results in 2023 (Table D-3).

The following exceedances are noted for the two overflow samples collected in 2023. Where a separate maximum guideline has been developed, results from the 3-day October overflow event have been compared against the maximum guideline; all other results have been compared against long-term (30-day) guidelines and standards:

- Nitrate and ammonia exceeded their respective 30-day guidelines in the overflow samples from SW-3 and SW-11 in April by factors of 1.1 to 3.4, and ammonia exceeded the 30-day guideline at these two sites in October by factors of 1.0 to 2.5 No samples exceeded the separate maximum FWAL guideline;
- Aluminum exceeded the 30-day guidelines in all samples from all three sites except SW-3 during the October overflow event. No maximum FWAL guidelines have been developed for aluminum;
- Chromium exceeded the 30-day guidelines in all samples from SW-3 and SW-11 by factors of 1.6 to 3.5. No maximum FWAL guidelines have been developed for chromium;
- Cobalt exceeded the CSR DW for the SW-3 overflow samples by factors of 1.5 to 1.6;
- Total copper exceeded the dissolved copper 30-day guidelines calculated for the longer April overflow event for samples collected from SW-3 and SW-11 (factors of 1.8 to 4.6). Samples from these sites for the shorter October event also slightly exceeded the maximum guideline (factors of 1.0 to 1.3).

- Iron exceeded the maximum guideline for both SW-3 and SW-11 samples by factors of 1.4 to 5.

All three samples from the October 2023 overflow event were also submitted for VOC analyses. No compounds were detected, except for acetone and methyl ethyl ketone in the SW-3 and SW-11 samples. Only CSR DW standards exist for these compounds, and the reported concentrations were at least 20 times less than the applicable standards.

Water quality results from the two sampled overflow events indicate that there is no measurable effect to Sandhill Creek at SW-1. Only aluminum exceeds FWAL guidelines at this site, but at concentrations typical of levels in background creeks.

5 CONCLUSIONS

Overall, the 2023 monitoring data indicate there is a continuing slight leachate effect to receiving waters in the vicinity of the West Coast Landfill. However, there are no long-term increasing trends apparent that would suggest the effects of the landfill are increasing over time.

5.1 LEACHATE COLLECTION SYSTEM

Recent chloride and ammonia data for the concentrated leachate display a consistent seasonal variation with monthly precipitation and temperature. Chloride concentrations generally increase when precipitation decreases due to the absence of surface runoff and the naturally brackish chemistry of the groundwater in the clay sediments that underlie the peat. Ammonia generally decreases when precipitation decreases, due to less leachate flushing and greater residence time (and renovation) along seepage pathways.

In 2023, the parameters that exceeded receiving water guidelines (FWAL), the May to August average phosphorus objective for Vancouver Island streams, and/or CSR standards in the concentrated leachate were chloride, nitrate, ammonia, total phosphorus, total aluminum, boron, chromium, cobalt, iron, and manganese (Tables A-3 and 3). Over the history of the monitoring program, toluene, cadmium, copper, and zinc exceedances have also occurred in leachate.

5.2 IRRIGATION RECEIVING AREA

Analysis results for sites SW-8 and SW-9, located on the overland flow pathway from the irrigation site towards Sandhill Creek, indicate that some renovation of leachate quality (e.g., nitrification and plant uptake of nutrients) does occur during the growing season, when temperatures are highest. The monitoring record to date for these two sites demonstrates a consistent reduction in ammonia concentration relative to the leachate lagoon (SW-3), indicating that the irrigation system mitigates ammonia effects during the summer and early autumn months, when receiving water dilution is lowest and ammonia concentrations present the highest level of risk.

SW-6 is sampled from an area of ephemeral ponding in the buffer zone along the west edge of the landfill where water from the spray irrigation area passes before leaving the property. The results of sampling events available for the SW-6 site indicate some slight leachate effect at this site.

5.3 SOUTH AND SOUTHWEST BOUNDARIES

Sampling results for SW-11, located in a natural gulley on the western boundary at the southwest corner of the site, exhibit a slight leachate effect, and indicate that leachate seepage past or around Leachate Ditch #2 is not entering the leachate storage lagoon. The most significant leachate effects at SW-11 are aluminum, chromium and iron, with concentrations regularly exceeding the FWAL guidelines. Total manganese concentrations have remained relatively low since 2019, possibly due to a change to low-flow sample collection with a peristaltic pump.

SW-12 is located on the southern boundary at the southwest corner of the landfill, and water quality results for this location are indicative of the landfill effect on Sandhill Creek. These indicate a slight leachate effect, with aluminum and iron concentrations exceeding the FWAL guideline.

5.4 RECEIVING CREEK

Monitoring results for the receiving water monitoring site (SW-1) indicated only very slight leachate effect during 2023. While several parameters exceeded FWAL and/or CSR AW standards for surface water on at least one occasion, the only parameter to regularly exceed FWAL guidelines was aluminum. Metals exceedances were isolated or only slightly exceeded the relevant guidelines/standards. Based on data from SW-10 and SW-11, it appears that elevated aluminum and iron concentrations at SW-1 that sometimes occur during the summer months may be due to background chemistry (Table 3), but could also include some leachate effect (Figures B-14 and B-16). Total phosphorus concentrations at SW-1 during the summer have regularly exceed the May to August phosphorus objective for Vancouver Island streams (0.005 mg/L per MOE, 2014), but are similar to those measured at SW-7, and are thus attributed to background.

Water quality in Sandhill Creek at SW-1 has generally been within the allowable envelope defined by the FWAL guidelines, and/or typical background concentrations for the area. The potential for ammonia concentrations to increase in the future presents the most significant risk to Sandhill Creek. This risk was partially mitigated with the irrigation system that was fully commissioned in 2004. Chloride and ammonia concentrations in Sandhill Creek have not shown a significant increase in the past ten years. However, ammonia may increase gradually over time, as a function of the volume and age of waste in the landfill, and it is important to continue to monitor and properly manage the irrigation system to achieve optimal performance. Additionally, consideration should also be given to completing portions of the landfill, and constructing final cap to reduce leachate quantity.

Monitoring data for the lower reach of Sandhill Creek at Highway 4 (SHC) do not exhibit any indication of leachate effect.

6 RECOMMENDATIONS

6.1 WATER SAMPLING PROGRAM

The current water sampling program (Table 1) should be continued in 2024 with the following recommendations:

- Samples should be collected from all sites when there is sufficient water present. Instances of insufficient quantity of water should be documented.
- As has been the practice since 2010, bioassay analysis for samples from SW-1 can be omitted unless leachate effects to Sandhill Creek are noted to change.
- Frequency of VOC monitoring at SW-3 and SW-1 can be reduced to one dry season and one wet season sampling event per year.

6.2 FLOW GAUGING AT SW-1 AND SW-11

The water level record and spot flow measurements at the SW-1 gauging station have been used to build a level-discharge relationship. The data loggers at SW-1 should continue to be downloaded twice per year, and spot flow measurements should continue at least twice per year to verify the level-discharge relationship on an ongoing basis. Once flow data from the leachate collection system and SW-11 are available, these can be used with SW-1 flows to calculate loadings in the creek and relate those to leachate strengths and quantities.

A flow gauging site should be established on the drainage downstream of SW-11 to facilitate calculation of concentrations/loading flowing past the SW-11 sampling point, and comparison to the concentrations/loadings at SW-1. This can be achieved by constructing a small weir across the gulley, and using a data logger and a staff gauge to measure and record water levels. The water level on the staff gauge should be recorded at the same time that samples are collected at SW-11, and the data logger should be downloaded twice per year. This flow monitoring will provide some indication of whether the SW-11 drainage course is the primary source of the iron at SW-1. If the flow at SW-11 is determined to be a significant source of the iron at SW-1, further measures to mitigate leachate losses along this pathway could include pumping this flow into the leachate storage lagoon during low-flow periods.

The recommendation to monitor flows at SW-11 could be pre-empted if the flow excursion at SW-11 no longer leaves the site. If the proposed leachate treatment system is constructed, the SW-11 flow would be captured with the construction of a new leachate pond. Alternatively, a cut-and-fill sump/berm could be constructed across the SW-11 channel to impound the water, and a sump pump could be installed to relay any flow to the leachate lagoon. A cumulative flow meter on the sump pump would document the volume of flow diverted.

6.3 OPERATIONAL PUMPING AND MONITORING

The water level in the leachate pond should be managed to limit the number and duration of overflow events. Monitoring of water levels and flows in the leachate storage lagoon will provide information on the pumping system and assist with future planning. The ACRD should:

- Install a cumulative flow meter on the leachate irrigation system to quantify flows from the leachate lagoon during normal operation. Readings should be recorded monthly.
- Survey the elevations of the staff gauge and culvert inlets in the leachate storage lagoon to correlate the water elevation measured in the pond with the overflow events.
- Continue to record the leachate storage lagoon staff gauge level quarterly and download the leachate storage lagoon and overflow pipe loggers twice annually.

6.4 OVERFLOW EVENT SAMPLING

Water quality samples should continue to be collected from SW-3, SW-11 and SW-1 during overflow events. It would be preferable to collect the samples near the mid-point of the events. Samples from each location should be analyzed for the regular analysis suite for SW-1 (Table 1). A VOC scan at all sites is recommended for one overflow event in 2024. Two coolers, each with the required bottles for one sampling suite, should be kept on hand for this purpose. If the overflow event continues for more than week, a second suite of samples should be collected. Sample bottles and coolers should be restocked following each overflow event.

6.5 PARTIAL CAPPING

The frequency of overflow events recorded since 2015 is a cause for concern. In addition, the very slight but apparent increase in some of the leachate concentrations should be addressed. As it is difficult to reduce the concentrations of metals and nutrients in the leachate, the only practicable method to reduce the contaminant loading that leachate conveys to Sandhill Creek is to reduce leachate quantity.

Partial capping of the landfill would allow diversion of runoff from some landfill areas away from the leachate lagoon. This would reduce the quantity of storm water that enters the leachate lagoon, and hence the frequency of overflow events. A partial cap would also reduce the total infiltration into the waste, in turn reducing leachate quantity.

Planning should include evaluation of possible phasing options that will allow a portion of the final landfill to be capped within the next three to five years. If this is not possible, an interim cap should be considered for inactive portions of the landfill. The goal of either approach should be to implement measures that would reduce leachate quantities and overflow events within the next three to five years.

7 LIMITATIONS

Piteau Associates Engineering Ltd. (Piteau) has exercised reasonable skill, care and diligence in obtaining, reviewing, analyzing and interpreting the information acquired during this study, but makes no guarantees or warranties, expressed or implied, as to the completeness of the information contained in this report. Conclusions and recommendations provided in this report are based on the information available at the time of this assessment.

In preparing the recommendations contained herein, Piteau has relied on information and interpretations provided by others. Piteau is not responsible for any errors or omissions in this information. This report is comprised of text, figures, tables, and appendices, and all components must be read and interpreted in the context of the whole report. The report has been prepared for the sole use of the Alberni-Clayoquot Regional District and no representation of any kind is made to any other party.

8 CLOSURE

We trust this report adequately presents and discusses the leachate sampling data collected to date. If you wish to discuss the 2023 sampling results, please contact us.

Respectfully submitted,

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TABLES

TABLE 1
SUMMARY OF WEST COAST LANDFILL SAMPLING SITES AND ANALYTICAL SUITES - 2023 PROGRAM

Site	Site Location	Field Parameters	LABORATORY								
			Physical Parameters	Anions	Nutrients	Total Metals	BOD	COD	VOC Scan	Detailed Analysis	Routine Potability
		temp, pH, conductance	pH, conductance, TDS, total hardness	alkalinity, chloride, sulphate	ammonia, nitrate, total phosphorus	ICP ICP/MS; FWAL detection limits					physical parameters, anions, cations, nitrate/nitrite, total Fe/Mn, total coliforms and e.coli
SW-1	Sandhill Creek near landfill	Q	Q	Q	Q	Q	Q	Q	Q (B for 2024)		
SW-2	West leachate collector ditch	Q	Q	Q	Q	Q (Al, Fe, Mn only)	Q	Q			
SW-3	Leachate storage lagoon	Q	Q	Q	Q	Q	Q	Q	Q (B for 2024)	A (Note 5)	
SW-4	East leachate collector ditch	Q	Q	Q	Q	Q (Al, Fe, Mn only)	Q	Q			
SW-6	West property line	Q	Q	Q	Q	Q (Al, Fe, Mn only)					
SW-7	Background at east property line	Q	Q	Q	Q	Q	Q	Q			
SW-8	Irrigation area	Q	Q	Q	Q	Q (Al, Fe, Mn only)	Q	Q			
SW-9	Irrigation area	Q	Q	Q	Q	Q (Al, Fe, Mn only)	Q	Q			
SW-10	Sandhill Creek upstream of SW-11 discharge	Q	Q	Q	Q	Q	Q	Q			
SW-10U/S	Sandhill Creek upstream of SW-10	A	A	A	A	A	A	A			
SW-11	West drainage at property line	Q	Q	Q	Q	Q	Q	Q			
SW-12	Sandhill Creek trib at south property line	Q	Q	Q	Q	Q (Al, Fe, Mn only)					
SW-14	Composting facility discharge	Q	Q	Q	Q	Q	Q	Q			
Sandhill Creek d/s [4]	Sandhill Creek at Highway	Q	Q	Q	Q	Q (Al, Fe, Mn only)					
Sandhill Creek East Tributary	East tributary to Sandhill Creek above Highway	A	A	A	A	A	A	A			
PW-SS [3]	Tap in the scale shack fed by the pumping well	A									A

Notes:

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1. Q indicates sample is collected quarterly, B indicates samply collected biannually (1 winter high flow and 1 summer low flow), A indicates sample is collected annually (in the summer if water is present).
2. Sites were not sampled when there was insufficient water.
3. PW-SS sampled by ACRD for routine potability, not as part of landfill monitoring program.
4. Sandhill Creek d/s has not shown any impact to date.
5. Summer sample for SW-3 was submitted for analysis of a broad spectrum of potential contaminants: chlorinated phenolics, non-chlorinated phenolics, hydrocarbons, polycyclic aromatic hydrocarbons, semi-volatile organics, and pesticides. A sample for PFAS was not analyzed in 2023, but is recommended for the summer of 2024.

TABLE 2
SUMMARY OF LEACHATE EFFECTS BASED ON MEAN 2023 CONCENTRATIONS

MONITORING WELL	Table Reference for full chemistry results	Recommended Number of Samples	Number of samples	Laboratory pH	Laboratory Conductivity	Total Dissolved Solids	Chloride	Ammonia Nitrogen[6]	Nitrate	Total Phosphorus[7]	Sulphate[6]	Total Hardness	Total Alkalinity	Total Aluminum[4]	Total Copper[6]	Total Iron	Total Manganese	Chemical Oxygen Demand
units				(pH units)	(µS/cm)	(mg/L)	(mg/L)	(mg/L-N)	(mg/L-N)	(mg/L)	(mg/L)	(mg/L $CaCO_3$)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
FWAL GUIDELINE [1]				6.5 - 9.0	-	-	150	1.84	3	0.005	128	-	-	0.70	0.01	1	1.57	-
CSR AW [5]				-	-	-	1500	18.4	400	-	1280	-	-	-	0.02	-	-	-
CSR DW [5]				-	-	-	250	-	10	-	500	-	-	9.5	1.5	6.5	1.5	-
LEACHATE COLLECTION SYSTEM																		
SW-2	A-2	4	3	7.9	1237	680	105	**23.1**	<2.17	**0.028**	<8.53	382	496	0.040	-	**20.4**	**2.23**	76
SW-3	A-3, A-15 to A-18	4	4	8.2	1035	607	95	**17.0**	1.19	**0.04**	<7.71	287	391	0.063	<0.0019	**5.67**	0.846	74
SW-4	A-4	4	2	8.2	951	521	60	**23.4**	0.837	**0.039**	8.88	309	429	0.054	-	**8.39**	**1.82**	61
SW-14	A-14	4	2	7.6	208	143	14	0.094	0.364	**0.08**	15.0	81.4	67.5	**0.914**	0.0026	**1.69**	0.173	27
LEACHATE IRRIGATION RECEIVING AREA AND WEST LANDFILL BOUNDARY																		
SW-6	A-6	4	2	8.1	498	327	41	0.051	**8.49**	**0.014**	15.0	159	148	0.179	-	0.226	0.023	-
SW-8	A-8	4	2	8.1	555	337	44	0.769	**10.3**	**0.028**	14.1	177	178	0.066	-	0.138	0.027	33
SW-9	A-9	4	2	8.1	531	332	43	0.347	**9.45**	**0.029**	16.4	171	160	0.085	-	0.103	0.020	31
SOUTHWEST AND SOUTH LANDFILL BOUNDARY																		
SW-11	A-11	4	2	6.9	148	108	26	0.028	0.263	**0.02**	11.0	31.4	18.7	**0.804**	0.0021	**2.10**	0.121	29
SW-12	A-12	4	2	7.2	151	106	17	0.588	0.490	**0.024**	11.0	42.4	34.5	**1.087**	-	**1.40**	0.050	-
BACKGROUND CREEKS																		
SHC East Tributary	A-13	1	1	**6.4**	72	69	11	0.007	<0.005	**0.091**	12.2	12.8	3.40	0.298	0.0009	0.255	0.020	23
SW-7	A-7	4	2	7.1	135	95	20	0.027	0.413	**0.01**	3.71	31.5	30.8	0.507	0.0013	**1.36**	0.313	31
RECEIVING CREEKS																		
SW-10 U/S	A-10	1	1	7.1	310	208	43	0.024	0.037	**0.02**	47.0	70.3	24.5	0.266	0.0009	0.994	0.105	36
SW-10	A-10	4	4	7.2	185	139	30	<0.011	0.410	**0.02**	9.37	42.6	29.7	0.310	0.0011	0.630	0.092	35
SW-1	A-1, A-15, A-16	4	3	7.2	165	127	26	<0.042	0.539	**0.02**	6.36	38.6	29.4	0.329	0.0011	0.632	0.114	29
SHC	A-5	4	4	6.8	155	113	36	0.014	0.114	**0.043**	4.49	23.0	8.38	0.363	-	0.744	0.034	-
SCALE SHACK																		
PW-SS	A-19	1	1	7.5	277	226	43	-	<0.005	<0.05	6.35	54.5	57.5	0.174	**0.210**	0.399	0.097	-
OVERFLOW EVENTS																		
SW-1-Overflow	D-2 to D-4	4	2	**6.4**	55	66	6.4	0.122	0.607	**0.01**	3.64	13.2	7.85	0.340	0.0015	0.304	0.013	41
SW-3-Overflow	D-2 to D-4	4	2	7.5	467	271	25	**5.44**	<2.55	**0.110**	31.2	145	162	**1.04**	0.0114	**3.43**	0.700	82
SW-11-Overflow	D-2 to D-4	4	2	7.2	311	200	24	**1.95**	1.96	**0.063**	25.1	101	84.1	0.665	0.0073	**1.54**	0.138	52

H:\Project\1576\Chem\2023\[Summary Tables.xlsm]Table2

Notes:
1. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.
   https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines.
   https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/bc_env_working_water_quality_guidelines.pdf
   Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL").
   Lowest guidelines are shown.
2. **Bolding** denotes parameters which exceed water quality criteria.
3. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.
4. FWAL guideline is for dissolved aluminum.
5. Per Schedule 3.2 of Stage 13 Amendment to Contaminated Sites Regulation (CSR), March 2023. AW standards assume minimum 1:10 dilution is available. As such, samples collected from background and receiving creeks are compared against CSR AW standards/10. https://www.bclaws.gov.bc.ca/civix/document/id/lc/statreg/375_96_08
6. CSR AW guidelines for ammonia, copper, and sulphate change with pH and hardness. Value shown appropriate for pH <7 and hardness <30 mg/L.
7. Phosphorus Objective for creeks from Phosphorous Management in Vancouver Island Streams. Available: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-reference-documents/phosphorous_management_vi_streams_guidance_2014.pdf. BC MOE, April 2014. Monthly average of May to September samples for total phosphorus should not exceed 0.005 mg/L, and maximum total phosphorus for this period should not exceed 0.01 mg/L in any one sample. Mean 2023 concentration compared against stringent guideline of 0.005 mg/L.

TABLE 3
SUMMARY OF 2023 EXCEEDANCES OF BC FWAL GUIDELINES AND CSR STANDARDS

Sampling Location	Table Reference for full chemistry results	Number of samples	pH	Anions and Nutrients				Total Metals											
				Chloride	Ammonia	Nitrate	Total Phosphorous[3]	Aluminum [4]	Arsenic	Boron	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Silver	Zinc
Leachate Collection System																			
SW-2	A-2	3		AW	AW		P							DW		DW			
SW-3	A-3, A-15 to A-18	4			AW		P					DW		DW		DW			
SW-4	A-4	2			AW									DW		DW			
SW-14	A-14	2										DW							
Leachate Irrigation Receiving Area and West Landfill Boundary																			
SW-6	A-6	2																	
SW-8	A-8	2				DW													
SW-9	A-9	2				DW													
Southwest and South Landfill Boundary																			
SW-11	A-11	2										DW							
SW-12	A-12	2																	
Background Creeks																			
SHC East Tributary	A-13	1																	
SW-7	A-7	2									AW/10	DW							
Receiving Creeks																			
SW-10 U/S	A-10	1					P												
SW-10	A-10	4					P					DW							AW/10
SW-1	A-1, A-15, A-16	3					P					DW							
SHC	A-5	4					P												
Scale Shack																			
PW-SS [6]	A-19	1											AW		DW				AW
OVERFLOW EVENTS																			
SW-1-Overflow	D-2 to D-4	2																	
SW-3-Overflow	D-2 to D-4	2										DW							
SW-11-Overflow	D-2 to D-4	2																	

H:\Project\1576\Chem\2023\[Summary Tables.xlsm]Table3

Orange shaded cells show sampling location has one or more exceedances of the BC FWAL[1]

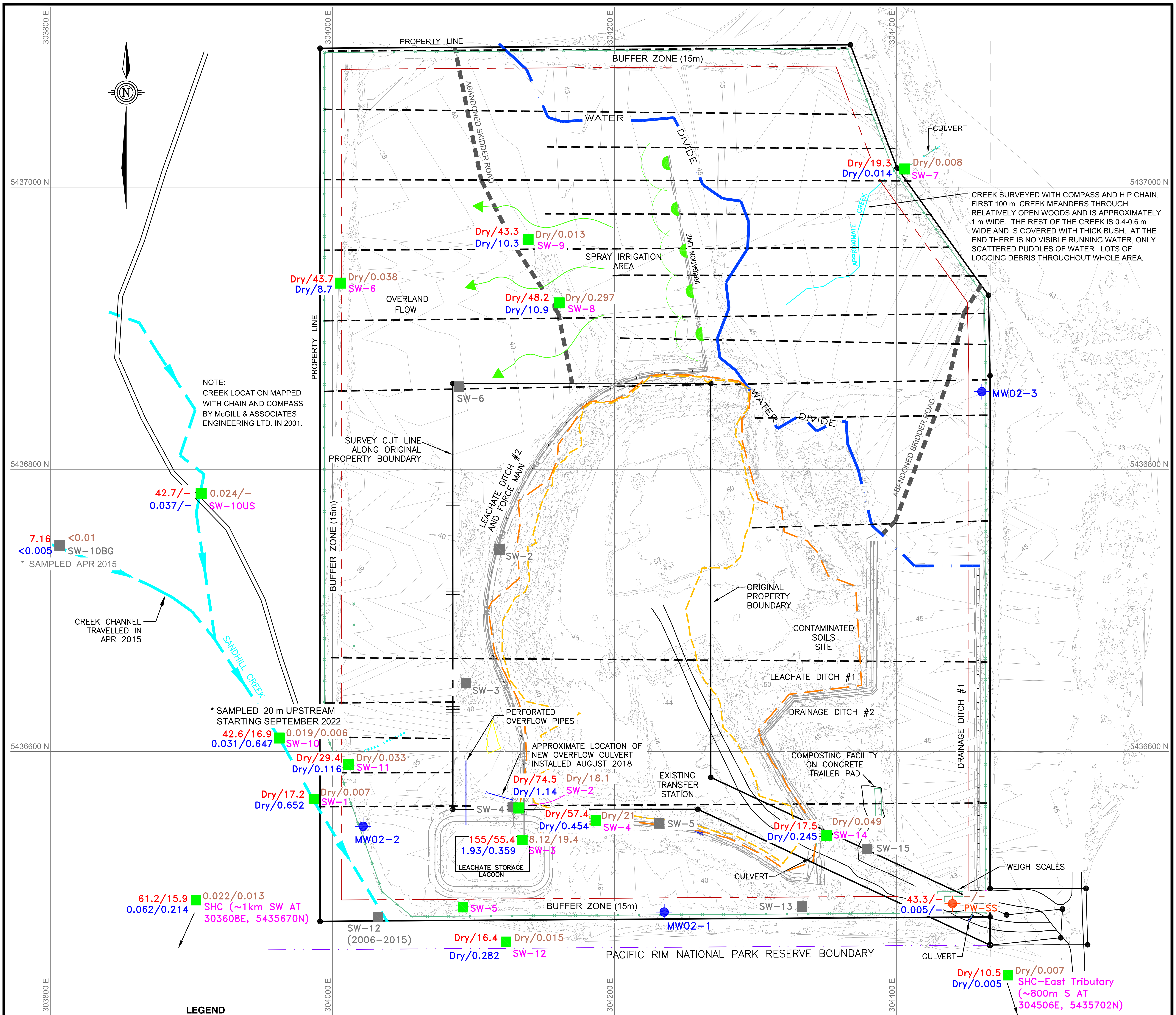
AW/DW Text indicates one or more exceedance of CSR[2] AW and/or DW or Vancouver Island Phosphorus Objective[3] (P)

No shading indicates all sampling results were below all guidelines

Grey shaded cells show sampling location was not analyzed for the parameter indicated or the site was dry when the guideline was relevant.

Notes:
1. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.
https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines
https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/bc_env_working_water_quality_guidelines.pdf
Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). Quarterly sampling events compared to 30-day average guidelines, overflow events compared to maximum guidelines.
2. Per Schedule 3.2 of Stage 13 Amendment to Contaminated Sites Regulation (CSR), March 2023. AW standards assume minimum 1:10 dilution is available. As such, samples collected from background and receiving creeks are compared against CSR AW standards/10. https://www.bclaws.gov.bc.ca/civix/document/id/lc/statreg/375_96_08
3. Phosphorus Objective for creeks from Phosphorous Management in Vancouver Island Streams. Available: https://www2.gov.bc.ca/assets/gov/environment/air-land-water /water/waterquality/water-quality-reference-documents/ phosphorous_management_vi_streams_guidance_2014.pdf. BC MOE, April 2014.
Monthly average of May to September samples for total phosphorus should not exceed 0.005 mg/L, and maximum total phosphorus for this period should not exceed 0.01 mg/L in any one sample. In 2023, May and September results compared against stringent guideline of 0.005 mg/L.
4. Total aluminum compared against dissolved aluminum FWAL guideline.
5. PW-SS also exceeded the Guidelines for Canadian Drinking Water Quality (Health Canada, 2022) for total coliforms, e. coli, total iron, total lead, and total manganese
https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/water-quality/guidelines-canadian-drinking-water-quality-summary-table.html

FIGURE



LEGEND

Dry/17.2 Dry/0.007 Dry/0.652 SW-1 — SAMPLING SITE AND PARAMETER CONCENTRATIONS (mg/L) (AUG 2023 / NOV 2023) EXCEPT AS NOTED

CHLORIDE AMMONIA NITRATE SAMPLING SITE

SW-4 — HISTORICAL SAMPLING SITES

TYPICAL SURVEY LINE OR STORM BAR

MW02-2 — MONITORING WELL

PW-SS — PUMPING WELL

2004 LANDFILL FOOTPRINT

2011 LANDFILL FOOTPRINT

TOPOGRAPHY PROVIDED BY SPERLING HANSEN (NOTE 1)

0 20 40 60 80 100m

SCALE 1:2000

NOTES:

1. LANDFILL TOPOGRAPHY (WCL 20201222 for DXF.dxf) AT 1m CONTOUR INTERVAL SURVEYED ON DECEMBER 22, 2020 AND PROVIDED BY SPERLING HANSEN ON JANUARY 20, 2021.
2. LEACHATE POND AND COLLECTION DITCHES CONSTRUCTED LATE SUMMER AND AUTUMN OF 2004.
3. SW-5 NOT SAMPLED SINCE 2012 DUE TO ABSENCE OF STANDING WATER.
4. SW-13 SAMPLED IN 2009, THEN DISCONTINUED DUE TO ABSENCE OF LEACHATE INDICATORS. SAMPLED ONCE MORE IN FEBRUARY 2015.
5. SHC SAMPLING SITE LOCATED 1km SW, AT HIGHWAY 4 CULVERT. SHC-EAST TRIBUTARY SAMPLING SITE LOCATED 800m S WHERE SANDHILL CREEK TRIBUTARY CROSSES ALASKA PINE ROAD CLOSE TO HIGHWAY 4.

ALBERNI - CLAYOQUOT REGIONAL DISTRICT
WATER QUALITY MONITORING PROGRAM
WEST COAST LANDFILL, UCLUELET, B.C.

PITEAU ASSOCIATES
GEOTECHNICAL AND WATER MANAGEMENT CONSULTANTS
A TETRA TECH COMPANY

PLAN SHOWING PROPERTY BOUNDARIES AND SAMPLING LOCATIONS

BY:	DATE:
RM/sl	MAR 24
APPROVED: JM	FIG: 1

APPENDIX A
MONITORING DATA TABLES

APPENDIX A

LIST OF TABLES

TABLE A-1

WATER CHEMISTRY DATA FOR SW-1

PARAMETER	units	RECEIVING WATER CRITERIA			SAMPLING DATE			
		AQUATIC LIFE (FWAL)[1]	CSR AQUATIC LIFE (AW)[2]	CSR DRINKING WATER (DW)[2]	28-Feb-23	05-Jun-23	22-Aug-23	21-Nov-23
PHYSICAL TESTS								
pH - Field	pH	6.5 - 9.0	-	-	7.19	7.50		7.55
pH - Lab	pH	6.5 - 9.0	-	-	6.88	7.65		6.97
Conductivity - Field	µS/cm	-	-	-	60	184	Dry	745
Conductivity - Lab	µS/cm	-	-	-	104	280		112
Total Hardness ($CaCO_3$)	mg/L	-	-	-	24.4	65.3		26
Total Dissolved Solids	mg/L	-	-	-	94	196		92
Temperature - Field	°C	-	-	-	3.6	9.8		7.9
DISSOLVED ANIONS								
Alkalinity - Total	mg/L $CaCO_3$	-	-	-	17.2	58		13
Chloride	mg/L	150	1500	250	15	45.9		17.2
Sulphate [4,7]	mg/L	128	1280	500	4.4	3.9		10.8
TOTAL CATIONS								
Calcium	mg/L	-	-	-	6.63	18.1		6.39
Magnesium	mg/L	-	-	-	1.9	4.88		2.45
Potassium	mg/L	-	-	-	1.32	7.94		1.27
Sodium	mg/L	-	-	200	9.79	25.5		11.8
NUTRIENTS								
Ammonia Nitrogen [5,8]	mg/L as N	1.84	18.5	-	<0.0050	0.113		0.0073
Nitrate Nitrogen	mg/L as N	3	400	10	0.91	0.0562		0.652
Total Phosphorus[3]	mg/L as P	0.005	-	-	0.0056	**0.0281**		0.0185
POLLUTANT TESTS								
Chemical Oxygen Demand	mg/L as O	-	-	-	28	29		30
Biochemical Oxygen Demand	mg/L as O	-	-	-	<2.0	<2.0		<2.0
TOTAL METALS								
Aluminum [5]	mg/L	0.29	-	9.5	**0.337**	0.284		**0.365**
Antimony	mg/L	0.07	0.09	0.006	<0.00010	0.00044		<0.00010
Arsenic	mg/L	0.005	0.05	0.01	0.00013	0.00042		0.00013
Barium	mg/L	1	10	1	0.00502	0.0114		0.00667
Beryllium	mg/L	0.00013	0.0015	0.008	<0.000100	<0.000100		<0.000100
Boron	mg/L	1.2	12	5	0.048	0.152		0.055
Cadmium [4,7]	mg/L	0.00008	0.0005	0.005	0.0000097	0.0000109		0.0000238
Chromium	mg/L	0.001	0.01	0.05	0.00053	0.00062		0.00059
Cobalt	mg/L	0.004	0.04	0.001	0.00018	*0.00183*		0.00049
Copper [7]	mg/L	0.0014	0.02	1.5	0.00082	0.00131		0.00105
Iron	mg/L	1	-	6.5	0.276	**1.29**		0.329
Lead [4,7]	mg/L	0.004	0.16	0.01	0.000103	0.000139		0.000145
Lithium	mg/L	-	-	0.008	<0.0010	<0.0010		<0.0010
Manganese [4]	mg/L	0.72	-	1.5	0.00764	0.315		0.0191
Mercury	µg/L	0.2	0.25	1	0.0056	<0.0000050		0.0000063
Molybdenum	mg/L	7.6	10	0.25	<0.000050	0.00006		<0.000050
Nickel [7]	mg/L	0.25	0.25	0.08	0.00081	0.00146		0.00151
Selenium	mg/L	0.002	0.02	0.01	<0.000050	0.000094		0.000116
Silver [4,7]	mg/L	0.00005	0.0005	0.02	<0.000010	0.000015		<0.000010
Strontium	mg/L	-	-	2.5	0.036	0.104		0.0394
Thallium	mg/L	-	0.003	-	<0.000010	<0.000010		<0.000010
Tin	mg/L	-	-	2.5	<0.00010	<0.00010		<0.00010
Titanium	mg/L	-	1	-	0.014	0.0132		0.00912
Tungsten	mg/L	-	-	0.003	<0.00010	<0.00010		<0.00010
Uranium	mg/L	0.01	0.085	0.02	0.000014	0.000013		0.000013
Vanadium	mg/L	-	-	0.02	0.00106	0.00129		0.00101
Zinc [4,7]	mg/L	0.0079	0.075	3	0.0045	0.0037		0.006

H:\Project\1576\Chem\2023\[Tables-2023.xlsx]Table A-1

NOTES:

1. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment. https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/bc_env_working_water_quality_guidelines.pdf Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). Lowest guidelines are shown (ie. Long term average if applicable).
2. Per Schedule 3.2 of the Contaminated Sites Regulation (CSR), March 2023. AW standards assume minimum 1:10 dilution is available. As such, samples collected from background and receiving creeks are compared against CSR AW standards/10. https://www.bclaws.gov.bc.ca/civix/document/id/lc/statreg/375_96_08
3. Phosphorus Objective for creeks from Phosphorous Management in Vancouver Island Streams. Available: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-reference-documents/phosphorous_management_vi_streams_guidance_2014.pdf. BC MOE, April 2014. Monthly average of May to September samples for total phosphorus should not exceed 0.005 mg/L, and maximum total phosphorus for this period should not exceed 0.01 mg/L
4. FWAL guideline for indicated parameter changes with hardness. Aluminum and zinc guidelines also vary with pH and DOC. Value shown appropriate for hardness of 26 mg/L-CaCO3, pH of 7.3 and DOC of 11. Cadmium and zinc guidelines are for dissolved metals.
5. FWAL guideline for indicated parameter changes with pH and temperature. Value shown appropriate for pH between 6.5 and 7 and temperature of 10˚C.
6. Dissolved copper FWAL guideline was calculated for each site using the average BC BLM software calculations between January 2020 - January 2022 with sample-specific parameters except for humic acid ratio (assumed value of 10).
7. CSR AW standard for indicated parameter changes with hardness. Value shown appropriate for hardness of 26 mg/L-CaCO3.
8. CSR AW standard for indicated parameter changes with pH. Value shown appropriate for pH 7.3.
9. **Bolding** denotes parameters which exceed BC FWAL water quality guideline. Underline denotes parameters which exceed CSR AW standard. *Italics* denotes parameters which exceed CSR DW standard.
10. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

TABLE A-2

WATER CHEMISTRY DATA FOR SW-2

PARAMETER	units	RECEIVING WATER CRITERIA			SAMPLING DATE			
		AQUATIC LIFE (FWAL)[1]	CSR AQUATIC LIFE (AW)[2]	CSR DRINKING WATER (DW)[2]	28-Feb-23	05-Jun-23	22-Aug-23	21-Nov-23
PHYSICAL TESTS								
pH - Field	pH	6.5 - 9.0	-	-	6.97	7.08		6.96
pH - Lab	pH	6.5 - 9.0	-	-	8.14	7.39		8.26
Conductivity - Field	µS/cm	-	-	-	545	1394	Dry	324
Conductivity - Lab	µS/cm	-	-	-	935	1820		955
Total Hardness ($CaCO_3$)	mg/L	-	-	-	293	536		317
Total Dissolved Solids	mg/L	-	-	-	499	1010		531
Temperature - Field	°C	-	-	-	3.6	11.7		7.6
DISSOLVED ANIONS								
Alkalinity - Total	mg/L $CaCO_3$	-	-	-	380	721		386
Chloride	mg/L	150	1500	250	66.1	**173**		74.5
Sulphate [4,6]	mg/L	429	4290	500	11.3	<3.00		11.3
NUTRIENTS								
Ammonia Nitrogen [5,7]	mg/L as N	1.84	18.4	-	**14.9**	**36.2**		**18.1**
Nitrate Nitrogen	mg/L as N	3.0	400	10	**5.31**	<0.0500		1.14
Total Phosphorus[3]	mg/L as P	0.005	-	-	0.0136	**0.0408**		0.0296
POLLUTANT TESTS								
Chemical Oxygen Demand	mg/L as O	-	-	-	43	130		56
Biochemical Oxygen Demand	mg/L as O	-	-	-	<2.0	2.6		2.9
TOTAL METALS								
Aluminum [5]	mg/L	0.66	-	9.5	0.0244	0.0656		0.0293
Iron	mg/L	1.0	-	6.5	0.756	***59.3***		**1.14**
Manganese [4]	mg/L	2.37	-	1.5	0.454	***5.8***		0.443

H:\Project\1576\Chem\2023\[Tables-2023.xlsx]Table A-2

NOTES:

1. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.
   https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf
   https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/bc_env_working_water_quality_guidelines.pdf
   Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). Lowest guidelines are shown (ie. Long term average if applicable).
2. Per Schedule 3.2 of the Contaminated Sites Regulation (CSR), March 2023. AW standards assume minimum 1:10 dilution is available. As such, samples collected from background and receiving creeks are compared against CSR AW standards/10. https://www.bclaws.gov.bc.ca/civix/document/id/lc/statreg/375_96_08
3. Phosphorus Objective for creeks from Phosphorous Management in Vancouver Island Streams. Available: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-reference-documents/phosphorous_management_vi_streams_guidance_2014.pdf.
   BC MOE, April 2014. Monthly average of May to September samples for total phosphorus should not exceed 0.005 mg/L, and maximum total phosphorus for this period should not exceed 0.01 mg/L in any one sample. May and September results compared against stringent guideline of 0.005 mg/L.
4. FWAL guideline for indicated parameter changes with hardness. Aluminum guideline also varies with pH and DOC. Value shown appropriate for hardness of 400 mg/L-CaCO3, pH of 7, and DOC of 20 mg/L.
5. FWAL guideline for indicated parameter changes with pH and temperature. Value shown appropriate for pH between 6.5 and 7 and temperature of 10˚C.
6. CSR AW standard for indicated parameter changes with hardness. Value shown appropriate for hardness of 400 mg/L-CaCO3.
7. CSR AW standard for indicated parameter changes with pH. Value shown appropriate for pH <7.
8. **Bolding** denotes parameters which exceed BC FWAL water quality guideline. Underline denotes parameters which exceed CSR AW standard. *Italics* denotes parameters which exceed CSR DW standard.
9. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

TABLE A-3

WATER CHEMISTRY DATA FOR SW-3

PARAMETER	units	RECEIVING WATER CRITERIA			SAMPLING DATE			
		AQUATIC LIFE (FWAL)[1]	CSR AQUATIC LIFE (AW)[2]	CSR DRINKING WATER (DW)[2]	28-Feb-23	05-Jun-23	22-Aug-23	21-Nov-23
PHYSICAL TESTS								
pH - Field	pH	6.5 - 9.0	-	-	7.30	7.61	7.52	7.03
pH - Lab	pH	6.5 - 9.0	-	-	8.18	8.18	8.07	8.40
Conductivity - Field	µS/cm	-	-	-	449	1022	967	614
Conductivity - Lab	µS/cm	-	-	-	834	1250	1220	836
Total Hardness ($CaCO_3$)	mg/L	-	-	-	266	357	257	267
Total Dissolved Solids	mg/L	-	-	-	450	710	817	452
Temperature - Field	°C	-	-	-	1.4	16.6	16.5	8.4
DISSOLVED ANIONS								
Alkalinity - Total	mg/L $CaCO_3$	-	-	-	350	492	353	368
Chloride	mg/L	150	1500	250	56.5	112	**155**	55.4
Sulphate [4,8]	mg/L	429	4290	500	12.1	<1.50	8.3	9.0
TOTAL CATIONS								
Calcium	mg/L	-	-	-	87.2	107	63.2	88.4
Magnesium	mg/L	-	-	-	11.7	21.8	24.2	11.3
Potassium	mg/L	-	-	-	15	24	30.5	17.9
Sodium	mg/L	-	-	200	49.5	101	136	49.1
NUTRIENTS								
Ammonia Nitrogen [5,8]	mg/L as N	1.84	18.5	-	**14.7**	**25.6**	**8.12**	**19.4**
Nitrate Nitrogen	mg/L as N	3	400	10	2.35	0.126	1.93	0.359
Total Phosphorus[3]	mg/L as P	0.005	-	-	0.0132	**0.0424**	**0.0499**	0.0428
POLLUTANT TESTS								
Chemical Oxygen Demand	mg/L as O	-	-	-	40	92	105	60
Biochemical Oxygen Demand	mg/L as O	-	-	-	<2.0	2.4	32.4	4
TOTAL METALS								
Aluminum [4,5]	mg/L	0.70	-	9.5	0.0346	0.0115	0.0385	0.166
Antimony	mg/L	0.07	0.09	0.006	0.00017	0.0002	0.00015	0.00018
Arsenic	mg/L	0.005	0.05	0.01	0.00036	0.0008	0.0009	0.00143
Barium	mg/L	1	10	1	0.04	0.0617	0.0504	0.095
Beryllium	mg/L	0.00013	0.0015	0.008	<0.000100	<0.000100	<0.000100	<0.000100
Boron	mg/L	1.2	12	5	0.574	1.14	**1.36**	0.742
Cadmium [4,7]	mg/L	0.00038	0.0040	0.005	0.0000153	<0.0000050	0.0000111	0.000024
Chromium	mg/L	0.001	0.01	0.05	0.0008	0.00072	0.0006	**0.0015**
Cobalt	mg/L	0.004	0.04	0.001	0.00069	*0.00168*	*0.00123*	*0.00281*
Copper [6,7]	mg/L	0.010	0.09	1.5	0.00135	<0.00050	0.00136	0.00445
Iron	mg/L	1	-	6.5	0.362	**1.8**	**1.5**	***19***
Lead [4,7]	mg/L	0.012	0.16	0.01	<0.000050	<0.000050	0.000069	0.00018
Lithium	mg/L	-	-	0.008	<0.0010	0.0012	0.0012	<0.0010
Manganese [4]	mg/L	1.57	-	1.5	0.317	0.627	0.0981	***2.34***
Mercury	µg/L	0.2	0.25	1	<0.0050	<0.0000050	<0.0000050	<0.0000050
Molybdenum	mg/L	7.6	10	0.25	0.000084	0.000238	0.000209	0.000191
Nickel [7]	mg/L	0.15	1.50	0.08	0.00241	0.0037	0.00412	0.00467
Selenium	mg/L	0.002	0.02	0.01	0.000106	0.000225	0.000189	0.000141
Silver [4,7]	mg/L	0.0015	0.0150	0.02	<0.000010	<0.000010	<0.000010	<0.000010
Strontium	mg/L	-	-	2.5	0.402	0.618	0.5	0.449
Thallium	mg/L	-	0.003	-	<0.000010	<0.000010	<0.000010	<0.000010
Tin	mg/L	-	-	2.5	<0.00010	0.0001	0.00017	0.0001
Titanium	mg/L	-	1	-	0.00191	0.00053	0.00156	0.00683
Tungsten	mg/L	-	-	0.003	<0.00010	<0.00010	<0.00010	<0.00010
Uranium	mg/L	0.01	0.09	0.02	0.000058	0.00006	0.000038	0.000059
Vanadium	mg/L	-	-	0.02	<0.00050	<0.00050	<0.00050	0.00128
Zinc [4,7]	mg/L	0.072	1.650	3	0.0056	<0.0030	0.0034	0.0186

H:\Project\1576\Chem\2023\[Tables-2023.xlsx]Table A-3

NOTES:

1. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment. https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/bc_env_working_water_quality_guidelines.pdf Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). Lowest guidelines are shown (ie. Long term average if applicable).
2. Per Schedule 3.2 of the Contaminated Sites Regulation (CSR), March 2023. AW standards assume minimum 1:10 dilution is available. As such, samples collected from background and receiving creeks are compared against CSR AW standards/10. https://www.bclaws.gov.bc.ca/civix/document/id/lc/statreg/375_96_08
3. Phosphorus Objective for creeks from Phosphorous Management in Vancouver Island Streams. Available: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-reference-documents/phosphorous_management_vi_streams_guidance_2014.pdf. BC MOE, April 2014. Monthly average of May to September samples for total phosphorus should not exceed 0.005 mg/L, and maximum total phosphorus for this period should not exceed 0.01 mg/L in any one sample. May and September results compared against stringent guideline of 0.005 mg/L.
4. FWAL guideline for indicated parameter changes with hardness. Aluminum and zinc guidelines also vary with pH and DOC. Value shown appropriate for hardness of 219 mg/L-CaCO3, pH of 7.3 and DOC of 22. Cadmium and zinc guidelines are for dissolved metals.
5. FWAL guideline for indicated parameter changes with pH and temperature. Value shown appropriate for pH between 6.5 and 7 and temperature of 10˚C.
6. Dissolved copper FWAL guideline was calculated for each site using the average BC BLM software calculations between January 2020 - January 2022 with sample-specific parameters except for humic acid ratio (assumed value of 10).
7. CSR AW standard for indicated parameter changes with hardness. Value shown appropriate for hardness of 219 mg/L-CaCO3.
8. CSR AW standard for indicated parameter changes with pH. Value shown appropriate for pH 7.3.
9. **Bolding** denotes parameters which exceed BC FWAL water quality guideline. Underline denotes parameters which exceed CSR AW standard. *Italics* denotes parameters which exceed CSR DW standard.
10. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

TABLE A-4

WATER CHEMISTRY DATA FOR SW-4

PARAMETER	units	RECEIVING WATER CRITERIA			SAMPLING DATE			
		AQUATIC LIFE (FWAL)[1]	CSR AQUATIC LIFE (AW)[2]	CSR DRINKING WATER (DW)[2]	28-Feb-23	05-Jun-23	22-Aug-23	21-Nov-23
PHYSICAL TESTS								
pH - Field	pH	6.5 - 9.0	-	-	7.21			6.91
pH - Lab	pH	6.5 - 9.0	-	-	8.11			8.29
Conductivity - Field	µS/cm	-	-	-	601	Dry	Dry	650
Conductivity - Lab	µS/cm	-	-	-	1040			862
Total Hardness ($CaCO_3$)	mg/L	-	-	-	327			290
Total Dissolved Solids	mg/L	-	-	-	541			501
Temperature - Field	°C	-	-	-	2.6			8.5
DISSOLVED ANIONS								
Alkalinity - Total	mg/L $CaCO_3$	-	-	-	474			383
Chloride	mg/L	150	1500	250	62.4			57.4
Sulphate [4,6]	mg/L	429	4290	500	8.8			9.0
NUTRIENTS								
Ammonia Nitrogen [5,7]	mg/L as N	1.84	18.4	-	<u>**25.7**</u>			<u>**21**</u>
Nitrate Nitrogen	mg/L as N	3	400	10	1.22			0.454
Total Phosphorus[3]	mg/L as P	0.005	-	-	0.021			0.0574
POLLUTANT TESTS								
Chemical Oxygen Demand	mg/L as O	-	-	-	51			70
Biochemical Oxygen Demand	mg/L as O	-	-	-	2.5			6
TOTAL METALS								
Aluminum [5]	mg/L	0.61	-	9.5	0.0304			0.078
Iron	mg/L	1	-	6.5	**3.17**			***13.6***
Manganese [4]	mg/L	1.93	-	1.5	*1.57*			***2.06***

H:\Project\1576\Chem\2023\[Tables-2023.xlsx]Table A-4

NOTES:

1. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.
   https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf
   https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/bc_env_working_water_quality_guidelines.pdf
   Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). Lowest guidelines are shown (ie. Long term average if applicable).
2. Per Schedule 3.2 of the Contaminated Sites Regulation (CSR), March 2023. AW standards assume minimum 1:10 dilution is available. As such, samples collected from background and receiving creeks are compared against CSR AW standards/10. https://www.bclaws.gov.bc.ca/civix/document/id/lc/statreg/375_96_08
3. Phosphorus Objective for creeks from Phosphorous Management in Vancouver Island Streams. Available: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-reference-documents/phosphorous_management_vi_streams_guidance_2014.pdf.
   BC MOE, April 2014. Monthly average of May to September samples for total phosphorus should not exceed 0.005 mg/L, and maximum total phosphorus for this period should not exceed 0.01 mg/L in any one sample. May and September results compared against stringent guideline of 0.005 mg/L.
4. FWAL guideline for indicated parameter changes with hardness. Aluminum guideline also varies with pH and DOC. Value shown appropriate for hardness of 300 mg/L-CaCO3, pH of 7, and DOC of 20 mg/L.
5. FWAL guideline for indicated parameter changes with pH and temperature. Value shown appropriate for pH between 6.5 and 7 and temperature of 10˚C.
6. CSR AW standard for indicated parameter changes with hardness. Value shown appropriate for hardness of 300 mg/L-CaCO3.
7. CSR AW standard for indicated parameter changes with pH. Value shown appropriate for pH <7.
8. **Bolding** denotes parameters which exceed BC FWAL water quality guideline. <u>Underline</u> denotes parameters which exceed CSR AW standard. *Italics* denotes parameters which exceed CSR DW standard.
9. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

TABLE A-5

WATER CHEMISTRY DATA FOR SANDHILL CREEK SAMPLING SITE

PARAMETER	units	RECEIVING WATER CRITERIA			SAMPLING DATE			
		AQUATIC LIFE (FWAL)[1]	CSR AQUATIC LIFE (AW)[2]	CSR DRINKING WATER (DW)[2]	28-Feb-23	05-Jun-23	14-Aug-23	21-Nov-23
PHYSICAL TESTS								
pH - Field	pH	6.5 - 9.0	-	-	6.61	7.12	7.06	7.24
pH - Lab	pH	6.5 - 9.0	-	-	6.55	7.08	6.77	6.70
Conductivity - Field	µS/cm	-	-	-	40	168	174	57
Conductivity - Lab	µS/cm	-	-	-	69	220	247	86
Total Hardness ($CaCO_3$)	mg/L	-	-	-	11.5	30.2	35	15.4
Total Dissolved Solids	mg/L	-	-	-	62	155	165	68
Temperature - Field	°C	-	-	-	3.6	9.7	12.4	7.9
DISSOLVED ANIONS								
Alkalinity - Total	mg/L $CaCO_3$	-	-	-	6.4	10.3	9.2	7.6
Chloride	mg/L	150	1500	250	13.8	54.7	61.2	15.9
Sulphate [4,6]	mg/L	128	1280	500	2.8	3.3	4.7	7.1
NUTRIENTS								
Ammonia Nitrogen [5,7]	mg/L as N	1.84	18.4	-	0.0078	0.013	0.0218	0.0133
Nitrate Nitrogen	mg/L as N	3	400	10	0.12	0.0606	0.0622	0.214
Total Phosphorus[3]	mg/L as P	0.005	-	-	0.0065	**0.0289**	**0.0243**	0.111
TOTAL METALS								
Aluminum [5]	mg/L	0.19	-	9.5	**0.331**	**0.218**	**0.587**	**0.315**
Iron	mg/L	1	-	6.5	0.313	0.81	**1.55**	0.302
Manganese [4]	mg/L	0.69	-	1.5	0.00711	0.0428	0.0778	0.00811

H:\Project\1576\Chem\2023\[Tables-2023.xlsx]Table A-5

NOTES:

1. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.
   https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf
   https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/bc_env_working_water_quality_guidelines.pdf
   Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). Lowest guidelines are shown (ie. Long term average if applicable).
2. Per Schedule 3.2 of the Contaminated Sites Regulation (CSR), March 2023. AW standards assume minimum 1:10 dilution is available. As such, samples collected from background and receiving creeks are compared against CSR AW standards/10. https://www.bclaws.gov.bc.ca/civix/document/id/lc/statreg/375_96_08
3. Phosphorus Objective for creeks from Phosphorous Management in Vancouver Island Streams. Available: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-reference-documents/phosphorous_management_vi_streams_guidance_2014.pdf.
   BC MOE, April 2014. Monthly average of May to September samples for total phosphorus should not exceed 0.005 mg/L, and maximum total phosphorus for this period should not exceed 0.01 mg/L in any one sample. May and September results compared against stringent guideline of 0.005 mg/L.
4. FWAL guideline for indicated parameter changes with hardness. Aluminum guideline also varies with pH and DOC. Value shown appropriate for hardness of 20 mg/L-CaCO3, pH of 7, and DOC of 10 mg/L.
5. FWAL guideline for indicated parameter changes with pH and temperature. Value shown appropriate for pH between 6.5 and 7 and temperature of 10˚C.
6. CSR AW standard for indicated parameter changes with hardness. Value shown appropriate for hardness of 20 mg/L-CaCO3.
7. CSR AW standard for indicated parameter changes with pH. Value shown appropriate for pH <7.
8. **Bolding** denotes parameters which exceed BC FWAL water quality guideline. <u>Underline</u> denotes parameters which exceed CSR AW standard. *Italics* denotes parameters which exceed CSR DW standard.
9. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

TABLE A-6

WATER CHEMISTRY DATA FOR SW-6

PARAMETER	units	RECEIVING WATER CRITERIA			SAMPLING DATE			
		AQUATIC LIFE (FWAL)[1]	CSR AQUATIC LIFE (AW)[2]	CSR DRINKING WATER (DW)[2]	28-Feb-23	05-Jun-23	22-Aug-23	21-Nov-23
PHYSICAL TESTS								
pH - Field	pH	6.5 - 9.0	-	-	7.07			7.81
pH - Lab	pH	6.5 - 9.0	-	-	7.93			8.17
Conductivity - Field	µS/cm	-	-	-	284	Dry	Dry	323
Conductivity - Lab	µS/cm	-	-	-	498			497
Total Hardness ($CaCO_3$)	mg/L	-	-	-	162			155
Total Dissolved Solids	mg/L	-	-	-	339			315
Temperature - Field	°C	-	-	-	4.1			7.9
DISSOLVED ANIONS								
Alkalinity - Total	mg/L $CaCO_3$	-	-	-	155			140
Chloride	mg/L	150	1500	250	38.9			43.7
Sulphate [4,6]	mg/L	309	3090	500	12.9			17.0
NUTRIENTS								
Ammonia Nitrogen [5,7]	mg/L as N	1.84	18.5	-	0.0637			0.0383
Nitrate Nitrogen	mg/L as N	3	400	10	**8.28**			**8.7**
Total Phosphorus[3]	mg/L as P	0.005	-	-	0.0076			0.0203
TOTAL METALS								
Aluminum [5]	mg/L	0.41	-	9.5	0.258			0.1
Iron	mg/L	1	-	6.5	0.31			0.141
Manganese [4]	mg/L	1.27	-	1.5	0.0334			0.0132

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NOTES:

1. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.
   https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf
   https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/bc_env_working_water_quality_guidelines.pdf
   Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). Lowest guidelines are shown (ie. Long term average if applicable).
2. Per Schedule 3.2 of the Contaminated Sites Regulation (CSR), March 2023. AW standards assume minimum 1:10 dilution is available. As such, samples collected from background and receiving creeks are compared against CSR AW standards/10. https://www.bclaws.gov.bc.ca/civix/document/id/lc/statreg/375_96_08
3. Phosphorus Objective for creeks from Phosphorous Management in Vancouver Island Streams. Available: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-reference-documents/phosphorous_management_vi_streams_guidance_2014.pdf.
   BC MOE, April 2014. Monthly average of May to September samples for total phosphorus should not exceed 0.005 mg/L, and maximum total phosphorus for this period should not exceed 0.01 mg/L in any one sample. May and September results compared against stringent guideline of 0.005 mg/L.
4. FWAL guideline for indicated parameter changes with hardness. Aluminum guideline also varies with pH and DOC. Value shown appropriate for hardness of 150 mg/L-CaCO3, pH of 7.4, and DOC of 10 mg/L.
5. FWAL guideline for indicated parameter changes with pH and temperature. Value shown appropriate for pH between 6.5 and 7 and temperature of 10˚C.
6. CSR AW standard for indicated parameter changes with hardness. Value shown appropriate for hardness of 150 mg/L-CaCO3.
7. CSR AW standard for indicated parameter changes with pH. Value shown appropriate for pH between 7.0 and 7.5.
8. **Bolding** denotes parameters which exceed BC FWAL water quality guideline. <u>Underline</u> denotes parameters which exceed CSR AW standard. *Italics* denotes parameters which exceed CSR DW standard.
9. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

TABLE A-7

WATER CHEMISTRY DATA FOR SW-7

PARAMETER	units	RECEIVING WATER CRITERIA: AQUATIC LIFE (FWAL)[1]	RECEIVING WATER CRITERIA: CSR AQUATIC LIFE (AW)[2]	RECEIVING WATER CRITERIA: CSR DRINKING WATER (DW)[2]	SAMPLING DATE: 28-Feb-23	SAMPLING DATE: 05-Jun-23	SAMPLING DATE: 22-Aug-23	SAMPLING DATE: 21-Nov-23
PHYSICAL TESTS								
pH - Field	pH	6.5 - 9.0	-	-	**6.28**			**6.49**
pH - Lab	pH	6.5 - 9.0	-	-	7.07			7.15
Conductivity - Field	μS/cm	-	-	-	83	Dry	Dry	82
Conductivity - Lab	μS/cm	-	-	-	149			120
Total Hardness ($CaCO_3$)	mg/L	-	-	-	35.4			27.5
Total Dissolved Solids	mg/L	-	-	-	95			94
Temperature - Field	°C	-	-	-	3.6			8.2
DISSOLVED ANIONS								
Alkalinity - Total	mg/L $CaCO_3$	-	-	-	33.8			27.8
Chloride	mg/L	150	1500	250	20.8			19.3
Sulphate [4,7]	mg/L	128	1280	500	4.1			3.3
TOTAL CATIONS								
Calcium	mg/L	-	-	-	9.68			6.97
Magnesium	mg/L	-	-	-	2.72			2.45
Potassium	mg/L	-	-	-	2.02			2.13
Sodium	mg/L	-	-	200	13.4			13.8
NUTRIENTS								
Ammonia Nitrogen [5,8]	mg/L as N	1.84	18.4	-	0.0458			0.0083
Nitrate Nitrogen	mg/L as N	3	400	10	0.811			0.0143
Total Phosphorus[3]	mg/L as P	0.005	-	-	0.0086			0.0212
POLLUTANT TESTS								
Chemical Oxygen Demand	mg/L as O	-	-	-	16			45
Biochemical Oxygen Demand	mg/L as O	-	-	-	<2.0			2.4
TOTAL METALS								
Aluminum [5]	mg/L	0.10	-	9.5	**0.43**			**0.584**
Antimony	mg/L	0.07	0.09	0.006	0.0001			<0.00010
Arsenic	mg/L	0.005	0.05	0.01	0.00019			0.00052
Barium	mg/L	1	10	1	0.00901			0.00922
Beryllium	mg/L	0.00013	0.0015	0.008	<0.000100			<0.000100
Boron	mg/L	1.2	12	5	0.103			0.102
Cadmium [4,7]	mg/L	0.000077	0.0005	0.005	0.0000291			0.0000174
Chromium	mg/L	0.001	0.01	0.05	0.00079			**0.00124**
Cobalt	mg/L	0.004	0.04	0.001	0.0003			*0.00168*
Copper [7]	mg/L	0.0013	0.02	1.5	0.00109			**0.00155**
Iron	mg/L	1	-	6.5	0.597			**2.13**
Lead [4,7]	mg/L	0.0039	0.16	0.01	0.000149			0.000185
Lithium	mg/L	-	-	0.008	<0.0010			<0.0010
Manganese [4]	mg/L	0.72	-	1.5	0.053			0.573
Mercury	μg/L	0.2	0.25	1	<0.0050			0.000014
Molybdenum	mg/L	7.6	10	0.25	<0.000050			0.000058
Nickel [7]	mg/L	0.25	0.25	0.08	0.00101			0.00136
Selenium	mg/L	0.002	0.02	0.01	0.000069			0.000164
Silver [4,7]	mg/L	0.00005	0.0005	0.02	<0.000010			<0.000010
Strontium	mg/L	-	-	2.5	0.0521			0.0404
Thallium	mg/L	-	0.003	-	<0.000010			<0.000010
Tin	mg/L	-	-	2.5	<0.00010			<0.00010
Titanium	mg/L	-	1	-	0.0236			0.0344
Tungsten	mg/L	-	-	0.003	<0.00010			<0.00010
Uranium	mg/L	0.01	0.09	0.02	0.000012			0.000018
Vanadium	mg/L	-	-	0.02	0.00162			0.00283
Zinc [4,7]	mg/L	0.015	0.075	3	0.006			0.0042

H:\Project\1576\Chem\2023\[Tables-2023.xlsx]Table A-7

NOTES:

1. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.
   https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf
   https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/bc_env_working_water_quality_guidelines.pdf
   Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). Lowest guidelines are shown (ie. Long term average if applicable).
2. Per Schedule 3.2 of the Contaminated Sites Regulation (CSR), March 2023. AW standards assume minimum 1:10 dilution is available. As such, samples collected from background and receiving creeks are compared against CSR AW standards/10. https://www.bclaws.gov.bc.ca/civix/document/id/lc/statreg/375_96_08
3. Phosphorus Objective for creeks from Phosphorous Management in Vancouver Island Streams. Available: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-reference-documents/phosphorous_management_vi_streams_guidance_2014.pdf. BC MOE, April 2014.
   Monthly average of May to September samples for total phosphorus should not exceed 0.005 mg/L, and maximum total phosphorus for this period should not exceed 0.01 mg/L in any one sample. May and September results compared against stringent guideline of 0.005 mg/L.
4. FWAL guideline for indicated parameter changes with hardness. Aluminum and zinc guidelines also vary with pH and DOC. Value shown appropriate for hardness of 25 mg/L-CaCO3, pH of 6.4 and DOC of 9. Cadmium and zinc guidelines are for dissolved metals.
5. FWAL guideline for indicated parameter changes with pH and temperature. Value shown appropriate for pH between 6.5 and 7 and temperature of 10˚C.
6. Dissolved copper FWAL guideline was calculated for each site using the average BC BLM software calculations between January 2020 - January 2022 with sample-specific parameters except for humic acid ratio (assumed value of 10).
7. CSR AW standard for indicated parameter changes with hardness. Value shown appropriate for hardness of 25 mg/L-CaCO3.
8. CSR AW standard for indicated parameter changes with pH. Value shown appropriate for pH 6.4.
9. **Bolding** denotes parameters which exceed BC FWAL water quality guideline. Underline denotes parameters which exceed CSR AW standard. *Italics* denotes parameters which exceed CSR DW standard.
10. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

TABLE A-8

WATER CHEMISTRY DATA FOR SW-8

PARAMETER	units	RECEIVING WATER CRITERIA			SAMPLING DATE			
		AQUATIC LIFE (FWAL)[1]	CSR AQUATIC LIFE (AW)[2]	CSR DRINKING WATER (DW)[2]	28-Feb-23	05-Jun-23	22-Aug-23	21-Nov-23
PHYSICAL TESTS								
pH - Field	pH	6.5 - 9.0	-	-	7.17			7.47
pH - Lab	pH	6.5 - 9.0	-	-	7.99			8.23
Conductivity - Field	µS/cm	-	-	-	300	Dry	Dry	371
Conductivity - Lab	µS/cm	-	-	-	542			568
Total Hardness ($CaCO_3$)	mg/L	-	-	-	173			181
Total Dissolved Solids	mg/L	-	-	-	329			345
Temperature - Field	°C	-	-	-	3.3			7.7
DISSOLVED ANIONS								
Alkalinity - Total	mg/L $CaCO_3$	-	-	-	170			186
Chloride	mg/L	150	1500	250	39.9			48.2
Sulphate [4,6]	mg/L	309	3090	500	11.9			16.2
NUTRIENTS								
Ammonia Nitrogen [5,7]	mg/L as N	1.84	3.7	-	1.24			0.297
Nitrate Nitrogen	mg/L as N	3	400	10	**9.62**			***10.9***
Total Phosphorus[3]	mg/L as P	0.005	-	-	0.0084			0.048
POLLUTANT TESTS								
Chemical Oxygen Demand	mg/L as O	-	-	-	29			37
Biochemical Oxygen Demand	mg/L as O	-	-	-	<2.0			<2.0
TOTAL METALS								
Aluminum [5]	mg/L	0.61	-	9.5	0.0709			0.0602
Iron	mg/L	1	-	6.5	0.137			0.138
Manganese [4]	mg/L	1.38	-	1.5	0.029			0.0243

H:\Project\1576\Chem\2023\[Tables-2023.xlsx]Table A-8

NOTES:

1. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.
https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf
https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/bc_env_working_water_quality_guidelines.pdf
Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). Lowest guidelines are shown (ie. Long term average if applicable).
2. Per Schedule 3.2 of the Contaminated Sites Regulation (CSR), March 2023. AW standards assume minimum 1:10 dilution is available. As such, samples collected from background and receiving creeks are compared against CSR AW standards/10. https://www.bclaws.gov.bc.ca/civix/document/id/lc/statreg/375_96_08
3. Phosphorus Objective for creeks from Phosphorous Management in Vancouver Island Streams. Available: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-reference-documents/phosphorous_management_vi_streams_guidance_2014.pdf.
BC MOE, April 2014. Monthly average of May to September samples for total phosphorus should not exceed 0.005 mg/L, and maximum total phosphorus for this period should not exceed 0.01 mg/L in any one sample. May and September results compared against stringent guideline of 0.005 mg/L.
4. FWAL guideline for indicated parameter changes with hardness. Aluminum guideline also varies with pH and DOC. Value shown appropriate for hardness of 177 mg/L-CaCO3, pH of 8.1, and DOC of 10 mg/L.
5. FWAL guideline for indicated parameter changes with pH and temperature. Value shown appropriate for pH between 6.5 and 7 and temperature of 10˚C.
6. CSR AW standard for indicated parameter changes with hardness. Value shown appropriate for hardness of 177 mg/L-CaCO3.
7. CSR AW standard for indicated parameter changes with pH. Value shown appropriate for pH between 8.0 and 8.5.
8. **Bolding** denotes parameters which exceed BC FWAL water quality guideline. Underline denotes parameters which exceed CSR AW standard. *Italics* denotes parameters which exceed CSR DW standard.
9. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

TABLE A-9

WATER CHEMISTRY DATA FOR SW-9

PARAMETER	units	RECEIVING WATER CRITERIA			SAMPLING DATE			
		AQUATIC LIFE (FWAL)[1]	CSR AQUATIC LIFE (AW)[2]	CSR DRINKING WATER (DW)[2]	28-Feb-23	05-Jun-23	22-Aug-23	21-Nov-23
PHYSICAL TESTS								
pH - Field	pH	6.5 - 9.0	-	-	7.16			7.57
pH - Lab	pH	6.5 - 9.0	-	-	8.02			8.12
Conductivity - Field	µS/cm	-	-	-	309	Dry	Dry	27
Conductivity - Lab	µS/cm	-	-	-	558			503
Total Hardness ($CaCO_3$)	mg/L	-	-	-	187			154
Total Dissolved Solids	mg/L	-	-	-	356			308
Temperature - Field	°C	-	-	-	3.1			7.8
DISSOLVED ANIONS								
Alkalinity - Total	mg/L $CaCO_3$	-	-	-	183			137
Chloride	mg/L	150	1500	250	42.1			43.3
Sulphate [4,6]	mg/L	309	3090	500	13.2			19.6
NUTRIENTS								
Ammonia Nitrogen [5,7]	mg/L as N	1.84	3.7	-	0.681			0.0132
Nitrate Nitrogen	mg/L as N	3	400	10	**8.59**			***10.3***
Total Phosphorus[3]	mg/L as P	0.005	-	-	0.0082			0.049
POLLUTANT TESTS								
Chemical Oxygen Demand	mg/L as O	-	-	-	28			34
Biochemical Oxygen Demand	mg/L as O	-	-	-	<2.0			<2.0
TOTAL METALS								
Aluminum [5]	mg/L	0.60	-	9.5	0.0816			0.0875
Iron	mg/L	1	-	6.5	0.107			0.098
Manganese [4]	mg/L	1.36	-	1.5	0.0171			0.0228

H:\Project\1576\Chem\2023\[Tables-2023.xlsx]Table A-9

NOTES:

1. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.
   https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf
   https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/bc_env_working_water_quality_guidelines.pdf
   Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). Lowest guidelines are shown (ie. Long term average if applicable).
2. Per Schedule 3.2 of the Contaminated Sites Regulation (CSR), March 2023. AW standards assume minimum 1:10 dilution is available. As such, samples collected from background and receiving creeks are compared against CSR AW standards/10. https://www.bclaws.gov.bc.ca/civix/document/id/lc/statreg/375_96_08
3. Phosphorus Objective for creeks from Phosphorous Management in Vancouver Island Streams. Available: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-reference-documents/phosphorous_management_vi_streams_guidance_2014.pdf.
   BC MOE, April 2014. Monthly average of May to September samples for total phosphorus should not exceed 0.005 mg/L, and maximum total phosphorus for this period should not exceed 0.01 mg/L in any one sample. May and September results compared against stringent guideline of 0.005 mg/L.
4. FWAL guideline for indicated parameter changes with hardness. Aluminum guideline also varies with pH and DOC. Value shown appropriate for hardness of 170.5 mg/L-CaCO3, pH of 8.1, and DOC of 10 mg/L.
5. FWAL guideline for indicated parameter changes with pH and temperature. Value shown appropriate for pH between 6.5 and 7 and temperature of 10˚C.
6. CSR AW standard for indicated parameter changes with hardness. Value shown appropriate for hardness of 171 mg/L-CaCO3.
7. CSR AW standard for indicated parameter changes with pH. Value shown appropriate for pH between 8.0 and 8.5.
8. **Bolding** denotes parameters which exceed BC FWAL water quality guideline. <u>Underline</u> denotes parameters which exceed CSR AW standard. *Italics* denotes parameters which exceed CSR DW standard.
9. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

TABLE A-10

WATER CHEMISTRY DATA FOR SW-10 AND SW-10US

PARAMETER	units	RECEIVING WATER CRITERIA			SAMPLING DATE				
					SW-10	SW-10	SW-10	SW-10US	SW-10
		AQUATIC LIFE (FWAL)[1]	CSR AQUATIC LIFE (AW)[2]	CSR DRINKING WATER (DW)[2]	22-Feb-22	05-Jun-23	14-Aug-23	14-Aug-23	21-Nov-23
PHYSICAL TESTS									
pH - Field	pH	6.5 - 9.0	-	-	7.38	7.54	7.48	7.17	7.11
pH - Lab	pH	6.5 - 9.0	-	-	6.91	7.62	7.13	7.11	6.97
Conductivity - Field	µS/cm	-	-	-	60	183	176	217	74
Conductivity - Lab	µS/cm	-	-	-	104	282	242	310	112
Total Hardness ($CaCO_3$)	mg/L	-	-	-	24.8	67.1	52.8	70.3	25.8
Total Dissolved Solids	mg/L	-	-	-	103	199	169	208	84
Temperature - Field	°C	-	-	-	3.7	8.8	12.2	11.8	7.9
DISSOLVED ANIONS									
Alkalinity - Total	mg/L $CaCO_3$	-	-	-	17.4	60.2	28.6	24.5	12.6
Chloride	mg/L	150	1500	250	15.4	45.9	42.6	42.7	16.9
Sulphate [4,7]	mg/L	128	1280	500	4.4	4.2	18.1	47.0	10.8
TOTAL CATIONS									
Calcium	mg/L	-	-	-	6.7	18.5	14	18.6	6.43
Magnesium	mg/L	-	-	-	1.95	5.08	4.34	5.8	2.38
Potassium	mg/L	-	-	-	1.36	6.1	5.41	5.71	1.16
Sodium	mg/L	-	-	200	9.99	27.4	22.1	24.8	11.2
NUTRIENTS									
Ammonia Nitrogen [5,8]	mg/L as N	1.84	18.4	-	<0.0050	0.0135	0.0191	0.0243	0.0055
Nitrate Nitrogen	mg/L as N	3	400	10	0.956	0.0052	0.031	0.0365	0.647
Total Phosphorus[3]	mg/L as P	0.005	-	-	0.0066	**0.0183**	**0.0329**	**0.0242**	0.0133
POLLUTANT TESTS									
Chemical Oxygen Demand	mg/L as O	-	-	-	24	33	55	36	27
Biochemical Oxygen Demand	mg/L as O	-	-	-	<2.0	<2.0	<2.0	<2.0	<2.0
TOTAL METALS									
Aluminum [5]	mg/L	0.20	-	9.5	**0.339**	0.164	**0.354**	**0.266**	**0.384**
Antimony	mg/L	0.07	0.09	0.006	<0.00010	0.00013	<0.00010	<0.00010	<0.00010
Arsenic	mg/L	0.005	0.05	0.01	0.00013	0.00026	0.00055	0.00037	0.00015
Barium	mg/L	1	10	1	0.0051	0.0116	0.00927	0.0107	0.0064
Beryllium	mg/L	0.00013	0.0015	0.008	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100
Boron	mg/L	1.2	12	5	0.048	0.167	0.082	0.088	0.059
Cadmium [4,7]	mg/L	0.000072	0.0005	0.005	0.0000087	0.000019	0.000013	0.0000121	0.0000244
Chromium	mg/L	0.001	0.01	0.05	<0.00050	<0.00050	0.00072	0.00057	0.0006
Cobalt	mg/L	0.004	0.04	0.001	0.00019	*0.00103*	0.00093	0.00067	0.00045
Copper [7]	mg/L	0.0012	0.02	1.5	0.00076	0.00116	**0.00122**	0.00088	**0.00135**
Iron	mg/L	1	-	6.5	0.258	0.608	**1.4**	0.994	0.305
Lead [4,7]	mg/L	0.0038	0.16	0.01	0.0001	0.000092	0.000159	0.000113	0.000158
Lithium	mg/L	-	-	0.008	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Manganese [4]	mg/L	0.71	-	1.5	0.00709	0.224	0.123	0.105	0.0146
Mercury	µg/L	0.2	0.25	1	<0.0050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum	mg/L	7.6	10	0.25	<0.000050	<0.000050	0.000072	<0.000050	<0.000050
Nickel [7]	mg/L	0.25	0.25	0.08	0.00084	0.00142	0.00125	0.00105	0.00153
Selenium	mg/L	0.002	0.02	0.01	0.000054	0.000057	0.0001	0.000062	0.000121
Silver [4,7]	mg/L	0.00005	0.0005	0.02	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Strontium	mg/L	-	-	2.5	0.0356	0.107	0.0767	0.101	0.0381
Thallium	mg/L	-	0.003	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Tin	mg/L	-	-	2.5	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Titanium	mg/L	-	1	-	0.0138	0.00472	0.02	0.0152	0.0141
Tungsten	mg/L	-	-	0.003	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Uranium	mg/L	0.01	0.09	0.02	0.000012	<0.000010	0.000013	0.000011	0.000012
Vanadium	mg/L	-	-	0.02	0.00101	0.00087	0.00215	0.00136	0.00102
Zinc [4,7]	mg/L	0.010	0.075	3	0.0032	0.0073	<0.0030	<0.0030	<u>0.0081</u>

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NOTES:

1. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.
   https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf
   https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/bc_env_working_water_quality_guidelines.pdf
   Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). Lowest guidelines are shown (ie. Long term average if applicable).
2. Per Schedule 3.2 of the Contaminated Sites Regulation (CSR), March 2023. AW standards assume minimum 1:10 dilution is available. As such, samples collected from background and receiving creeks are compared against CSR AW standards/10. https://www.bclaws.gov.bc.ca/civix/document/id/lc/statreg/375_96_08
3. Phosphorus Objective for creeks from Phosphorous Management in Vancouver Island Streams. Available: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-reference-documents/phosphorous_management_vi_streams_guidance_2014.pdf. BC MOE, April 2014.
   Monthly average of May to September samples for total phosphorus should not exceed 0.005 mg/L, and maximum total phosphorus for this period should not exceed 0.01 mg/L in any one sample. May and September results compared against stringent guideline of 0.005 mg/L.
4. FWAL guideline for indicated parameter changes with hardness. Aluminum and zinc guidelines also vary with pH and DOC. Value shown appropriate for hardness of 23 mg/L-CaCO3, pH of 6.9 and DOC of 13. Cadmium and zinc guidelines are for dissolved metals.
5. FWAL guideline for indicated parameter changes with pH and temperature. Value shown appropriate for pH between 6.5 and 7 and temperature of 10˚C.
6. Dissolved copper FWAL guideline was calculated for each site using the average BC BLM software calculations between January 2020 - January 2022 with sample-specific parameters except for humic acid ratio (assumed value of 10).
7. CSR AW standard for indicated parameter changes with hardness. Value shown appropriate for hardness of 23 mg/L-CaCO3.
8. CSR AW standard for indicated parameter changes with pH. Value shown appropriate for pH 6.9.
9. **Bolding** denotes parameters which exceed BC FWAL water quality guideline. <u>Underline</u> denotes parameters which exceed CSR AW criteria standard. *Italics* denotes parameters which
10."-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

TABLE A-11

WATER CHEMISTRY DATA FOR SW-11

PARAMETER	units	RECEIVING WATER CRITERIA			SAMPLING DATE			
		AQUATIC LIFE (FWAL)[1]	CSR AQUATIC LIFE (AW)[2]	CSR DRINKING WATER (DW)[2]	28-Feb-23	05-Jun-23	22-Aug-23	21-Nov-23
PHYSICAL TESTS								
pH - Field	pH	6.5 - 9.0	-	-	7.18			6.96
pH - Lab	pH	6.5 - 9.0	-	-	6.92			6.97
Conductivity - Field	µS/cm	-	-	-	78	Dry	Dry	111
Conductivity - Lab	µS/cm	-	-	-	131			164
Total Hardness ($CaCO_3$)	mg/L	-	-	-	29			33.8
Total Dissolved Solids	mg/L	-	-	-	104			112
Temperature - Field	°C	-	-	-	5.1			8.4
DISSOLVED ANIONS								
Alkalinity - Total	mg/L $CaCO_3$	-	-	-	23.2			14.1
Chloride	mg/L	150	1500	250	21.6			29.4
Sulphate [4,7]	mg/L	218	2180	500	5.9			16.1
TOTAL CATIONS								
Calcium	mg/L	-	-	-	7.82			9.05
Magnesium	mg/L	-	-	-	2.29			2.72
Potassium	mg/L	-	-	-	1.99			2.69
Sodium	mg/L	-	-	200	12.7			17
NUTRIENTS								
Ammonia Nitrogen [5,8]	mg/L as N	1.84	18.4	-	0.0222			0.0328
Nitrate Nitrogen	mg/L as N	3	400	10	0.409			0.116
Total Phosphorus[3]	mg/L as P	0.005	-	-	0.0114			0.0217
POLLUTANT TESTS								
Chemical Oxygen Demand	mg/L as O	-	-	-	27			30
Biochemical Oxygen Demand	mg/L as O	-	-	-	<2.0			2
TOTAL METALS								
Aluminum [5]	mg/L	0.17	-	9.5	**0.775**			**0.832**
Antimony	mg/L	0.07	0.09	0.006	<0.00010			0.00013
Arsenic	mg/L	0.005	0.05	0.01	0.00028			0.00044
Barium	mg/L	1	10	1	0.0087			0.0147
Beryllium	mg/L	0.00013	0.0015	0.008	<0.000100			<0.000100
Boron	mg/L	1.2	12	5	0.067			0.143
Cadmium [4,7]	mg/L	0.00012	0.0015	0.005	0.0000152			0.0000507
Chromium	mg/L	0.001	0.01	0.05	**0.00131**			**0.00133**
Cobalt	mg/L	0.004	0.04	0.001	0.00033			*0.00278*
Copper [7]	mg/L	0.0014	0.02	1.5	**0.00185**			**0.00237**
Iron	mg/L	1	-	6.5	**1.46**			**2.73**
Lead [4,7]	mg/L	0.0045	0.16	0.01	0.000292			0.000355
Lithium	mg/L	-	-	0.008	<0.0010			<0.0010
Manganese [4]	mg/L	0.80	-	1.5	0.0409			0.201
Mercury	µg/L	0.2	0.25	1	0.0082			0.0000091
Molybdenum	mg/L	7.6	10	0.25	<0.000050			<0.000050
Nickel [7]	mg/L	0.25	0.25	0.08	0.00089			0.00146
Selenium	mg/L	0.002	0.02	0.01	0.000068			0.000111
Silver [4,7]	mg/L	0.00005	0.0005	0.02	<0.000010			<0.000010
Strontium	mg/L	-	-	2.5	0.0425			0.0545
Thallium	mg/L	-	0.003	-	<0.000010			<0.000010
Tin	mg/L	-	-	2.5	<0.00010			<0.00010
Titanium	mg/L	-	1	-	0.0418			0.0366
Tungsten	mg/L	-	-	0.003	<0.00010			<0.00010
Uranium	mg/L	0.01	0.09	0.02	0.000029			0.000021
Vanadium	mg/L	-	-	0.02	0.0038			0.00403
Zinc [4,7]	mg/L	0.019	0.075	3	0.0083			0.0147

H:\Project\1576\Chem\2023\[Tables-2023.xlsx]Table A-11

NOTES:

1. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.
   https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf
   https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/bc_env_working_water_quality_guidelines.pdf
   Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). Lowest guidelines are shown (ie. Long term average if applicable).
2. Per Schedule 3.2 of the Contaminated Sites Regulation (CSR), March 2023. AW standards assume minimum 1:10 dilution is available. As such, samples collected from background and receiving creeks are compared against CSR AW standards/10. https://www.bclaws.gov.bc.ca/civix/document/id/lc/statreg/375_96_08
3. Phosphorus Objective for creeks from Phosphorous Management in Vancouver Island Streams. Available: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-reference-documents/phosphorous_management_vi_streams_guidance_2014.pdf. BC MOE, April 2014.
   Monthly average of May to September samples for total phosphorus should not exceed 0.005 mg/L, and maximum total phosphorus for this period should not exceed 0.01 mg/L in any one sample. May and September results compared against stringent guideline of 0.005 mg/L.
4. FWAL guideline for indicated parameter changes with hardness. Aluminum and zinc guidelines also vary with pH and DOC. Value shown appropriate for hardness of 45 mg/L-CaCO3, pH of 6.7 and DOC of 0. Cadmium and zinc guidelines are for dissolved metals.
5. FWAL guideline for indicated parameter changes with pH and temperature. Value shown appropriate for pH between 6.5 and 7 and temperature of 10˚C.
6. Dissolved copper FWAL guideline was calculated for each site using the average BC BLM software calculations between January 2020 - January 2022 with sample-specific parameters except for humic acid ratio (assumed value of 10).
7. CSR AW standard for indicated parameter changes with hardness. Value shown appropriate for hardness of 45 mg/L-CaCO3.
8. CSR AW standard for indicated parameter changes with pH. Value shown appropriate for pH 6.7.
9. **Bolding** denotes parameters which exceed BC FWAL water quality criteria. Underline denotes parameters which exceed CSR AW criteria. *Italics* denotes parameters which exceed CSR DW.
10. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

TABLE A-12
WATER CHEMISTRY DATA FOR SW-12

PARAMETER	units	RECEIVING WATER CRITERIA			SAMPLING DATE			
		AQUATIC LIFE (FWAL)[1]	CSR AQUATIC LIFE (AW)[2]	CSR DRINKING WATER (DW)[2]	28-Feb-23	05-Jun-23	22-Aug-23	21-Nov-23
PHYSICAL TESTS								
pH - Field	pH	6.5 - 9.0	-	-	7.24			7.93
pH - Lab	pH	6.5 - 9.0	-	-	7.36			7.12
Conductivity - Field	µS/cm	-	-	-	101	Dry	Dry	85
Conductivity - Lab	µS/cm	-	-	-	175			127
Total Hardness ($CaCO_3$)	mg/L	-	-	-	50.5			34.2
Total Dissolved Solids	mg/L	-	-	-	114			98
Temperature - Field	°C	-	-	-	4.4			8.4
DISSOLVED ANIONS								
Alkalinity - Total	mg/L $CaCO_3$	-	-	-	49.9			19
Chloride	mg/L	150	1500	250	17.4			16.4
Sulphate [4,6]	mg/L	218	2180	500	7.6			14.3
NUTRIENTS								
Ammonia Nitrogen [5,7]	mg/L as N	1.84	18.5	-	1.16			0.0152
Nitrate Nitrogen	mg/L as N	3	400	10	0.698			0.282
Total Phosphorus[3]	mg/L as P	0.005	-	-	0.0138			0.034
TOTAL METALS								
Aluminum [5]	mg/L	0.29	-	9.5	**1.28**			**0.893**
Iron	mg/L	1	-	6.5	**1.67**			**1.12**
Manganese [4]	mg/L	0.79	-	1.5	0.0635			0.0372

H:\Project\1576\Chem\2023\[Tables-2023.xlsx]Table A-12

NOTES:

1. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment. https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/bc_env_working_water_quality_guidelines.pdf Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). Lowest guidelines are shown (ie. Long term average if applicable).
2. Per Schedule 3.2 of the Contaminated Sites Regulation (CSR), March 2023. AW standards assume minimum 1:10 dilution is available. As such, samples collected from background and receiving creeks are compared against CSR AW standards/10. https://www.bclaws.gov.bc.ca/civix/document/id/lc/statreg/375_96_08
3. Phosphorus Objective for creeks from Phosphorous Management in Vancouver Island Streams. Available: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-reference-documents/phosphorous_management_vi_streams_guidance_2014.pdf. BC MOE, April 2014. Monthly average of May to September samples for total phosphorus should not exceed 0.005 mg/L, and maximum total phosphorus for this period should not exceed 0.01 mg/L in any one sample. May and September results compared against stringent guideline of 0.005 mg/L.
4. FWAL guideline for indicated parameter changes with hardness. Aluminum guideline also varies with pH and DOC. Value shown appropriate for hardness of 42.35 mg/L-CaCO3, pH of 7.2, and DOC of 10 mg/L.
5. FWAL guideline for indicated parameter changes with pH and temperature. Value shown appropriate for pH between 6.5 and 7 and temperature of 10˚C.
6. CSR AW standard for indicated parameter changes with hardness. Value shown appropriate for hardness of 42 mg/L-CaCO3.
7. CSR AW standard for indicated parameter changes with pH. Value shown appropriate for pH <7.
8. **Bolding** denotes parameters which exceed BC FWAL water quality guideline. <u>Underline</u> denotes parameters which exceed CSR AW standard. *Italics* denotes parameters which exceed CSR DW standard.
9. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

TABLE A-13

WATER CHEMISTRY DATA FOR SANDHILL CREEK EAST TRIBUTARY

PARAMETER	units	RECEIVING WATER CRITERIA			SAMPLING DATE
		AQUATIC LIFE (FWAL)[1]	CSR AQUATIC LIFE (AW)[2]	CSR DRINKING WATER (DW)[2]	21-Nov-23
PHYSICAL TESTS					
pH - Field	pH	6.5 - 9.0	-	-	**5.91**
pH - Lab	pH	6.5 - 9.0	-	-	**6.36**
Conductivity - Field	µS/cm	-	-	-	50
Conductivity - Lab	µS/cm	-	-	-	72
Total Hardness ($CaCO_3$)	mg/L	-	-	-	12.8
Total Dissolved Solids	mg/L	-	-	-	69
Temperature - Field	°C	-	-	-	9.1
DISSOLVED ANIONS					
Alkalinity - Total	mg/L $CaCO_3$	-	-	-	3.4
Chloride	mg/L	150	1500	250	10.5
Sulphate [4,7]	mg/L	128	1280	500	12.2
TOTAL CATIONS					
Calcium	mg/L	-	-	-	2.09
Magnesium	mg/L	-	-	-	1.84
Potassium	mg/L	-	-	-	0.524
Sodium	mg/L	-	-	200	8.19
NUTRIENTS					
Ammonia Nitrogen [5,8]	mg/L as N	1.84	18.4	-	0.0072
Nitrate Nitrogen	mg/L as N	3.0	400	10	<0.0050
Total Phosphorus [3]	mg/L as P	0.005	-	-	0.0914
POLLUTANT TESTS					
Chemical Oxygen Demand	mg/L as O	-	-	-	23
Biochemical Oxygen Demand	mg/L as O	-	-	-	<2.0
TOTAL METALS					
Aluminum [5]	mg/L	0.06	-	9.5	**0.298**
Antimony	mg/L	0.07	0.09	0.006	<0.00010
Arsenic	mg/L	0.005	0.05	0.01	0.00014
Barium	mg/L	1.0	10	1	0.00695
Beryllium	mg/L	0.0	0.0015	0.008	<0.000100
Boron	mg/L	1.2	12	5	0.025
Cadmium [4,7]	mg/L	0.000039	0.0005	0.005	0.0000337
Chromium	mg/L	0.001	0.01	0.05	0.00054
Cobalt	mg/L	0.004	0.04	0.001	0.00034
Copper [7]	mg/L	0.00020	0.02	1.5	**0.00094**
Iron	mg/L	1	-	6.5	0.255
Lead [4,7]	mg/L	0.0035	0.16	0.01	0.000065
Lithium	mg/L	-	-	0.008	<0.0010
Manganese [4]	mg/L	0.649	-	1.5	0.0199
Mercury	µg/L	0.2	0.25	1	<0.0000050
Molybdenum	mg/L	7.6	10	0.25	<0.000050
Nickel [7]	mg/L	0.25	0.25	0.08	0.00092
Selenium	mg/L	0.002	0.02	0.01	0.00017
Silver [4,7]	mg/L	0.00005	0.0005	0.02	<0.000010
Strontium	mg/L	-	-	2.5	0.0231
Thallium	mg/L	-	0.003	-	<0.000010
Tin	mg/L	-	-	2.5	<0.00010
Titanium	mg/L	-	1	-	0.00884
Tungsten	mg/L	-	-	0.003	<0.00010
Uranium	mg/L	0.009	0.085	0.02	0.000012
Vanadium	mg/L	-	-	0.02	0.00081
Zinc [4,7]	mg/L	0.00605	0.075	3	0.0054

H:\Project\1576\Chem\2023\[Tables-2023.xlsx]Table A-13 Sandhill Creek East

NOTES:

1. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment. https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/bc_env_working_water_quality_guidelines.pdf
   Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). Lowest guidelines are shown (ie. Long term average if applicable).
2. Per Schedule 3.2 of the Contaminated Sites Regulation (CSR), March 2023. AW standards assume minimum 1:10 dilution is available. As such, samples collected from background and receiving creeks are compared against CSR AW standards/10. https://www.bclaws.gov.bc.ca/civix/document/id/lc/statreg/375_96_08
3. Phosphorus Objective for creeks from Phosphorous Management in Vancouver Island Streams. Available: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-reference-documents/phosphorous_management_vi_streams_guidance_2014.pdf. BC MOE, April 2014. Monthly average of May to September samples for total phosphorus should not exceed 0.005 mg/L, and maximum total phosphorus for this period should not exceed 0.01 mg/L in any one sample. May and September results compared against stringent guideline of 0.005 mg/L.
4. FWAL guideline for indicated parameter changes with hardness. Aluminum and zinc guidelines also vary with pH and DOC. Value shown appropriate for hardness of 10 mg/L-CaCO3, pH of 6.4 and DOC of 9. Cadmium and zinc guidelines are for dissolved metals.
5. FWAL guideline for indicated parameter changes with pH and temperature. Value shown appropriate for pH between 6.5 and 7 and temperature of 10˚C.
6. Dissolved copper FWAL guideline was calculated for each site using the average BC BLM software calculations between January 2020 - January 2022 with sample-specific parameters except for humic acid ratio (assumed value of 10).
7. CSR AW standard for indicated parameter changes with hardness. Value shown appropriate for hardness of 10 mg/L-CaCO3.
8. CSR AW standard for indicated parameter changes with pH. Value shown appropriate for pH 6.4.
9. **Bolding** denotes parameters which exceed BC FWAL water quality guideline. Underline denotes parameters which exceed CSR AW standard. *Italics* denotes parameters which exceed CSR DW standard.
10. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

TABLE A-14

WATER CHEMISTRY DATA FOR SW-14

PARAMETER	units	RECEIVING WATER CRITERIA			SAMPLING DATE			
		AQUATIC LIFE (FWAL)[1]	CSR AQUATIC LIFE (AW)[2]	CSR DRINKING WATER (DW)[2]	28-Feb-23	05-Jun-23	22-Aug-23	21-Nov-23
PHYSICAL TESTS								
pH - Field	pH	6.5 - 9.0	-	-	6.50			7.23
pH - Lab	pH	6.5 - 9.0	-	-	7.34			7.80
Conductivity - Field	µS/cm	-	-	-	90	Dry	Dry	160
Conductivity - Lab	µS/cm	-	-	-	167			248
Total Hardness ($CaCO_3$)	mg/L	-	-	-	65.1			97.6
Total Dissolved Solids	mg/L	-	-	-	123			163
Temperature - Field	°C	-	-	-	2.2			7.7
DISSOLVED ANIONS								
Alkalinity - Total	mg/L $CaCO_3$	-	-	-	55.6			79.3
Chloride	mg/L	150	1500	250	10.6			17.5
Sulphate [4,8]	mg/L	309	3090	500	10.4			19.6
TOTAL CATIONS								
Calcium	mg/L	-	-	-	19.7			30.7
Magnesium	mg/L	-	-	-	3.86			5.09
Potassium	mg/L	-	-	-	1.07			2.6
Sodium	mg/L	-	-	200	7.2			11.2
NUTRIENTS								
Ammonia Nitrogen [5,8]	mg/L as N	1.84	11.3	-	0.139			0.049
Nitrate Nitrogen	mg/L as N	3	400	10	0.482			0.245
Total Phosphorus[3]	mg/L as P	0.005	-	-	0.0282			0.136
POLLUTANT TESTS								
Chemical Oxygen Demand	mg/L as O	-	-	-	21			33
Biochemical Oxygen Demand	mg/L as O	-	-	-	<2.0			<2.0
TOTAL METALS								
Aluminum [5]	mg/L	0.49	-	9.5	**1.15**			**0.678**
Antimony	mg/L	0.07	0.09	0.006	0.00017			<0.00010
Arsenic	mg/L	0.005	0.05	0.01	0.00039			0.00055
Barium	mg/L	1	10	1	0.00754			0.0116
Beryllium	mg/L	0.00013	0.0015	0.008	<0.000100			<0.000100
Boron	mg/L	1.2	12	5	0.012			0.021
Cadmium [4,7]	mg/L	0.00018	0.0015	0.005	0.0000449			0.0000552
Chromium	mg/L	0.001	0.01	0.05	**0.0016**			0.00097
Cobalt	mg/L	0.004	0.04	0.001	0.00071			*0.001*
Copper [7]	mg/L	0.010	0.04	1.5	0.00237			0.00284
Iron	mg/L	1	-	6.5	**1.34**			**2.04**
Lead [4,7]	mg/L	0.0058	0.16	0.01	0.000354			0.000354
Lithium	mg/L	-	-	0.008	<0.0010			<0.0010
Manganese [4]	mg/L	0.96	-	1.5	0.105			0.241
Mercury	µg/L	0.2	0.25	1	0.0072			0.0000088
Molybdenum	mg/L	7.6	10	0.25	0.000513			0.00035
Nickel [7]	mg/L	0.08	0.65	0.08	0.00127			0.00114
Selenium	mg/L	0.002	0.02	0.01	0.000115			0.000168
Silver [4,7]	mg/L	0.00005	0.0005	0.02	0.000011			<0.000010
Strontium	mg/L	-	-	2.5	0.0419			0.0647
Thallium	mg/L	-	0.003	-	<0.000010			<0.000010
Tin	mg/L	-	-	2.5	<0.00010			<0.00010
Titanium	mg/L	-	1	-	0.0623			0.0261
Tungsten	mg/L	-	-	0.003	<0.00010			<0.00010
Uranium	mg/L	0.01	0.09	0.02	0.000156			0.000181
Vanadium	mg/L	-	-	0.02	0.00391			0.00334
Zinc [4,7]	mg/L	0.0425	0.075	3	0.0124			0.0086

H:\Project\1576\Chem\2023\[Tables-2023.xlsx]Table A-14_SW-14

NOTES:

1. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.
   https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf
   https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/bc_env_working_water_quality_guidelines.pdf
   Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). Lowest guidelines are shown (ie. Long term average if applicable).
2. Per Schedule 3.2 of the Contaminated Sites Regulation (CSR), March 2023. AW standards assume minimum 1:10 dilution is available. As such, samples collected from background and receiving creeks are compared against CSR AW standards/10. https://www.bclaws.gov.bc.ca/civix/document/id/lc/statreg/375_96_08
3. Phosphorus Objective for creeks from Phosphorous Management in Vancouver Island Streams. Available: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-reference-documents/phosphorous_management_vi_streams_guidance_2014.pdf. BC MOE, April 2014.
   Monthly average of May to September samples for total phosphorus should not exceed 0.005 mg/L, and maximum total phosphorus for this period should not exceed 0.01 mg/L in any one sample. May and September results compared against stringent guideline of 0.005 mg/L.
4. FWAL guideline for indicated parameter changes with hardness. Aluminum and zinc guidelines also vary with pH and DOC. Value shown appropriate for hardness of 81 mg/L-CaCO3, pH of 7.6 and DOC of 0. Cadmium and zinc guidelines are for dissolved metals.
5. FWAL guideline for indicated parameter changes with pH and temperature. Value shown appropriate for pH between 6.5 and 7 and temperature of 10˚C.
6. Dissolved copper FWAL guideline was calculated for each site using the average BC BLM software calculations between January 2020 - January 2022 with sample-specific parameters except for humic acid ratio (assumed value of 10).
7. CSR AW standard for indicated parameter changes with hardness. Value shown appropriate for hardness of 81 mg/L-CaCO3.
8. CSR AW standard for indicated parameter changes with pH. Value shown appropriate for pH 7.6.
9. **Bolding** denotes parameters which exceed BC FWAL water quality guideline. <u>Underline</u> denotes parameters which exceed CSR AW standard. *Italics* denotes parameters which exceed CSR DW standard.
10. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

TABLE A-15

WATER CHEMISTRY DATA SUMMARY FOR VOCs

PARAMETER	units	RECEIVING WATER CRITERIA			SAMPLING DATE						
					SW-1	SW-1	SW-1	SW-3	SW-3	SW-3	SW-3
		AQUATIC LIFE (FWAL)[1]	CSR AQUATIC LIFE (AW)[2]	CSR DRINKING WATER (DW)[2]	28-Feb-23	05-Jun-23	21-Nov-23	28-Feb-23	05-Jun-23	22-Aug-23	21-Nov-23
VOCs											
Acetone	µg/L	-	-	3500	<20	<20	<20	<20	<20	<20	<20
Bromobenzene	µg/L	-	-	30	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Bromochloromethane	µg/L	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Bromomethane	µg/L	-	-	5.5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Butylbenzene, n-	µg/L	-	-	200	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Butylbenzene, sec-	µg/L	-	-	400	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Butylbenzene, tert-	µg/L	-	-	400	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Carbon disulfide	µg/L	-	-	400	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Chlorobenzene	µg/L	-	13	80	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chloromethane	µg/L	-	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Chlorotoluene, 2-	µg/L	-	-	80	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chlorotoluene, 4-	µg/L	-	-	80	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cyclohexane	µg/L	-	-	7	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dibromo-3-chloropropane, 1,2-	µg/L	-	-	0.5	<1.0	<0.50	<0.50	<1.0	<0.50	<0.50	<0.50
Dibromobenzene, 1,3-	µg/L	-	-	1.5	<10	<10	<10	<10	<10	<10	<10
Dibromobenzene, 1,4-	µg/L	-	-	40	<10	<10	<10	<10	<10	<10	<10
Dibromomethane	µg/L	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-Dichlorobenzene	µg/L	1	7	200	<1.0	<1.0	<1.0	<1.0	<1.0	<0.40	<1.0
1,3-Dichlorobenzene	µg/L	150	1500	-	<1.0	<1.0	<1.0	<1.0	<1.0	<0.40	<1.0
1,4-Dichlorobenzene	µg/L	26	260	5	<1.0	<1.0	<1.0	<1.0	<1.0	<0.40	<1.0
Dichlorodifluoromethane	µg/L	-	-	800	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-Dichloropropane	µg/L	-	-	4.5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dichloropropane, 1,3-	µg/L	-	-	80	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dichloropropane, 2,2-	µg/L	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dichloropropylene, 1,1-	µg/L	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
cis&trans-1,3-Dichloropropene	µg/L	-	-	1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
cis-1,3-Dichloropropene	µg/L	-	-	1.5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Diethyl ether	µg/L	-	-	800	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Ethyl acetate	µg/L	-	-	3500	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Hexachlorobutadiene	µg/L	1	15	2	<1.0	<1.0	<1.0	<1.0	<1.0	<0.0080	<1.0
Hexanone, 2-	µg/L	-	-	20	<10	<10	<10	<10	<10	<10	<10
Methyl ethyl ketone [MEK]	µg/L	-	-	2500	<20	<20	<20	<20	<20	<20	<20
Methyl isobutyl carbinol [MIBC]	µg/L	-	-	-	<20	<20	<20	<20	<20	<20	<20
Methyl isobutyl ketone [MIBK]	µg/L	-	-	-	<20	<20	<20	<20	<20	<20	<20
Octane, n-	µg/L	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Pentane, n-	µg/L	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1,2,2-Tetrachloroethane	µg/L	-	-	0.8	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1,1,2-Tetrachloroethane	µg/L	-	-	6	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Trichloro-1,2,2-trifluoroethane, 1,1,2- [Freon 11	µg/L	-	-	100000	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Trichlorobenzene, 1,2,3-	µg/L	8	3	80	<1.0	<1.0	<1.0	<1.0	<1.0	<0.40	<1.0
Trichlorobenzene, 1,2,4-	µg/L	24	250	5.5	<1.0	<1.0	<1.0	<1.0	<1.0	<0.40	<1.0
1,1,2-Trichloroethane	µg/L	-	-	3	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Trichlorofluoromethane	µg/L	-	-	1000	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Trichloropropane, 1,1,2-	µg/L	-	-	20	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Trichloropropane, 1,2,3-	µg/L	-	-	0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Trichloropropylene, 1,2,3-	µg/L	-	-	10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

H:\Project\1576\Chem\2023\[Tables-2023.xlsx]Table A-15 VOCs 1

NOTES:

1. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.
   https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf
   https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/bc_env_working_water_quality_guidelines.pdf
   Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). Lowest guidelines are shown (ie. Long term average if applicable).
2. Per Schedule 3.2 of the Contaminated Sites Regulation (CSR), March 2023. AW standards assume minimum 1:10 dilution is available. As such, samples collected from background and receiving creeks are compared against CSR AW standards/10. https://www.bclaws.gov.bc.ca/civix/document/id/lc/statreg/375_96_08
3. **Bolding** denotes parameters which exceed BC FWAL water quality guideline. <u>Underline</u> denotes parameters which exceed CSR AW standard.
   Italics denotes parameters which exceed CSR DW standard.
4. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

TABLE A-16

WATER CHEMISTRY DATA SUMMARY FOR VOCs (CONTINUED)

PARAMETER	units	RECEIVING WATER CRITERIA			SAMPLING DATE						
					SW-1	SW-1	SW-1	SW-3	SW-3	SW-3	SW-3
		AQUATIC LIFE (FWAL)[1]	CSR AQUATIC LIFE (AW)[2]	CSR DRINKING WATER (DW)[2]	28-Feb-23	05-Jun-23	21-Nov-23	28-Feb-23	05-Jun-23	22-Aug-23	21-Nov-23
VOCs (DRY CLEANING)											
Carbon Tetrachloride	µg/L	-	130	2	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chloroethane	µg/L	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethane	µg/L	100	-	30	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethene	µg/L	-	-	14	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
cis-1,2-Dichloroethene	µg/L	-	-	8	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
trans-1,2-Dichloroethene	µg/L	-	-	80	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dichloromethane	µg/L	-	980	50	<1.0	<1.0	<50.0	<1.0	<1.0	<1.0	<50.0
trans-1,3-Dichloropropene	µg/L	-	-	1.5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Tetrachloroethene	µg/L	-	1100	3	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1,1-Trichloroethane	µg/L	-	-	8000	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Trichloroethylene	µg/L	-	200	5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Vinyl Chloride	µg/L	-	-	2	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
VOCs (FUEL)											
BTEX+Styrene, total	µg/L	-	-	-	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
BTEX, total	µg/L	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzene	µg/L	40	400	5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Butadiene, 1,3-	µg/L	-	-	1	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Cymene, p-	µg/L	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Decane, n-	µg/L	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dibromoethane, 1,2-	µg/L	-	-	0.5	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,2-Dichloroethane	µg/L	100	1000	5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Ethylbenzene	µg/L	200	2000	140	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Heptane, n-	µg/L	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Hexane, n-	µg/L	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Isopropylbenzene	µg/L	-	-	400	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Methyl t-Butyl Ether	µg/L	3400	34000	95	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Methylcyclohexane	µg/L	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Nonane, n-	µg/L	-	-	1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Propylbenzene, n-	µg/L	-	-	400	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Styrene	µg/L	72	720	800	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Toluene	µg/L	1	5	60	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Trimethylbenzene, 1,2,3-	µg/L	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Trimethylbenzene, 1,2,4-	µg/L	-	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Trimethylbenzene, 1,3,5-	µg/L	-	-	40	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
m&p-Xylene	µg/L	-	-	-	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
o-Xylene	µg/L	-	-	-	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Xylenes	µg/L	30	300	90	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
VOCs (THMs)	µg/L										
Bromodichloromethane	µg/L	-	-	100	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Bromoform	µg/L	-	-	100	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chloroform	µg/L	1.8	20	100	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dibromochloromethane	µg/L	-	-	100	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Trihalomethanes [THMs], total	µg/L	-	-	100	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0

H:\Project\1576\Chem\2023\[Tables-2023.xlsx]Table A-16 VOCs 2

NOTES:

1. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.
https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf
https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/bc_env_working_water_quality_guidelines.pdf
Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). Lowest guidelines are shown (ie. Long term average if applicable).
2. Per Schedule 3.2 of the Contaminated Sites Regulation (CSR), March 2023. AW standards assume minimum 1:10 dilution is available. As such, samples collected from background and receiving creeks are compared against CSR AW standards/10. https://www.bclaws.gov.bc.ca/civix/document/id/lc/statreg/375_96_08
3. **Bolding** denotes parameters which exceed BC FWAL water quality guideline. <u>Underline</u> denotes parameters which exceed CSR AW standard.
Italics denotes parameters which exceed CSR DW standard.
4."-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

TABLE A-17
WATER CHEMISTRY DATA FOR POTENTIAL CONTAMINANTS AT SW-3

PARAMETER	units	RECEIVING WATER CRITERIA			SAMPLING DATE
		AQUATIC LIFE (FWAL)[1]	CSR AQUATIC LIFE (AW)[2]	CSR DRINKING WATER (DW)[2]	22-Aug-23
CHLORINATED PHENOLICS					
Chlorophenol, 2-	µg/L	-	20	45	<0.30
Dichlorophenol, 2,4-	µg/L	1	3	900	<0.30
Dichlorophenol, 2,6-	µg/L	2	10	-	<0.50
Methylphenol, 4-chloro-3-	µg/L	-	-	400	<0.50
Pentachlorophenol [PCP]	µg/L	0	1	60	<0.50
Tetrachlorophenol, 2,3,4,5-	µg/L	0	2	-	<0.50
Tetrachlorophenol, 2,3,4,6-	µg/L	1	6	100	<0.50
Tetrachlorophenol, 2,3,5,6-	µg/L	1	3	-	<0.50
Trichlorophenol, 2,3,4-	µg/L	1	3	-	<0.50
Trichlorophenol, 2,3,5-	µg/L	1	3	-	<0.50
Trichlorophenol, 2,4,5-	µg/L	1	3	400	<0.50
Trichlorophenol, 2,4,6-	µg/L	1	6	5	<0.50
NON-CHLORINATED PHENOLICS					
Dimethylphenol, 2,4-	µg/L	-	-	80	<0.50
Dinitrophenol, 2,4-	µg/L	-	2000	8	<0.50
Methylphenol, 2-	µg/L	-	2500	200	<0.50
Methylphenol, 3+4-	µg/L	-	700	200	<0.50
Methylphenols, total	µg/L	-	-	-	<0.75
Nitrophenol, 2-	µg/L	-	-	-	<0.50
Nitrophenol, 4-	µg/L	-	-	-	<0.50
Phenol	µg/L	50	2000	1000	<0.50
Phenol, 2-methyl-4,6-dinitro- [DNOC]	µg/L	-	750	1	<2.0
HYDROCARBONS					
EPH (C10-C19)	µg/L	-	5000	5000	<250
EPH (C19-C32)	µg/L	-	-	-	<250
HEPHw	µg/L	-	-	-	<250
LEPH	µg/L	-	500	-	<250
POLYCYCLIC AROMATIC HYDROCARBONS					
Acenaphthene	µg/L	6	60	250	<0.20
Acenaphthylene	µg/L	-	60	250	<0.20
Anthracene	µg/L	4	1	1000	<0.20
Benzo(a)anthracene	µg/L	0	1	0	<0.20
Benzo(a)pyrene	µg/L	0	0	0	<0.050
Benzo(b+j)fluoranthene	µg/L	-	-	0	<0.20
Benzo(e)pyrene	µg/L	-	-	-	<0.050
Benzo(g,h,i)perylene	µg/L	-	-	-	<0.20
Benzo(k)fluoranthene	µg/L	-	-	-	<0.20
Camphene	µg/L	-	-	-	<0.40
Chrysene	µg/L	-	1	7	<0.20
Dibenz(a,h)anthracene	µg/L	-	-	0	<0.20
Dibenzofuran	µg/L	-	-	4	<0.20
Fluoranthene	µg/L	4	2	150	<0.20
Fluorene	µg/L	12	120	150	<0.20
Indeno(1,2,3-cd)pyrene	µg/L	-	-	-	<0.20
1-Methylnaphthalene	µg/L	-	-	6	<0.40
2-Methylnaphthalene	µg/L	-	-	15	<0.40
Naphthalene	µg/L	1	10	80	<0.20
Perylene	µg/L	-	-	-	<0.20
Phenanthrene	µg/L	0.3	3	-	<0.20
Pyrene	µg/L	0.02	0.2	100	<0.20
Acridine	µg/L	3	0.5	-	<0.010
Benzo(b+j+k)fluoranthene	µg/L	-	-	-	<0.015
Methylnaphthalene, 1+2-	µg/L	-	-	-	<0.60
Quinoline	µg/L	3.4	34	0.05	<0.050
SEMI-VOLATILE ORGANIC					
Hexachlorobenzene	µg/L	-	-	0.10	<0.0080
Hexachloroethane	µg/L	-	-	3.0	<0.0080
Biphenyl	µg/L	-	-	2000	<0.40
Bromophenylphenyl ether, 4-	µg/L	-	-	-	<0.40
Chloroaniline, 4-	µg/L	-	-	1	<0.40
Chloronaphthalene, 1-	µg/L	-	-	-	<0.40
Chloronaphthalene, 2-	µg/L	-	-	300	<0.40
Chlorophenylphenyl ether, 4-	µg/L	-	-	-	<0.40
Dichlorobenzidine, 3,3'-	µg/L	-	-	0.35	<0.40
Dinitrotoluene, 2,4-	µg/L	-	-	0.50	<0.40
Dinitrotoluene, 2,6-	µg/L	-	-	0.10	<0.40
Dinitrotoluene, 2,4 + 2,6-	µg/L	-	-	-	<0.60
Diphenyl amine	µg/L	-	-	100	<0.40
Diphenyl ether	µg/L	-	-	-	<0.40
Hexachlorocyclopentadiene	µg/L	-	-	25	<0.40
Indole	µg/L	-	-	-	<0.40
Isophorone	µg/L	-	-	150	<0.40
Nitroacenaphthene, 5-	µg/L	-	-	-	<0.40
Nitrobenzene	µg/L	-	-	8	<0.40
Nitrosodi-n-propylamine, N-	µg/L	-	-	0.020	<0.40
bis(2-Chloro-1-methylethyl) ether	µg/L	-	-	150	<0.40
bis(2-Chloroethoxy)methane	µg/L	-	-	10	<0.44
bis(2-Chloroethyl) ether	µg/L	-	-	0.15	<0.40

H:\Project\1576\Chem\2023\[Tables-2023.xlsx]Table A-17 SW-3 Phenols

NOTES:

1. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environme
   https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf
   https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/bc_env_working_water_quality_guidelines.pdf
   Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). Lowest guidelines are shown (ie. Long term average if applicable).
2. Per Schedule 3.2 of the Contaminated Sites Regulation (CSR), March 2023. AW standards assume minimum 1:10 dilution is available.
   As such, samples collected from background and receiving creeks are compared against CSR AW standards/10.
   https://www.bclaws.gov.bc.ca/civix/document/id/lc/statreg/375_96_08
3. **Bolding** denotes parameters which exceed BC FWAL water quality guideline. Underline denotes parameters which exceed CSR AW standard. *Italics* denotes parameters which exceed CSR DW standard.
4."-" denotes parameter was not analysed, or a receiving water criteria was not applicable.
3. **Bolding** denotes parameters which exceed water quality criteria.
4. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

TABLE A-18
WATER CHEMISTRY DATA FOR PESTICIDES AT SW-3

PARAMETER	units	RECEIVING WATER CRITERIA			SAMPLING DATE
		AQUATIC LIFE (FWAL)[1]	CSR AQUATIC LIFE (AW)[2]	CSR DRINKING WATER (DW)[2]	22-Aug-23
ORGANOCHLORINE PESTICIDES					
Aldrin	µg/L	-	0.04	0.009	<0.0080
Aldrin + Dieldrin	µg/L	-	-	-	<0.011
Chlordane, cis- (alpha)	µg/L	-	0.06	0.45	<0.0080
Chlordane, total	µg/L	-	0.06	0.45	<0.011
Chlordane, trans- (gamma)	µg/L	-	0.06	0.45	<0.0080
DDD, 2,4'-	µg/L	-	-	-	<0.0040
DDD, 4,4'-	µg/L	-	-	-	<0.0040
DDD, total	µg/L	-	-	-	<0.0060
DDE, 2,4'-	µg/L	-	-	-	<0.0040
DDE, 4,4'-	µg/L	-	-	-	<0.0040
DDE, total	µg/L	-	-	-	<0.0060
DDT + metabolites, total	µg/L	-	-	-	<0.010
DDT, 2,4'-	µg/L	-	-	-	<0.0040
DDT, 4,4'-	µg/L	-	-	-	<0.0040
DDT, total	µg/L	-	0.01	0.45	<0.0060
Dieldrin	µg/L	-	0.04	0.01	<0.0080
Endosulfan sulfate	µg/L	-	-	-	<0.0070
Endosulfan, alpha-	µg/L	-	0.01	25	<0.0070
Endosulfan, beta-	µg/L	-	0.01	25	<0.0070
Endosulfan, total	µg/L	0.0007	0.01	25	<0.010
Endrin	µg/L	-	0.023	1	<0.010
Endrin aldehyde	µg/L	-	-	-	<0.010
Heptachlor	µg/L	-	0.1	0.035	<0.0080
Heptachlor + Heptachlor epoxide	µg/L	-	0.1	-	<0.011
Heptachlor epoxide	µg/L	-	0.1	0.015	<0.0080
Hexachlorocyclohexane, alpha-	µg/L	-	0.1	0.025	<0.0080
Hexachlorocyclohexane, beta-	µg/L	-	0.1	0.085	<0.0080
Hexachlorocyclohexane, delta-	µg/L	-	-	-	<0.0080
Hexachlorocyclohexane, gamma-	µg/L	-	0.1	0.15	<0.0080
Hexachlorocyclohexane, total	µg/L	-	0.1	-	<0.016
Methoxychlor	µg/L	-	-	20	<0.0080
Mirex	µg/L	-	-	0.0085	<0.0080
Nonachlor, trans-	µg/L	-	-	-	<0.010
Oxychlordane	µg/L	-	-	-	<0.0080
Pentachloronitrobenzene	µg/L	-	-	0.6	<0.010
PESTICIDES					
Alachlor	µg/L	-	-	3	<0.10
Ametryn	µg/L	-	-	35	<0.10
Atrazine	µg/L	1.8	20	5	<0.10
Atrazine + N-dealkylated metabolites	µg/L	-	-	-	<0.20
Atrazine-desethyl	µg/L	-	-	-	<0.10
Azinphos-methyl	µg/L	-	-	20	<0.10
Carbaryl	µg/L	0.2	2	90	<0.20
Carbofuran	µg/L	1.8	18	90	<0.20
Chlorpyrifos	µg/L	0.002	0.02	90	<0.10
Cyanazine	µg/L	2.0	20	0.2	<0.10
Diazinon	µg/L	0.0043	0.03	20	<0.15
Diclofop-methyl	µg/L	6.1	-	-	<0.10
Dimethoate	µg/L	6.2	62	3	<0.10
Ethalfluralin	µg/L	-	-	-	<0.10
Fluazifop-p-butyl	µg/L	-	-	-	<0.10
Malathion	µg/L	0.1	1	190	<0.10
Metolachlor	µg/L	7.8	80	50	<0.10
Metribuzin	µg/L	1.0	10	80	<0.10
Parathion	µg/L	-	-	25	<0.10
Parathion-methyl	µg/L	-	-	1	<0.10
Phorate	µg/L	-	-	2	<0.10
Prometon	µg/L	-	-	60	<0.10
Prometryn	µg/L	-	-	15	<0.10
Propazine	µg/L	-	-	80	<0.10
Simazine	µg/L	10.0	100	10	<0.10
Temephos	µg/L	-	-	80	<1.0
Terbufos	µg/L	-	-	1	<0.10
Terbutryn	µg/L	-	-	4	<0.10
Triallate	µg/L	0.2	2.4	50	<0.10
Trifluralin	µg/L	0.2	2	45	<0.10
PHTHALATE ESTERS					
Butyl benzyl phthalate	µg/L	-	-	80	<0.52
Di-n-butyl phthalate	µg/L	-	190	400	<1.0
Di-n-octyl phthalate [DNOP]	µg/L	-	-	40	<0.40
Diethyl phthalate	µg/L	-	-	3000	<0.20
Dimethyl phthalate	µg/L	-	-	-	<0.20
bis(2-Ethylhexyl) phthalate [DEHP]	µg/L	16	160	10	<1.0

H:\Project\1576\Chem\2023\[Tables-2023.xlsx]Table A-18 SW-3 Pesticides

NOTES:

1. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.
https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf
https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/bc_env_working_water_quality_guidelines.pdf
Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). Lowest guidelines are shown (ie. Long term average if applicable).
2. Per Schedule 3.2 of the Contaminated Sites Regulation (CSR), March 2023. AW standards assume minimum 1:10 dilution is available.
As such, samples collected from background and receiving creeks are compared against CSR AW standards/10.
https://www.bclaws.gov.bc.ca/civix/document/id/lc/statreg/375_96_08
3. **Bolding** denotes parameters which exceed BC FWAL water quality guideline. Underline denotes parameters which exceed CSR AW standard.
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4."-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

TABLE A-19

WATER CHEMISTRY DATA FOR SCALE SHACK TAP

PARAMETER	units	RECEIVING WATER CRITERIA				SAMPLING DATE
		GCDWQ MAC or AO[1]	AQUATIC LIFE (FWAL)[2]	CSR AQUATIC LIFE (AW)[3]	CSR DRINKING WATER (DW)[3]	22-Aug-23
PHYSICAL TESTS						
pH - Field	pH	7.0 - 10.5	6.5 - 9.0	-	-	7.00
pH - Lab	pH	7.0 - 10.5	6.5 - 9.0	-	-	7.46
Conductivity - Field	µS/cm	-	-	-	-	222
Conductivity - Lab	µS/cm	-	-	-	-	277
Total Hardness ($CaCO_3$)	mg/L	-	-	-	-	54.5
Total Dissolved Solids	mg/L	500	-	-	-	226
Temperature - Field	°C	-	-	-	-	17.5
MICROBIOLOGY [10]						
Total Coliforms	MPN/100mL	0.0	-	-	-	200
E. Coli	MPN/100mL	0.0	-	-	-	11
DISSOLVED ANIONS						
Alkalinity - Total	mg/L $CaCO_3$	-	-	-	-	57.5
Chloride	mg/L	250	150	1500	250	43.3
Sulphate [5,7]	mg/L	500	128	1280	500	6.35
TOTAL CATIONS						
Calcium	mg/L	-	-	-	-	16.7
Magnesium	mg/L	-	-	-	-	3.12
Potassium	mg/L	-	-	-	-	4.74
Sodium	mg/L	200	-	-	200	29.7
NUTRIENTS						
Nitrate Nitrogen	mg/L as N	10	3	400	10	<0.0050
Nitrite Nitrogen[9]	mg/L as N	1	0.2	2.0	1	0.001
TOTAL METALS						
Aluminum	mg/L	2.9	0.21	-	9.5	0.174
Antimony	mg/L	0.006	0.07	0.09	0.006	<0.00010
Arsenic	mg/L	0.01	0.005	0.05	0.01	0.00032
Barium	mg/L	2	1	10	1	0.015
Beryllium	mg/L	-	0.00013	0.0015	0.008	<0.000100
Boron	mg/L	5	1.2	12	5	0.075
Cadmium [4,7]	mg/L	0.007	0.00015	0.0015	0.005	0.0000239
Chromium	mg/L	0.05	0.001	0.01	0.05	<0.00050
Cobalt	mg/L	-	0.004	0.04	0.001	0.00028
Copper [6]	mg/L	1	0.002	0.03	1.5	**0.21**
Iron	mg/L	0.3	1	-	6.5	0.399
Lead [4,7]	mg/L	0.005	0.005	0.16	0.01	***0.0128***
Lithium	mg/L	-	-	-	0.008	<0.0010
Manganese [4]	mg/L	0.02	0.89	-	1.5	0.0965
Mercury	µg/L	1	0.2	0.25	1	<0.0000050
Molybdenum	mg/L	-	7.6	10	0.25	0.000185
Nickel [7]	mg/L	-	0.068	0.65	0.08	0.00073
Selenium	mg/L	0.05	0.002	0.02	0.01	<0.000050
Silver [4,7]	mg/L	-	0.00005	0.0005	0.02	**0.000204**
Strontium	mg/L	7	-	-	2.5	0.113
Thallium	mg/L	-	-	0.003	-	<0.000010
Tin	mg/L	-	-	-	2.5	0.00024
Titanium	mg/L	-	-	1	-	0.00834
Tungsten	mg/L	-	-	-	0.003	<0.00010
Uranium	mg/L	0.02	0.01	0.09	0.02	0.000014
Vanadium	mg/L	-	-	-	0.02	0.00086
Zinc [4,7]	mg/L	5	0.0266	0.075	3	**0.0956**

H:\Project\1576\Chem\2023\[Tables-2023.xlsx]Table A-19 Scale Shack

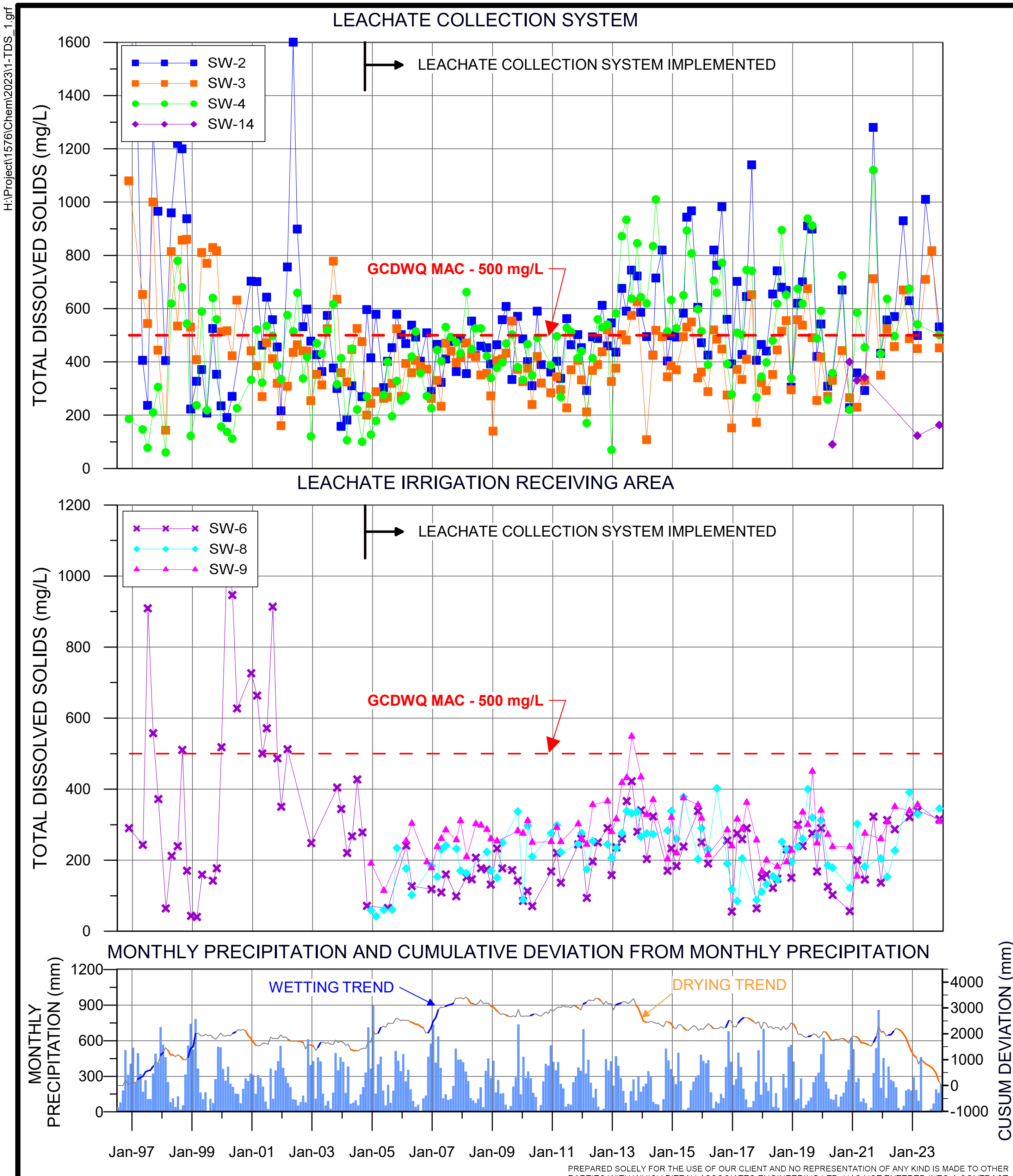
NOTES:

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, 2022)
   MAC = Maximum acceptable concentration; AO = Aesthetic objective.
2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.
   https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines
   https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/bc_env_working_water_quality_guidelines.pdf
   Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). Lowest guidelines are shown (ie. Long term average if applicable).
3. Per Schedule 3.2 of the Contaminated Sites Regulation (CSR), March 2023. AW standards assume minimum 1:10 dilution is available. As such, samples collected from background and receiving creeks are compared against CSR AW standards/10. https://www.bclaws.gov.bc.ca/civix/document/id/lc/statreg/375_96_08
4. FWAL guideline for indicated parameter changes with hardness. Aluminum and zinc guidelines also vary with pH and DOC. Value shown appropriate for hardness of 64 mg/L-CaCO3, pH of 6.8 and DOC of 10. Cadmium and zinc guidelines are for dissolved metals.
5. FWAL guideline for indicated parameter changes with pH and temperature. Value shown appropriate for pH between 6.5 and 7 and temperature of 10˚C.
6. Dissolved copper FWAL guideline was calculated for each site using the average BC BLM software calculations between January 2020 - January 2022 with sample-specific parameters except for humic acid ratio (assumed value of 10).
7. CSR AW standard for indicated parameter changes with hardness. Value shown appropriate for hardness of 60 mg/L-$CaCO_3$.
8. CSR AW standard for indicated parameter changes with pH. Value shown appropriate for pH 6.8.
9. FWAL guideline for indicated parameter changes with chloride. Value shown appropriate for chloride of 43 mg/L-CaCO3.
10. Microbiology samples collected in August 2023 were analyzed past recommended hold time.
11. **Bolding** denotes parameters which exceed BC FWAL water quality criteria, underline denotes parameters which exceed CSR AW criteria, *italics* which exceed CSR DW criteria, and yellow highlight denotes parameters exceeding the GCDWQ.
12. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

APPENDIX B
MONITORING DATA PLOTS

APPENDIX B

LIST OF FIGURES



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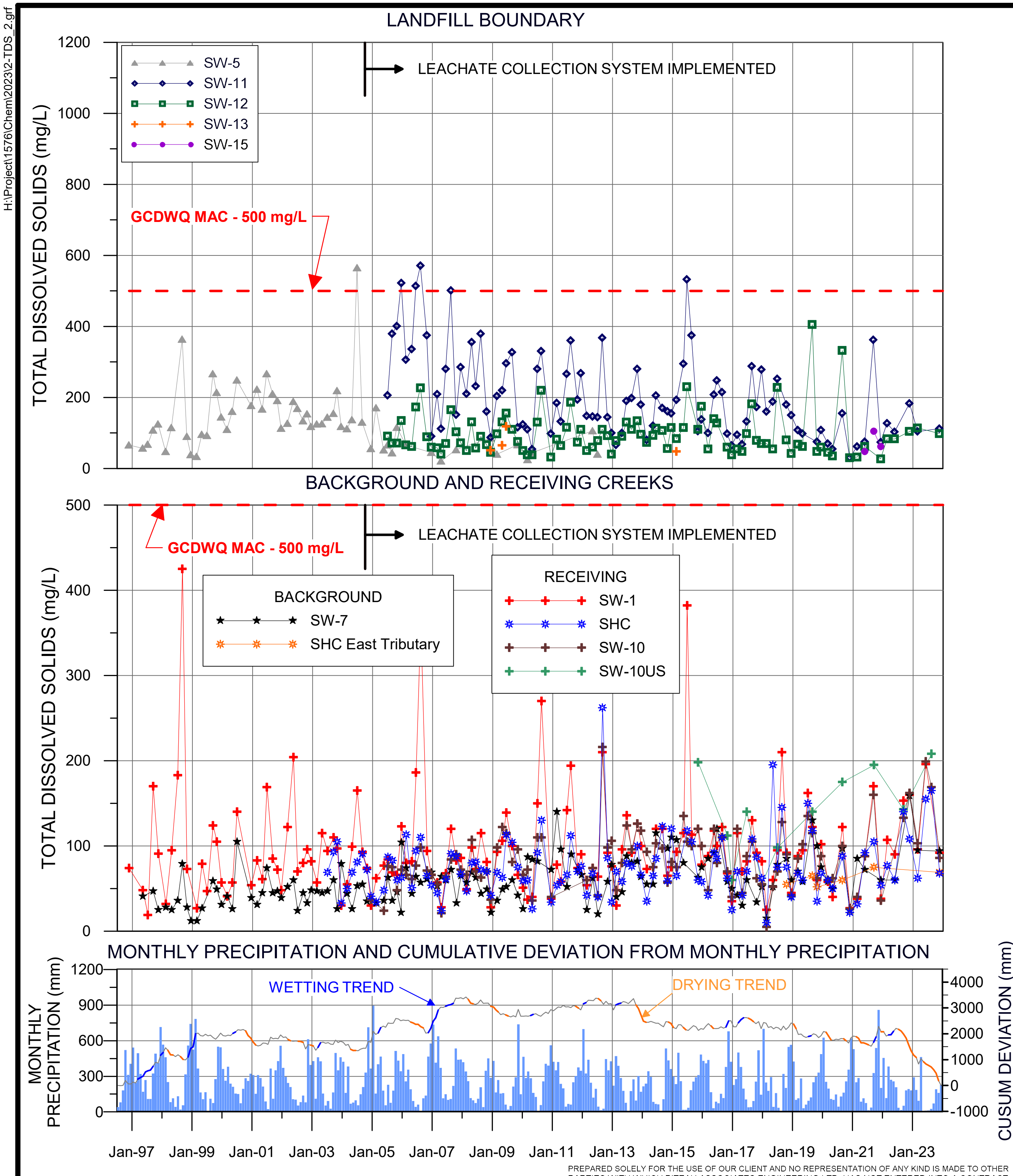
TOTAL DISSOLVED SOLIDS CONCENTRATION TIME-SERIES PLOTS FOR LEACHATE COLLECTION SYSTEM AND LEACHATE IRRIGATION RECEIVING AREA

BY:	DATE:
OB	MAR 24
APPROVED:	FIG:
JM	B-1



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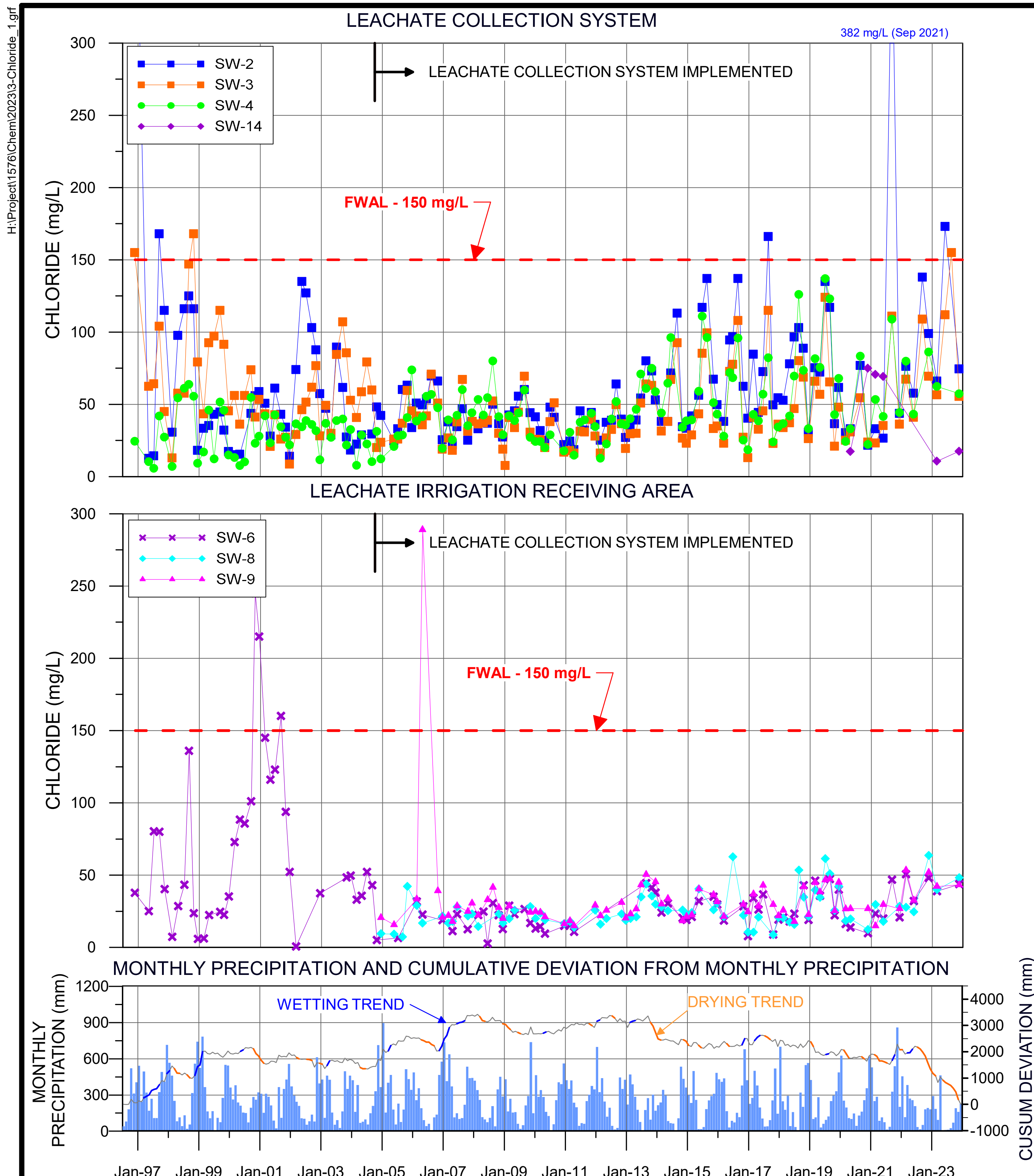
TOTAL DISSOLVED SOLIDS CONCENTRATION
TIME-SERIES PLOTS FOR LANDFILL BOUNDARY
AND BACKGROUND AND RECEIVING CREEKS

BY:	DATE:
OB	MAR 24
APPROVED:	FIG:
JM	B-2



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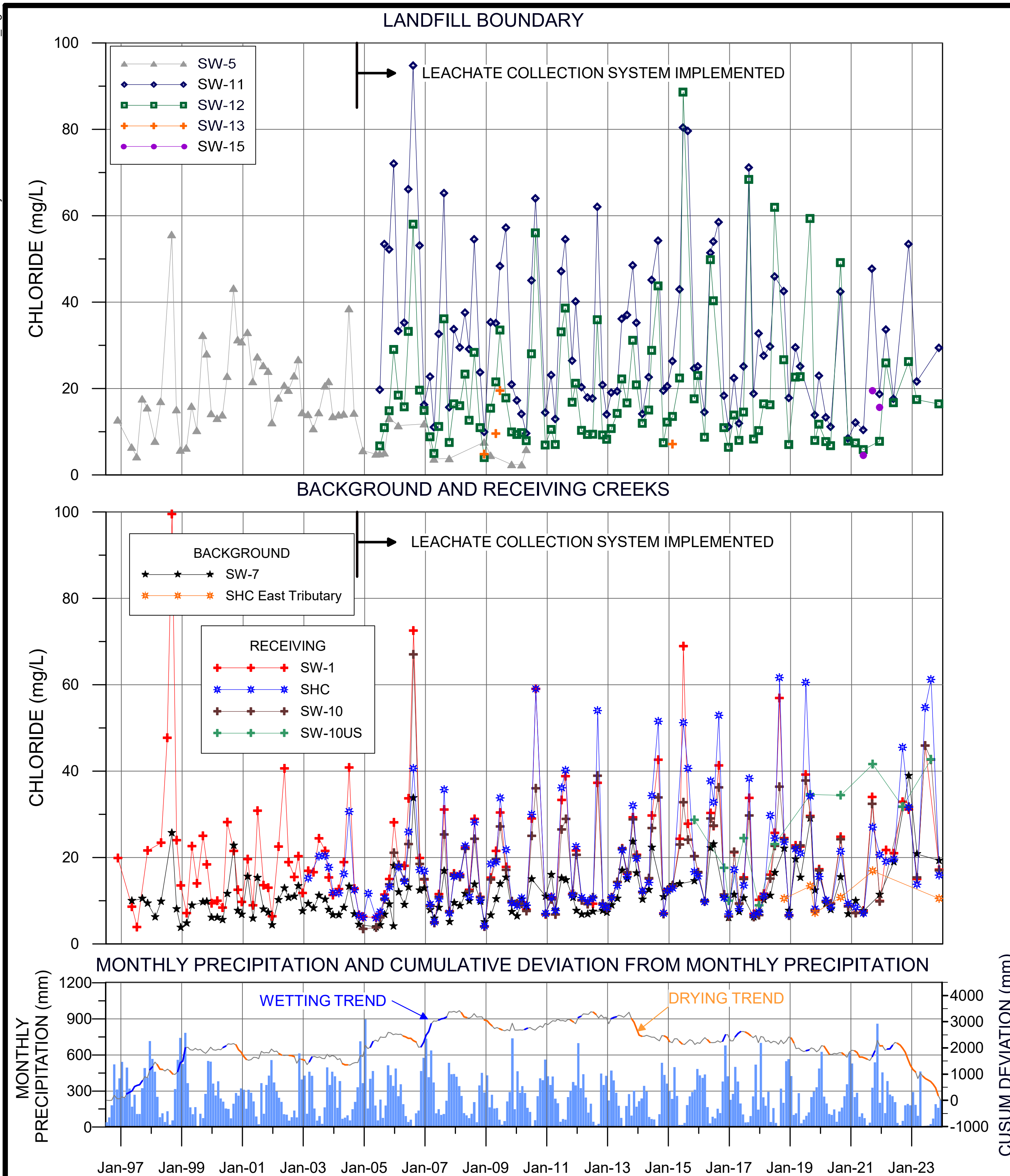
CHLORIDE CONCENTRATION
TIME-SERIES PLOTS FOR LEACHATE COLLECTION SYSTEM AND LEACHATE IRRIGATION RECEIVING AREA

BY:	DATE:
OB	MAR 24
APPROVED: JM	FIG: B-3

H:\Project\1576\Chem\2023\4-Chloride_2.grf



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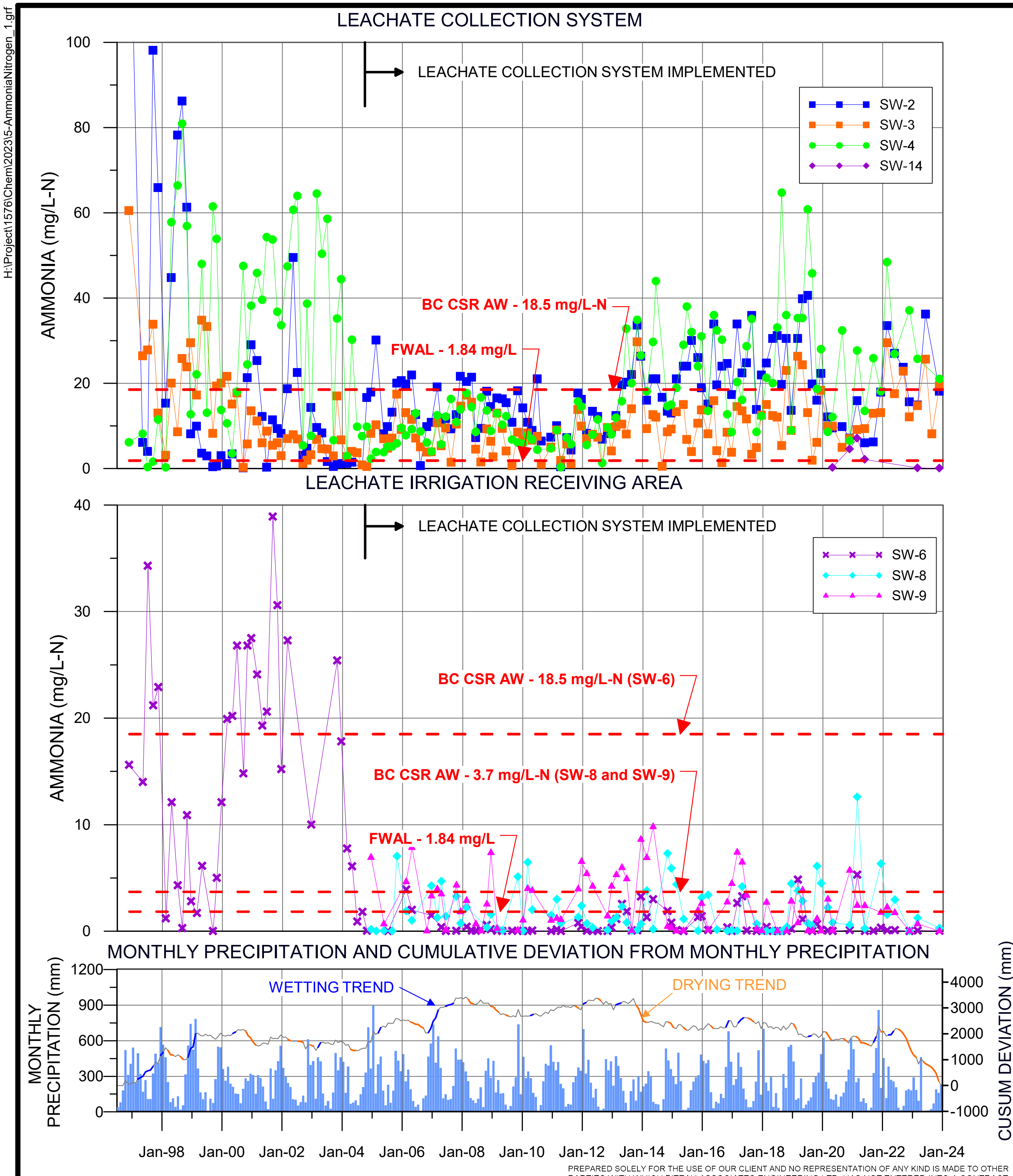
CHLORIDE CONCENTRATION
TIME-SERIES PLOTS FOR LANDFILL BOUNDARY
AND BACKGROUND AND RECEIVING CREEKS

BY:	DATE:
OB	MAR 24
APPROVED: JM	FIG: B-4



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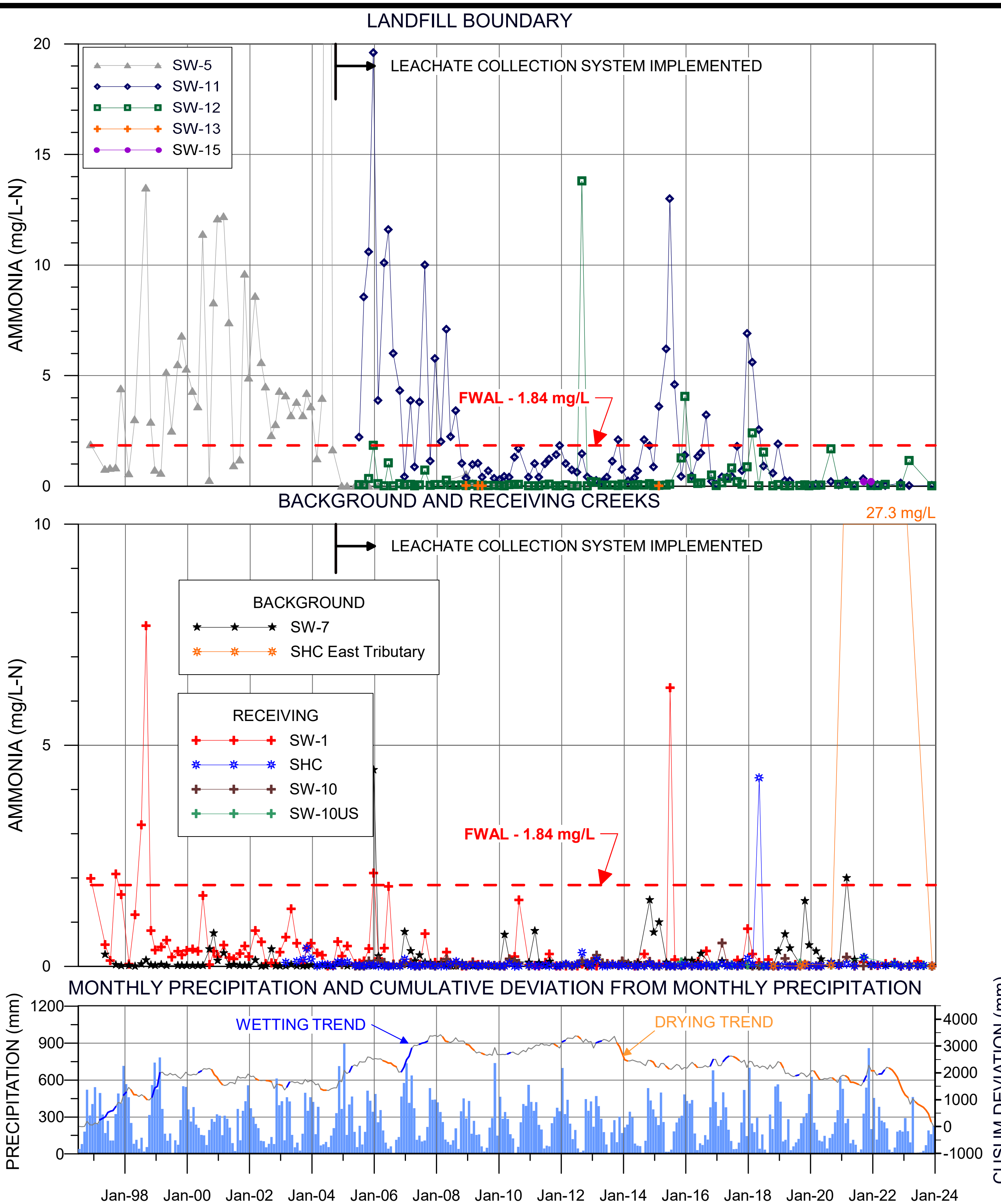
AMMONIA NITROGEN CONCENTRATION
TIME-SERIES PLOTS FOR LEACHATE COLLECTION SYSTEM
AND LEACHATE IRRIGATION RECEIVING AREA

BY:	DATE:
OB	MAR 24
APPROVED: JM	FIG: B-5

H:\Project\1576\Chem\2023\6-AmmoniaNitrogen_2.grf



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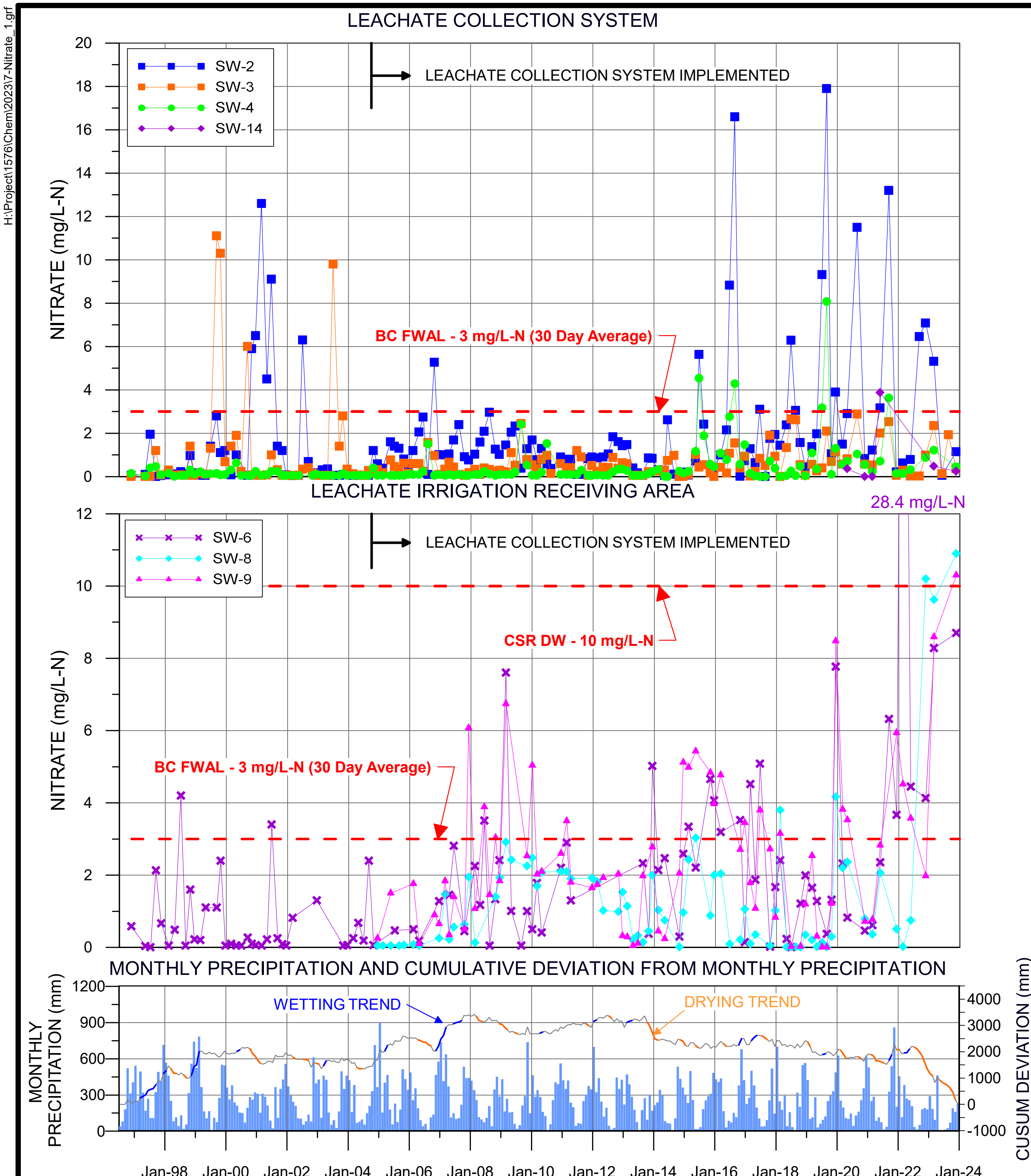
AMMONIA NITROGEN CONCENTRATION
TIME-SERIES PLOTS FOR LANDFILL BOUNDARY
AND BACKGROUND AND RECEIVING CREEKS

BY:	DATE:
OB	MAR 24
APPROVED: JM	FIG: B-6



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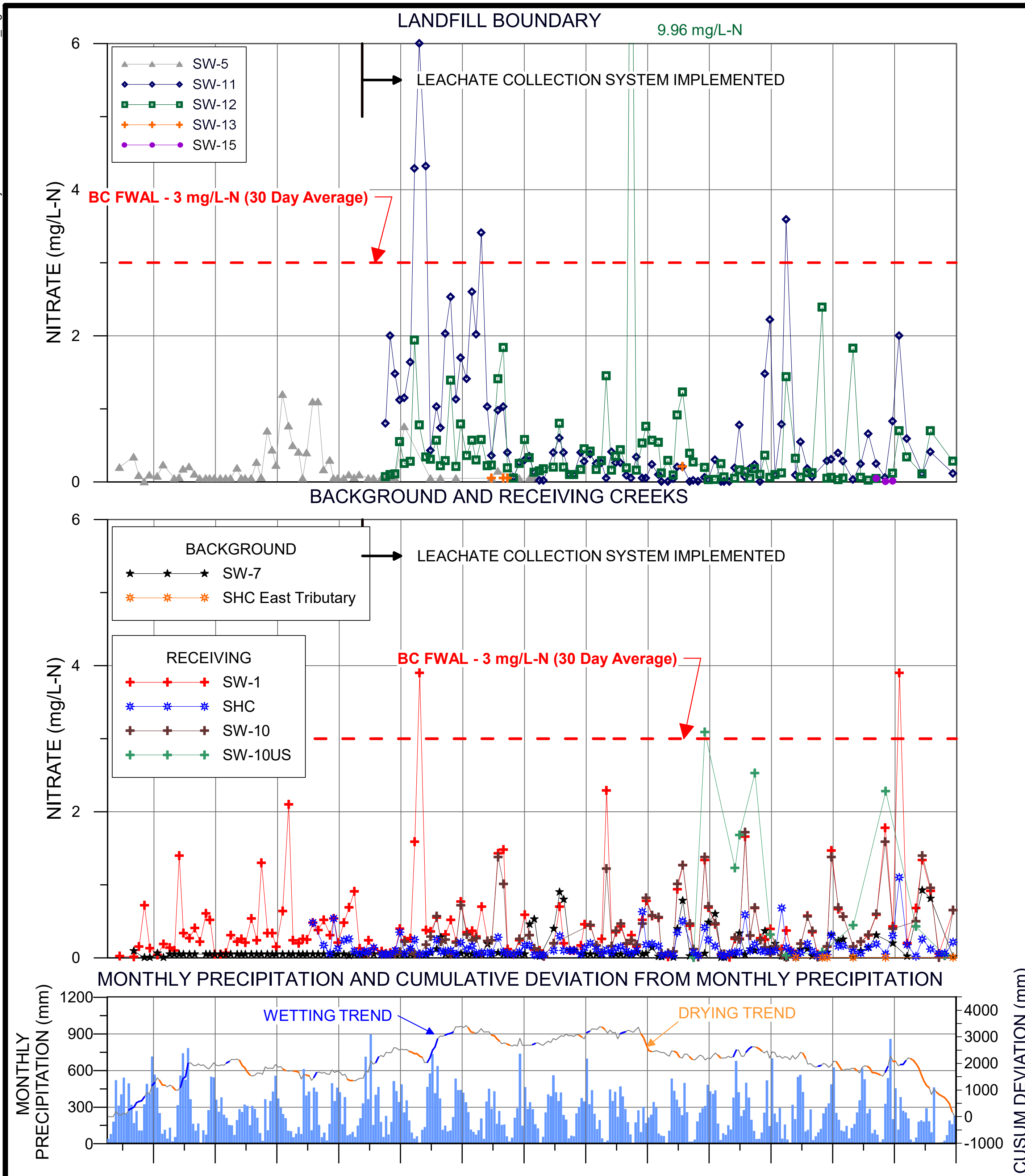
NITRATE CONCENTRATION
TIME-SERIES PLOTS FOR LEACHATE COLLECTION SYSTEM
AND LEACHATE IRRIGATION RECEIVING AREA

BY:	DATE:
OB	MAR 24
APPROVED: JM	FIG: B-7

H:\Project\1576\Chem\2023\8-Nitrate_2.grf



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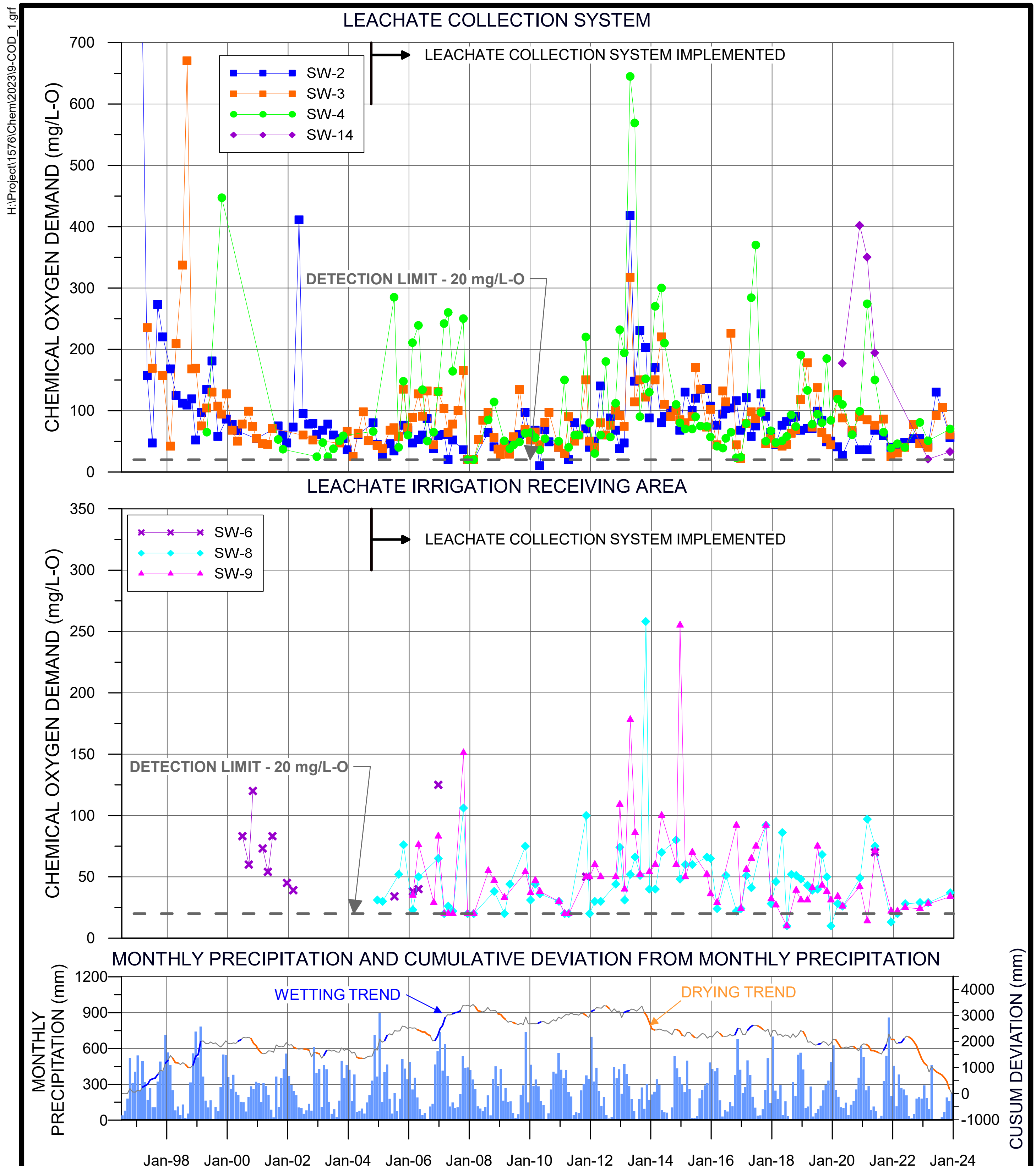
NITRATE CONCENTRATION
TIME-SERIES PLOTS FOR LANDFILL BOUNDARY
AND BACKGROUND AND RECEIVING CREEKS

BY:	DATE:
OB	MAR 24
APPROVED: JM	FIG: B-8



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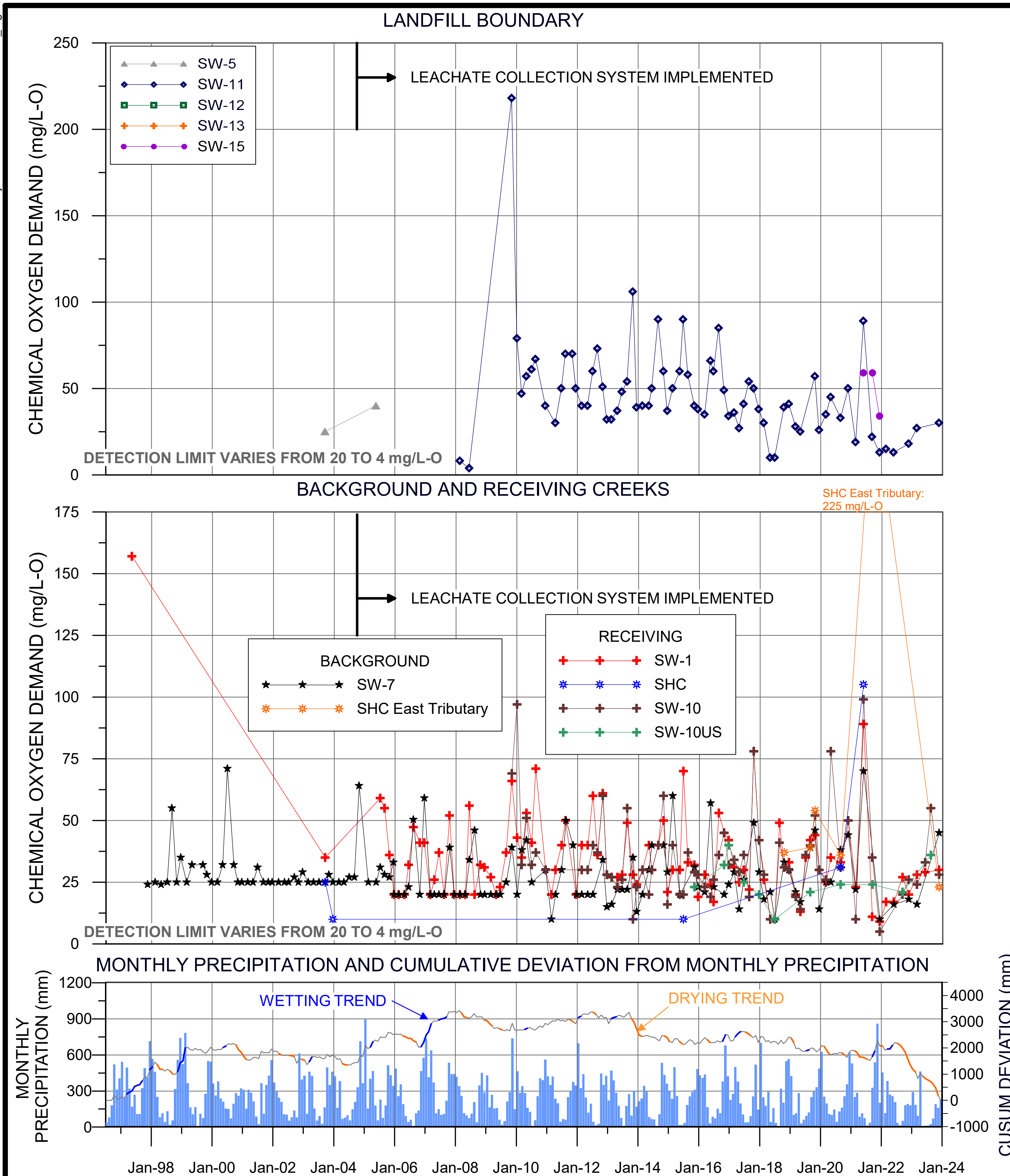
CHEMICAL OXYGEN DEMAND CONCENTRATION
TIME-SERIES PLOTS FOR LEACHATE COLLECTION SYSTEM
AND LEACHATE IRRIGATION RECEIVING AREA

BY:	DATE:
OB	MAR 24
APPROVED: JM	FIG: B-9

H:\Project\1576\Chem\2023\10-COD_2.grf



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CHEMICAL OXYGEN DEMAND CONCENTRATION
TIME-SERIES PLOTS FOR LANDFILL BOUNDARY
AND BACKGROUND AND RECEIVING CREEKS

BY:	DATE:
OB	MAR 24
APPROVED: JM	FIG: B-10

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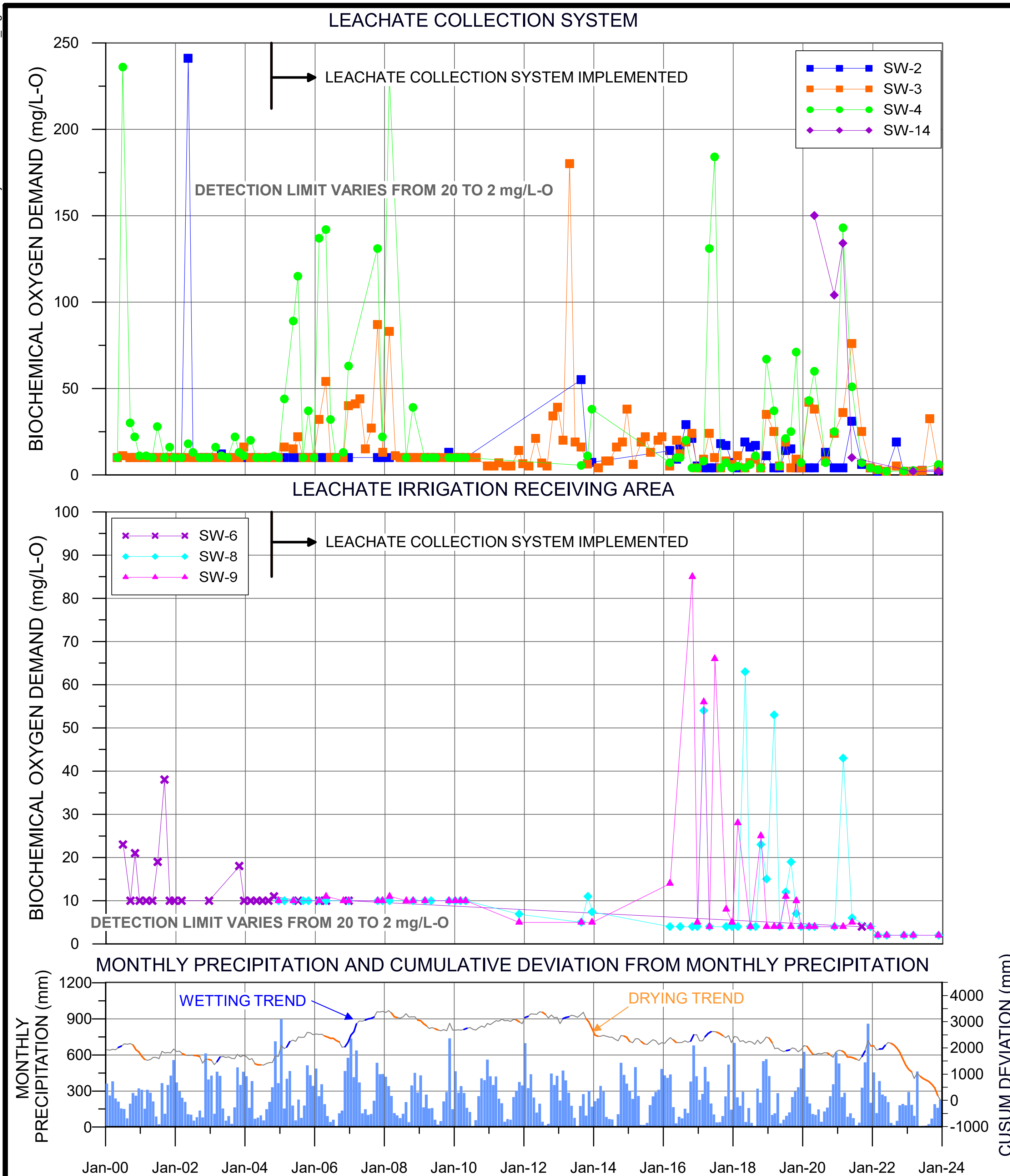

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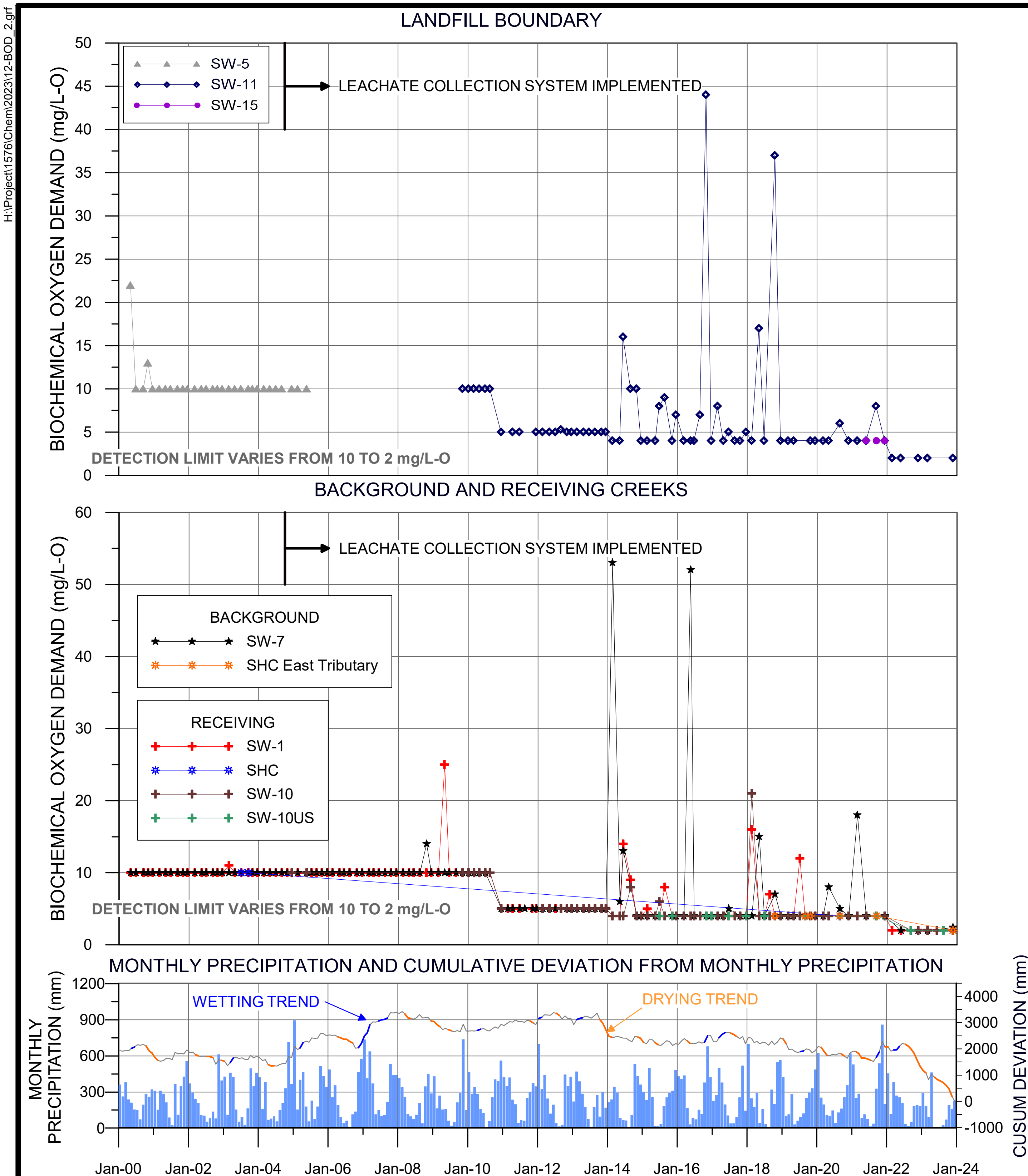
BIOCHEMICAL OXYGEN DEMAND CONCENTRATION TIME-SERIES PLOTS FOR LEACHATE COLLECTION SYSTEM AND LEACHATE IRRIGATION RECEIVING AREA

BY:	DATE:
OB	MAR 24
APPROVED:	FIG:
JM	B-11



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BIOCHEMICAL OXYGEN DEMAND CONCENTRATION
TIME-SERIES PLOTS FOR LANDFILL BOUNDARY
AND BACKGROUND AND RECEIVING CREEKS

BY:	DATE:
OB	MAR 24
APPROVED:	FIG:
JM	B-12

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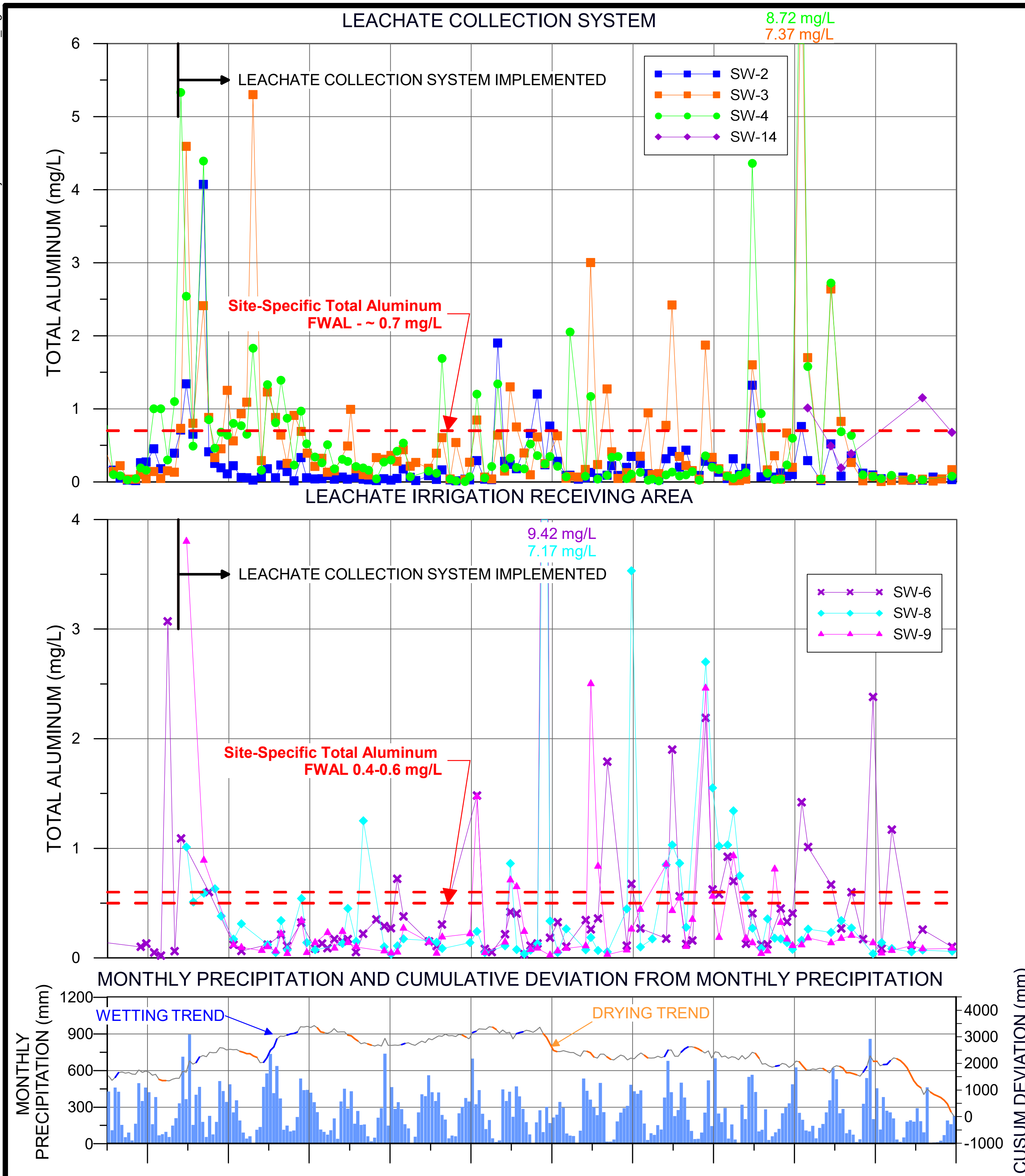

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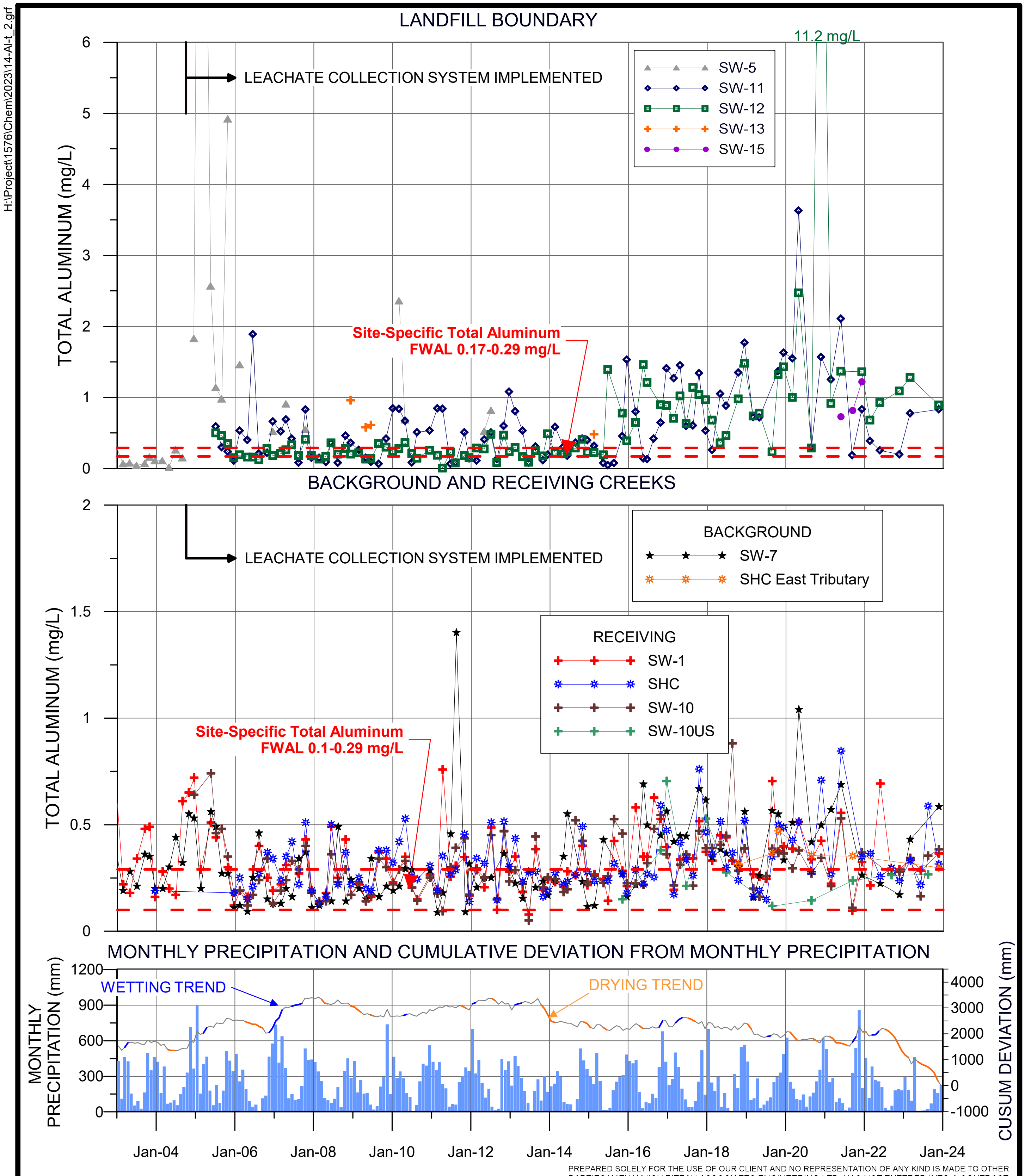
TOTAL ALUMINUM CONCENTRATION
TIME-SERIES PLOTS FOR LEACHATE COLLECTION SYSTEM
AND LEACHATE IRRIGATION RECEIVING AREA

BY:	DATE:
OB	MAR 24
APPROVED: JM	FIG: B-13



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TOTAL ALUMINUM CONCENTRATION
TIME-SERIES PLOTS FOR LANDFILL BOUNDARY
AND BACKGROUND AND RECEIVING CREEKS

BY:	DATE:
OB	MAR 24
APPROVED: JM	FIG: B-14

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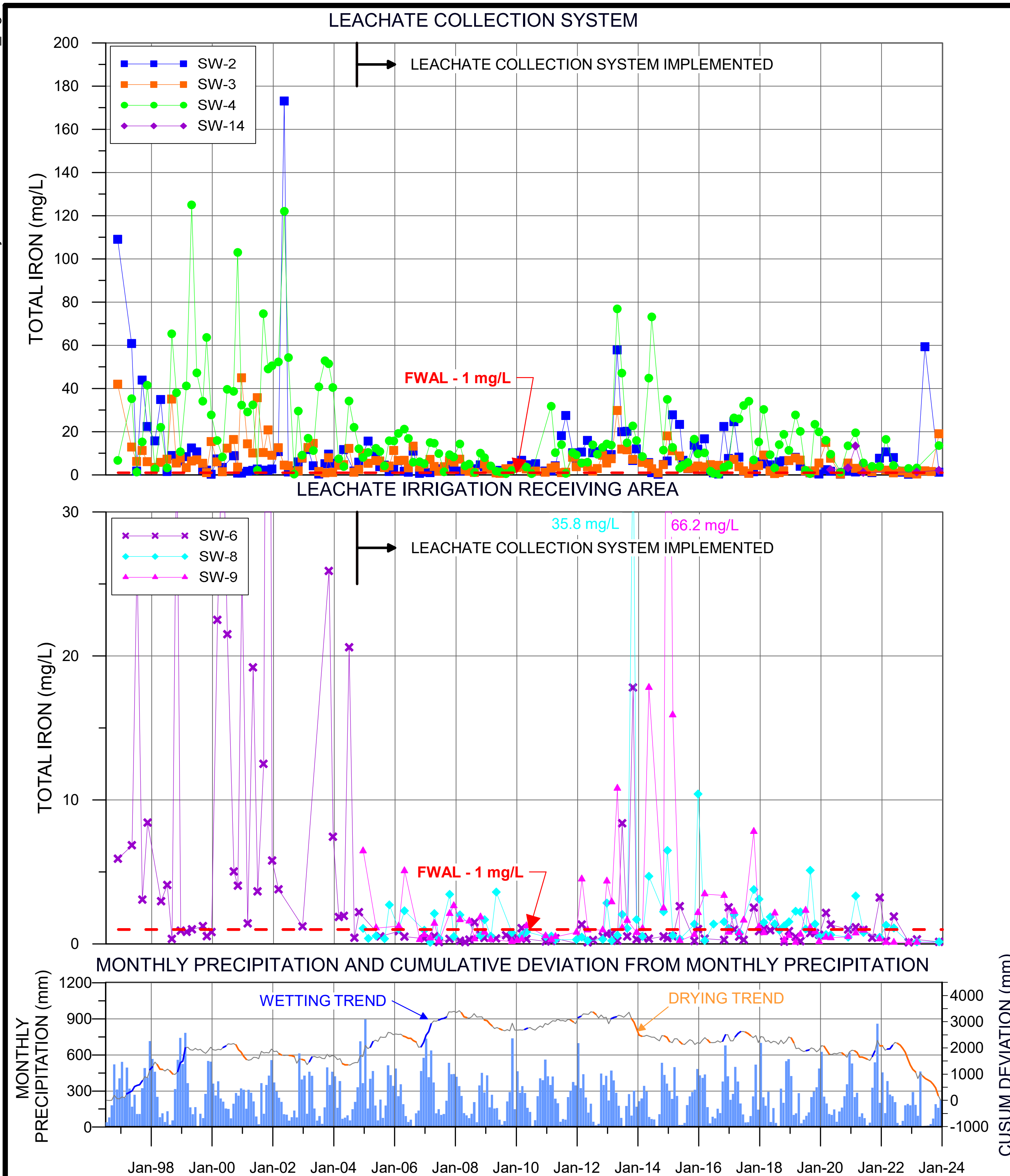

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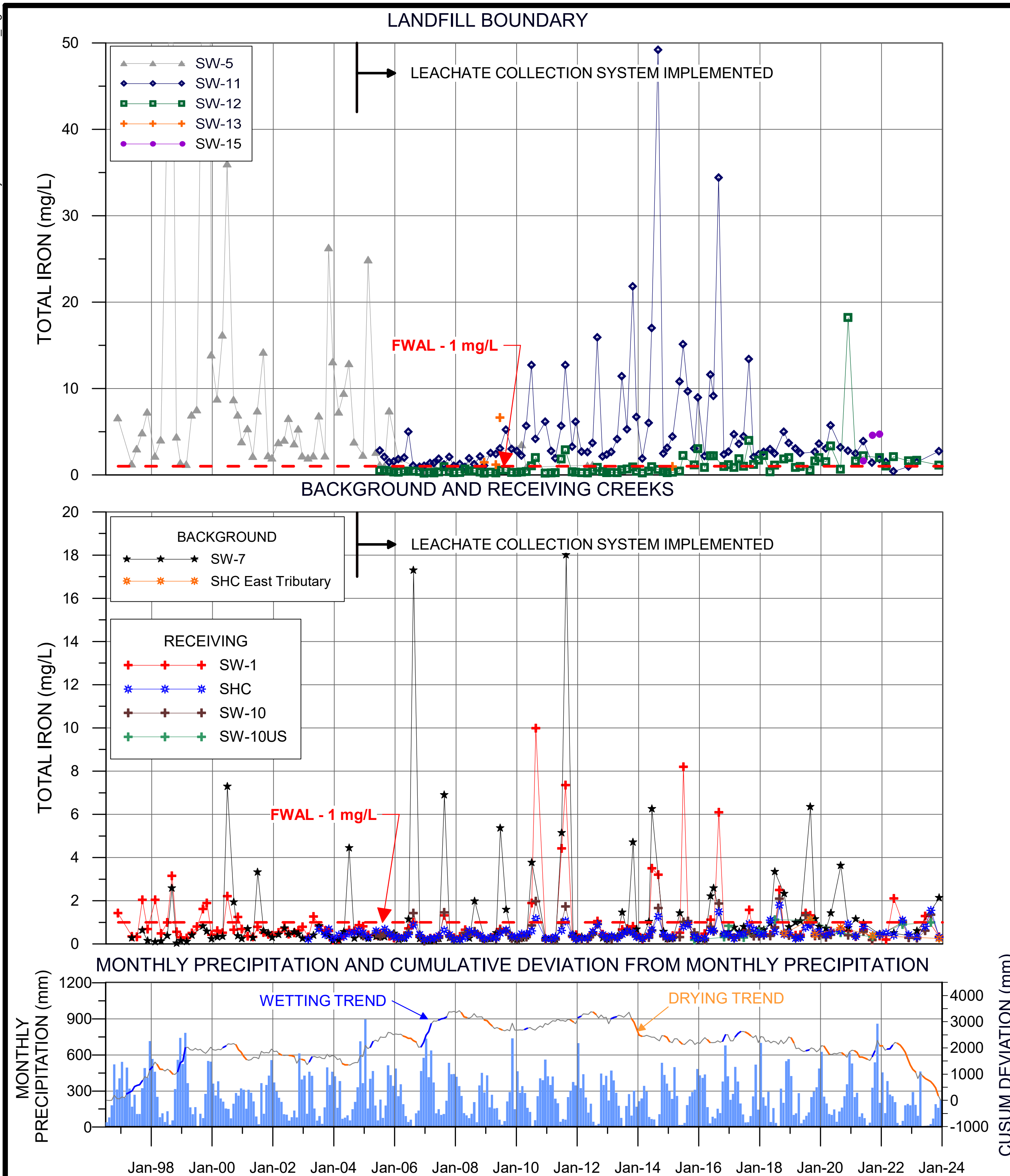
TOTAL IRON CONCENTRATION
TIME-SERIES PLOTS FOR LEACHATE COLLECTION SYSTEM
AND LEACHATE IRRIGATION RECEIVING AREA

BY:	DATE:
OB	MAR 24
APPROVED: JM	FIG: B-15



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TOTAL IRON CONCENTRATION
TIME-SERIES PLOTS FOR LANDFILL BOUNDARY
AND BACKGROUND AND RECEIVING CREEKS

BY: OB
DATE: MAR 24
APPROVED: JM
FIG: B-16

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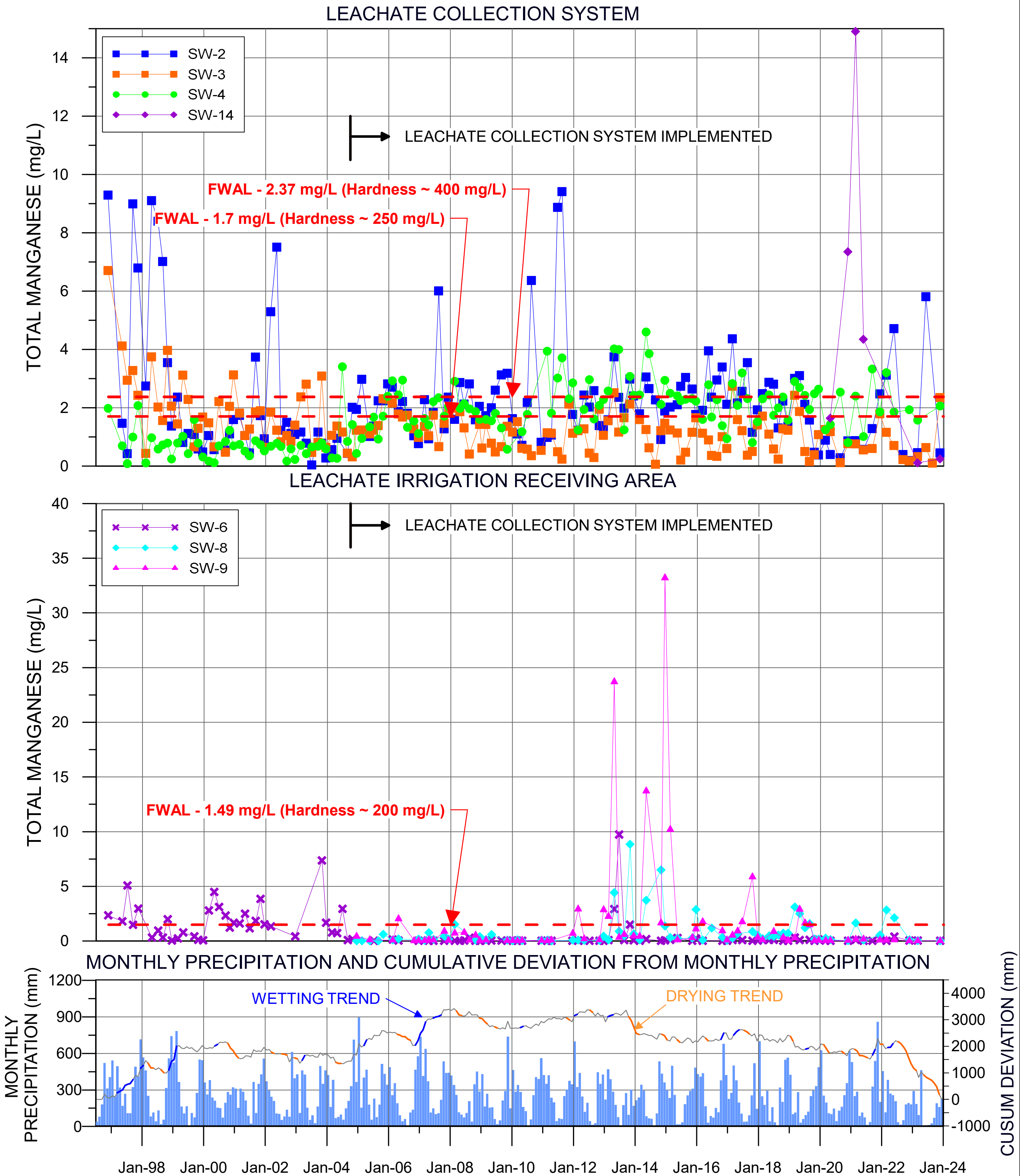

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TOTAL MANGANESE CONCENTRATION
TIME-SERIES PLOTS FOR LEACHATE COLLECTION SYSTEM
AND LEACHATE IRRIGATION RECEIVING AREA

BY: OB	DATE: MAR 24
APPROVED: JM	FIG: B-17

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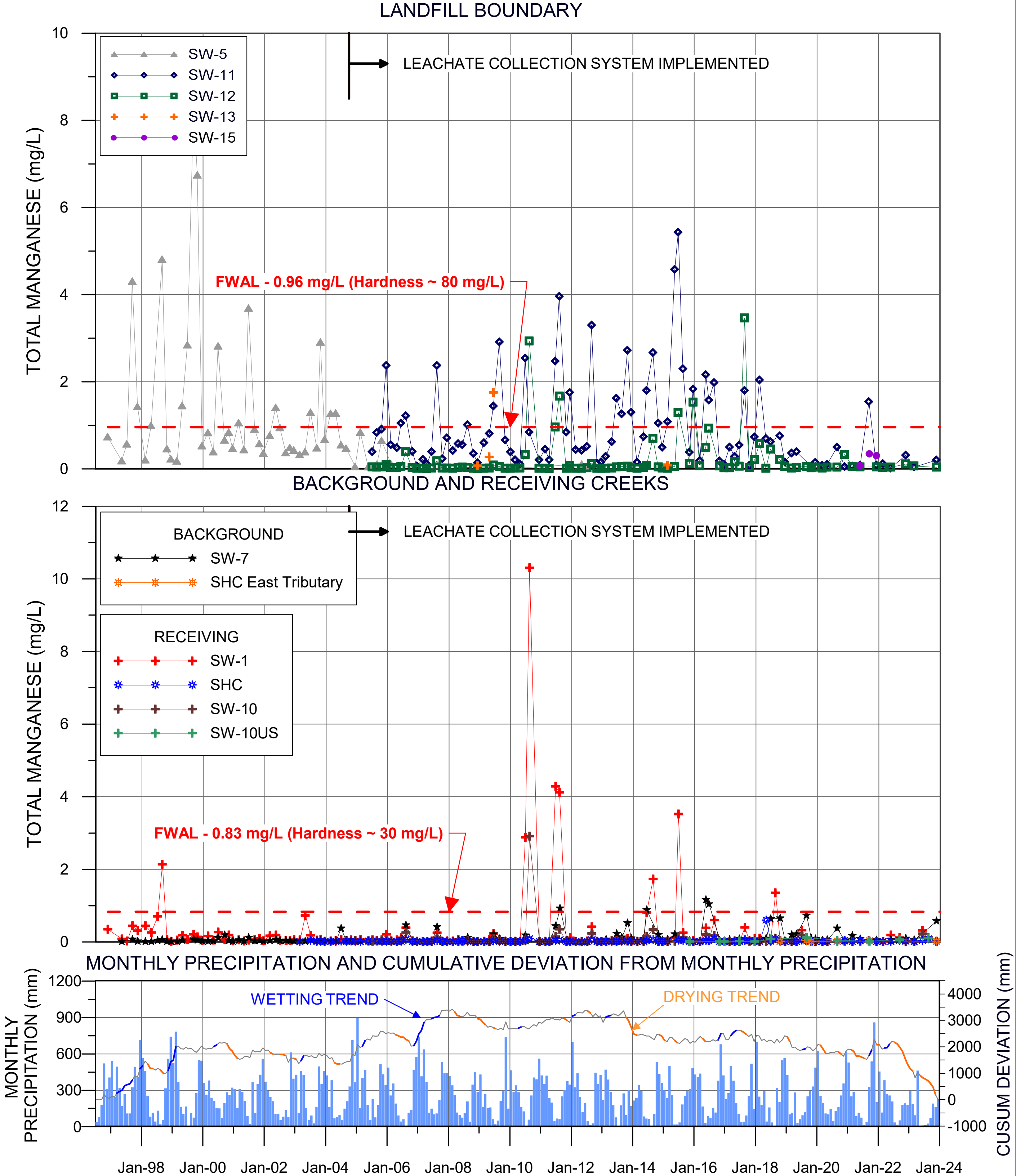

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TOTAL MANGANESE CONCENTRATION
TIME-SERIES PLOTS FOR LANDFILL BOUNDARY
AND BACKGROUND AND RECEIVING CREEKS

BY: OB
DATE: MAR 24
APPROVED: JM
FIG: B-18

APPENDIX C
MONITORING DATA TABLE FOR 2023 DUPLICATE SAMPLES

APPENDIX C

LIST OF TABLES

TABLE C-1
SUMMARY OF DUPLICATE SAMPLE RESULTS
2023

		SW-1			SW-10		
SAMPLE DATE SAMPLE TYPE LAB NAME	UNITS	28-Feb-23 PR ALS	28-Feb-23 DUP ALS	RPD	21-Nov-23 PR ALS	21-Nov-23 DUP ALS	RPD
PHYSICAL TESTS							
pH - Lab	pH	6.88	6.96	1	6.97	6.93	1
Conductivity - Lab	µS/cm	104	105	1	112	112	0
Total Hardness ($CaCO_3$)	mg/L	24.4	25.2	3	25.8	25.8	0
Total Dissolved Solids	mg/L	94	96	2	84	86	2
DISSOLVED ANIONS							
Alkalinity - Total	mg/L $CaCO_3$	17.2	17.5	2	12.6	12.6	0
Chloride	mg/L	15	14.9	1	16.9	17	1
Sulphate	mg/L	4.42	4.34	2	10.8	10.8	0
NUTRIENTS							
Ammonia Nitrogen	mg/L as N	<0.0050	<0.0050	-	0.0055	0.005	10
Nitrate Nitrogen	mg/L as N	0.91	0.916	1	0.647	0.652	1
Total Phosphorus	mg/L as P	0.0056	0.0058	4	0.0133	0.0159	18
POLLUTANT TESTS							
Chemical Oxygen Demand	mg/L as O	28	28	0	27	28	4
Biochemical Oxygen Demand	mg/L as O	<2.0	<2.0	-	<2.0	<2.0	-
TOTAL METALS							
Aluminum	mg/L	0.337	0.344	2	0.384	0.346	10
Antimony	mg/L	<0.00010	<0.00010	-	<0.00010	<0.00010	-
Arsenic	mg/L	0.00013	0.00014	7	0.00015	0.00014	7
Barium	mg/L	0.00502	0.00506	1	0.0064	0.00659	3
Beryllium	mg/L	<0.000100	<0.000100	-	<0.000100	<0.000100	-
Boron	mg/L	0.048	0.054	12	0.059	0.056	5
Cadmium	mg/L	0.0000097	0.000007	32	0.0000244	0.0000328	29
Chromium	mg/L	0.00053	0.00063	17	0.0006	0.0006	0
Cobalt	mg/L	0.00018	0.00019	5	0.00045	0.00044	2
Copper	mg/L	0.00082	0.00083	1	0.00135	0.00141	4
Iron	mg/L	0.276	0.281	2	0.305	0.285	7
Lead	mg/L	0.000103	0.000108	5	0.000158	0.000169	7
Lithium	mg/L	<0.0010	<0.0010	-	<0.0010	<0.0010	-
Manganese	mg/L	0.00764	0.00775	1	0.0146	0.014	4
Mercury	µg/L	0.0056	<0.0050	>11	<0.0000050	0.000006	>11
Molybdenum	mg/L	<0.000050	<0.000050	-	<0.000050	<0.000050	-
Nickel	mg/L	0.00081	0.00089	9	0.00153	0.00143	7
Selenium	mg/L	<0.000050	0.000057	>13	0.000121	0.00011	10
Silver	mg/L	<0.000010	<0.000010	-	<0.000010	0.000011	>10
Strontium	mg/L	0.036	0.0353	2	0.0381	0.04	5
Thallium	mg/L	<0.000010	<0.000010	-	<0.000010	<0.000010	-
Tin	mg/L	<0.00010	<0.00010	-	<0.00010	<0.00010	-
Titanium	mg/L	0.014	0.0133	5	0.0141	0.00918	42
Tungsten	mg/L	<0.00010	<0.00010	-	<0.00010	<0.00010	-
Uranium	mg/L	0.000014	0.000011	24	0.000012	0.000011	9
Vanadium	mg/L	0.00106	0.00114	7	0.00102	0.00091	11
Zinc	mg/L	0.0045	0.0041	9	0.0081	0.0131	47

	SW-1	SW-10
RPD Average	>6	>9
RPD Min	0	0
RPD Max	32	47

H:\Project\1576\Chem\2023\[QAQC Dups.xlsm]Table C-1

NOTES:
"-" denotes parameter was not analyzed.
bold values indicate RPD > 65
PR = primary sample
DUP = duplicate sample
RPD = relative percent difference
The duplicate sample also included a VOC Scan. All VOC concentrations for the PR and DUP were below the detection limit, and therefore no RPD was calculated.

APPENDIX D
OVERFLOW EVENTS DATA

APPENDIX D

TABLE

FIGURE

TABLE D-1
SUMMARY OF 2023 OVERFLOW EVENTS

Date Overflow Started	Duration of Event[1]	Precipitation over Preceding Five Days (mm)	Precipitation over Preceding Five Days and Period of Overflow Event (mm) [2]
24-Dec-22 [4]	32 days	8.0 [3]	412.2 [3]
06-Feb-23	20 days	55.7	184.4
01-Mar-23	4.8 days	11.1	22.0
07-Mar-23	3.2 days	10.9	36.9
14-Mar-23	28 hrs	9.3	16.1
17-Apr-23	35 days	123.2	305.1
18-Oct-23	3.0 days	88.4	154.7

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Notes:

1. Duration of event estimated from water level in overflow pipe measured by Solinst Levelogger.
2. Precipitation measured by Environment Canada at Tofino Airport Climate Station.
3. Missing precipitation data
4. Event preceeded by heavy snowfall.

TABLE D-2
WATER CHEMISTRY SUMMARY FOR OVERFLOW EVENTS - PHYSICAL TESTS, ANIONS AND NUTRIENTS, AND AGGREGATE ORGANICS

PARAMETERS	UNITS	RECEIVING WATER CRITERIA				SW-3-Overflow	SW-3-Overflow	SW-11-Overflow	SW-11-Overflow	SW-1-Overflow	SW-1-Overflow
		AQUATIC LIFE (FWAL) (30 DAY)	AQUATIC LIFE (FWAL)[1] (Max)	CSR AQUATIC LIFE (AW)[7]	CSR DRINKING WATER (DW)[7]	17-Apr-23	19-Oct-23	17-Apr-23	19-Oct-23	17-Apr-23	19-Oct-23
Length of Overflow Event based on datalogger record						35 days	3 days	35 days	3 days	35 days	3 days
PHYSICAL TESTS											
pH	pH	6.5 - 9.0	6.5 - 9.0	-	-	7.63	7.28	7.32	7.04	6.53	**6.22**
Conductivity	µS/cm	-	-	-	-	426	507	278	343	55	55.2
Total Hardness ($CaCO_3$)	mg/L	-	-	-	-	-	145	-	101	-	13.2
Total Dissolved Solids	mg/L	-	-	-	-	273	269	180	219	63	69
ANIONS											
Alkalinity	mg/L	-	-	-	-	153	171	84	84.1	9	6.7
Chloride	mg/L	150	600	1500	250	21.3	28.3	18	29	5.8	7.03
Sulfate[5,8]	mg/L	309	309	3090	500	15	47.4	11	39.1	2.2	5.07
NUTRIENTS											
Ammonia[6,9]	mg/L	1.84	20.5	18.5	-	**6.28**	**4.59**	**1.99**	**1.9**	0.16	0.0836
Nitrate as N	mg/L	3	32.8	400	10	**5.1**	<0.0050	**3.9**	0.0263	1.2	0.0133
Phosphorus	mg/L	-	-	-	-	0.1	0.12	0.049	0.0767	0.012	0.017
POLLUTANT TESTS											
BOD	mg/L	-	-	-	-	10	13.7	<2	<6.0	<2	<2.0
COD	mg/L	-	-	-	-	55	108	25	78	24	58

H:\Project\1576\Chem\Overflow\2023\[1576_OverflowEvents_ChemistrySummary.xlsx]TABLE D-2

NOTES:
1. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.
   https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf
   https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/bc_env_working_water_quality_guidelines.pdf
   Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). Maximum guidelines are shown (ie. short term acute if applicable).
2. **Bolding** denotes parameters which exceed 30-day FWAL water quality guideline. Yellow highlight denotes parameters which exceed maximum FWAL water quality guideline where a separate guideline has been developed.
3. *Italics* denotes parameters which exceed the CSR DW standard
4. Single underline denotes parameters which exceed the CSR AW standard.
5. FWAL guideline for indicated parameter changes with hardness. Water quality criteria was calculated with a hardness of 100 mg/L CaCO3.
6. FWAL guideline for indicated parameter changes with pH and temperature. Water quality criteria was calculated with pH<7 and temperature of 10˚C
8. Per Schedule 3.2 of Stage 13 Amendment to Contaminated Sites Regulation (CSR), March 2023. AW standards assume minimum 1:10 dilution is available. As such, samples collected from SW-1-Overflow are compared against CSR AW standards/10. https://www.bclaws.gov.bc.ca/civix/document/id/lc/statreg/375_96_08
8. CSR AW standard for indicated parameter changes with hardness. Water quality standard was calculated with a hardness of 100 mg/L CaCO3.
9. CSR AW standard for indicated parameter changes with pH. Water quality standard valid for pH<7.
10. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

TABLE D-3
WATER CHEMISTRY SUMMARY FOR OVERFLOW EVENTS - TOTAL METALS

PARAMETERS	UNITS	RECEIVING WATER CRITERIA				SW-3-Overflow	SW-3-Overflow	SW-11-Overflow	SW-11-Overflow	SW-1-Overflow	SW-1-Overflow
		AQUATIC LIFE (FWAL) (30 day)	AQUATIC LIFE (FWAL)[1] (Max)	CSR AQUATIC LIFE (AW)[8]	CSR DRINKING WATER (DW)[8]	17-Apr-23	19-Oct-23	17-Apr-23	19-Oct-23	17-Apr-23	19-Oct-23
Length of Overflow Event based on datalogger record						35 days	3 days	35 days	3 days	35 days	3 days
TOTAL METALS											
Aluminum[5]	mg/L	0.294	0.294	-	9.5	**1.8**	0.289	**0.937**	**0.392**	**0.299**	**0.381**
Antimony	mg/L	0.074	0.25	0.09	0.006	<0.001	0.00041	<0.001	0.00024	<0.001	<0.00010
Arsenic	mg/L	0.005	0.005	0.05	0.01	0.002	0.00127	<0.001	0.0008	<0.001	0.00018
Barium	mg/L	1	1	10	1.0	<0.05	0.0409	<0.05	0.0283	<0.05	0.00436
Beryllium	mg/L	0.00013	0.00013	0.0015	0.008	<0.0005	<0.000100	<0.0005	<0.000100	<0.0005	<0.000100
Boron	mg/L	1.2	1.2	12	5	0.36	0.442	0.21	0.4	0.04	0.053
Cadmium[5,9]	mg/L	0.0002	0.00059	0.0025	0.005	0.000074	0.000148	0.000032	0.000151	<0.000016	0.0000156
Calcium	mg/L	-	-	-	-	53.1	48.4	26.9	31.4	3.97	3.55
Chromium	mg/L	0.001	0.001	0.01	0.05	**0.0035**	**0.00185**	**0.0019**	**0.00162**	0.0006	0.00064
Cobalt	mg/L	0.004	0.11	0.04	0.001	*0.0015*	*0.00159*	<0.0009	0.00095	<0.0009	0.00025
Copper[7,9]	mg/L	0.0018	0.011	0.05	1.5	**0.0083**	**0.0145**	**0.0033**	**0.0113**	0.0013	0.00166
Iron	mg/L	1	1	-	6.5	**5.01**	**1.84**	**1.71**	**1.36**	0.27	0.338
Lead[5,9]	mg/L	0.0065	0.0816	0.16	0.01	0.001	0.000622	0.0003	0.000439	0.0001	0.000167
Lithium	mg/L	-	-	-	0.008	0.002	<0.0010	<0.001	<0.0010	<0.001	<0.0010
Magnesium	mg/L	-	-	-	-	6.61	5.78	4.39	5.59	0.922	1.06
Manganese[5]	mg/L	1.05	1.64	-	1.5	0.619	0.781	0.0306	0.246	0.0059	0.021
Mercury	µg/L	0.2	0.2	0.25	1	0.02	0.0128	0.01	0.0234	<0.01	0.0112
Molybdenum	mg/L	7.6	46.0	10	0.25	<0.001	0.000319	<0.001	0.000148	<0.001	<0.000050
Nickel[5,9]	mg/L	0.096	0.096	0.65	0.08	0.004	0.00529	<0.003	0.00301	<0.003	0.00064
Potassium	mg/L	-	-	-	-	9.48	11.4	4.66	6.82	0.7	0.92
Selenium[6]	mg/L	0.002	0.002	0.02	0.01	<0.0005	0.000132	<0.0005	0.000108	<0.0005	0.000087
Silver[9]	mg/L	0.00005	0.00010	0.015	0.02	<0.00005	0.000018	<0.00005	0.000022	<0.00005	<0.000010
Sodium	mg/L	-	-	-	200	23.1	26	15.8	25.4	4.99	6.03
Strontium	mg/L	-	-	-	2.5	0.228	0.232	0.12	0.165	0.019	0.0211
Thallium	mg/L	-	-	0.003	-	<0.0001	0.00002	<0.0001	0.000013	<0.0001	<0.000010
Tin	mg/L	-	-	-	2.5	<0.0005	<0.00010	<0.0005	<0.00010	<0.0005	<0.00010
Titanium	mg/L	-	-	1	-	0.082	0.013	0.047	0.0229	0.013	0.00926
Tungsten	mg/L	-	-	-	0.003	<0.0001	<0.00010	<0.0001	<0.00010	<0.0001	<0.00010
Uranium	mg/L	0.0085	0.0085	0.085	0.02	<0.001	0.000036	<0.001	0.000026	<0.001	0.000015
Vanadium	mg/L	-	-	-	0.02	0.007	0.00124	0.004	0.00185	<0.001	0.00099
Zinc[5,9]	mg/L	0.0333	0.0681	0.900	3	0.028	**0.0351**	0.007	0.0173	<0.004	<0.0030

H:\Project\1576\Chem\Overflow\2023\[1576_OverflowEvents_ChemistrySummary.xlsx]TABLE D-3

NOTES:
1. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.
   https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf
   https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/bc_env_working_water_quality_guidelines.pdf
   Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). Maximum guidelines are shown (ie. short term acute if applicable).
2. **Bolding** denotes parameters which exceed 30-day FWAL water quality guideline. Yellow highlight denotes parameters which exceed maximum FWAL water quality guideline where a separate guideline has been developed.
3. *Italics* denotes parameters which exceed the CSR DW standard.
4. Single underline denotes parameters which exceed the CSR AW standard.
5. FWAL guideline for indicated parameter changes with hardness. Aluminum and zinc guidelinese also vary with pH and DOC. Value shown appropriate for hardness of 100 mg/L-CaCO3, pH of 7, and DOC of 10. Cadmium and zinc gudelines are for dissolved metals.
6. Selenium alert concentration is 0.001 mg/L. Guideline is 0.002 mg/L.
7. FWAL guideline uses the dissolved copper guideline calculated by the BC BLM for short-term exposure and used a hardness of 100 mg/L CaCO3, pH 7, and DOC of 10 mg/L.
8. Per Schedule 3.2 of Stage 13 Amendment to Contaminated Sites Regulation (CSR), March 2023. AW standards assume minimum 1:10 dilution is available. As such, samples collected from SW-1-Overflow are compared against CSR AW standards/10. https://www.bclaws.gov.bc.ca/civix/document/id/lc/statreg/375_96_08
9. CSR AW standard for indicated parameter changes with hardness. Water quality standard was calculated with a hardness of 100 mg/L CaCO3.
10. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

TABLE D-4
WATER CHEMISTRY SUMMARY FOR OVERFLOW EVENTS - VOLATILE ORGANICS

PARAMETERS	UNITS	RECEIVING WATER CRITERIA				SW-3-Overflow	SW-11-Overflow	SW-1-Overflow
		Aquatic Life (FWAL)[1] (30 day)	Aquatic Life (FWAL)[1] (Max)	CSR AQUATIC LIFE (AW)[4]	CSR DRINKING WATER (DW)	19-Oct-23	19-Oct-23	19-Oct-23
Length of Overflow Event based on datalogger record						3 days	3 days	3 days
VOLATILE ORGANICS								
Acetone	µg/L	-	-	-	3500	123	122	<20
Bromobenzene	µg/L	-	-	-	30	<1.0	<1.0	<1.0
Bromochloromethane	µg/L	-	-	-	-	<1.0	<1.0	<1.0
Bromomethane	µg/L	-	-	-	5.5	<1.0	<1.0	<1.0
Butylbenzene, n-	µg/L	-	-	-	200	<1.0	<1.0	<1.0
Butylbenzene, sec-	µg/L	-	-	-	400	<1.0	<1.0	<1.0
Butylbenzene, tert-	µg/L	-	-	-	400	<1.0	<1.0	<1.0
Carbon disulfide	µg/L	-	-	-	400	<5.0	<5.0	<5.0
Chlorobenzene	µg/L	-	-	13	80	<1.0	<1.0	<1.0
Chloromethane	µg/L	-	-	-	-	<5.0	<5.0	<5.0
Chlorotoluene, 2-	µg/L	-	-	-	80	<1.0	<1.0	<1.0
Chlorotoluene, 4-	µg/L	-	-	-	80	<1.0	<1.0	<1.0
Cyclohexane	µg/L	-	-	-	7	<1.0	<1.0	<1.0
Dibromo-3-chloropropane, 1,2-	µg/L	-	-	-	0.5	<0.50	<0.50	<0.50
Dibromobenzene, 1,3-	µg/L	-	-	-	1.5	<10	<10	<10
Dibromobenzene, 1,4-	µg/L	-	-	-	40	<10	<10	<10
Dibromomethane	µg/L	-	-	-	-	<1.0	<1.0	<1.0
1,2-Dichlorobenzene	µg/L	0.7	0.7	7	200	<1.0	<1.0	<1.0
1,3-Dichlorobenzene	µg/L	150	150	1500	-	<1.0	<1.0	<1.0
1,4-Dichlorobenzene	µg/L	26	26	260	5	<1.0	<1.0	<1.0
Dichlorodifluoromethane	µg/L	-	-	-	800	<1.0	<1.0	<1.0
1,2-Dichloropropane	µg/L	-	-	-	4.5	<1.0	<1.0	<1.0
Dichloropropane, 1,3-	µg/L	-	-	-	80	<1.0	<1.0	<1.0
Dichloropropane, 2,2-	µg/L	-	-	-	-	<1.0	<1.0	<1.0
Dichloropropylene, 1,1-	µg/L	-	-	-	-	<1.0	<1.0	<1.0
cis&trans-1,3-Dichloropropene	µg/L	-	-	-	1.5	<1.5	<1.5	<1.5
cis-1,3-Dichloropropene	µg/L	-	-	-	1.5	<1.0	<1.0	<1.0
Diethyl ether	µg/L	-	-	-	800	<1.0	<1.0	<1.0
Ethyl acetate	µg/L	-	-	-	3500	<1.0	<1.0	<1.0
Hexachlorobutadiene	µg/L	1.3	1.3	15	2	<1.0	<1.0	<1.0
Hexanone, 2-	µg/L	-	-	-	20	<10	<10	<10
Methyl ethyl ketone [MEK]	µg/L	-	-	-	2500	96	91	<20
Methyl isobutyl carbinol [MIBC]	µg/L	-	-	-	-	<20	<20	<20
Methyl isobutyl ketone [MIBK]	µg/L	-	-	-	-	<20	<20	<20
Octane, n-	µg/L	-	-	-	-	<1.0	<1.0	<1.0
Pentane, n-	µg/L	-	-	-	-	<2.5	<3.0	<2.5
1,1,2,2-Tetrachloroethane	µg/L	-	-	-	0.8	<1.0	<1.0	<1.0
1,1,1,2-Tetrachloroethane	µg/L	-	-	-	6	<0.20	<0.20	<0.20
Trichloro-1,2,2-trifluoroethane, 1,1,2- [Freon 113]	µg/L	-	-	-	100000	<1.0	<1.0	<1.0
Trichlorobenzene, 1,2,3-	µg/L	8	8	3	80	<1.0	<1.0	<1.0
Trichlorobenzene, 1,2,4-	µg/L	24	24	250	5.5	<1.0	<1.0	<1.0
1,1,2-Trichloroethane	µg/L	-	-	-	3	<1.0	<1.0	<1.0
Trichlorofluoromethane	µg/L	-	-	-	1000	<1.0	<1.0	<1.0
Trichloropropane, 1,1,2-	µg/L	-	-	-	20	<1.0	<1.0	<1.0
Trichloropropane, 1,2,3-	µg/L	-	-	-	0.5	<0.50	<0.50	<0.50
Trichloropropylene, 1,2,3-	µg/L	-	-	-	10	<1.0	<1.0	<1.0

H:\Project\1576\Chem\Overflow\2023\[1576_OverflowEvents_ChemistrySummary.xlsx]TABLE D-4

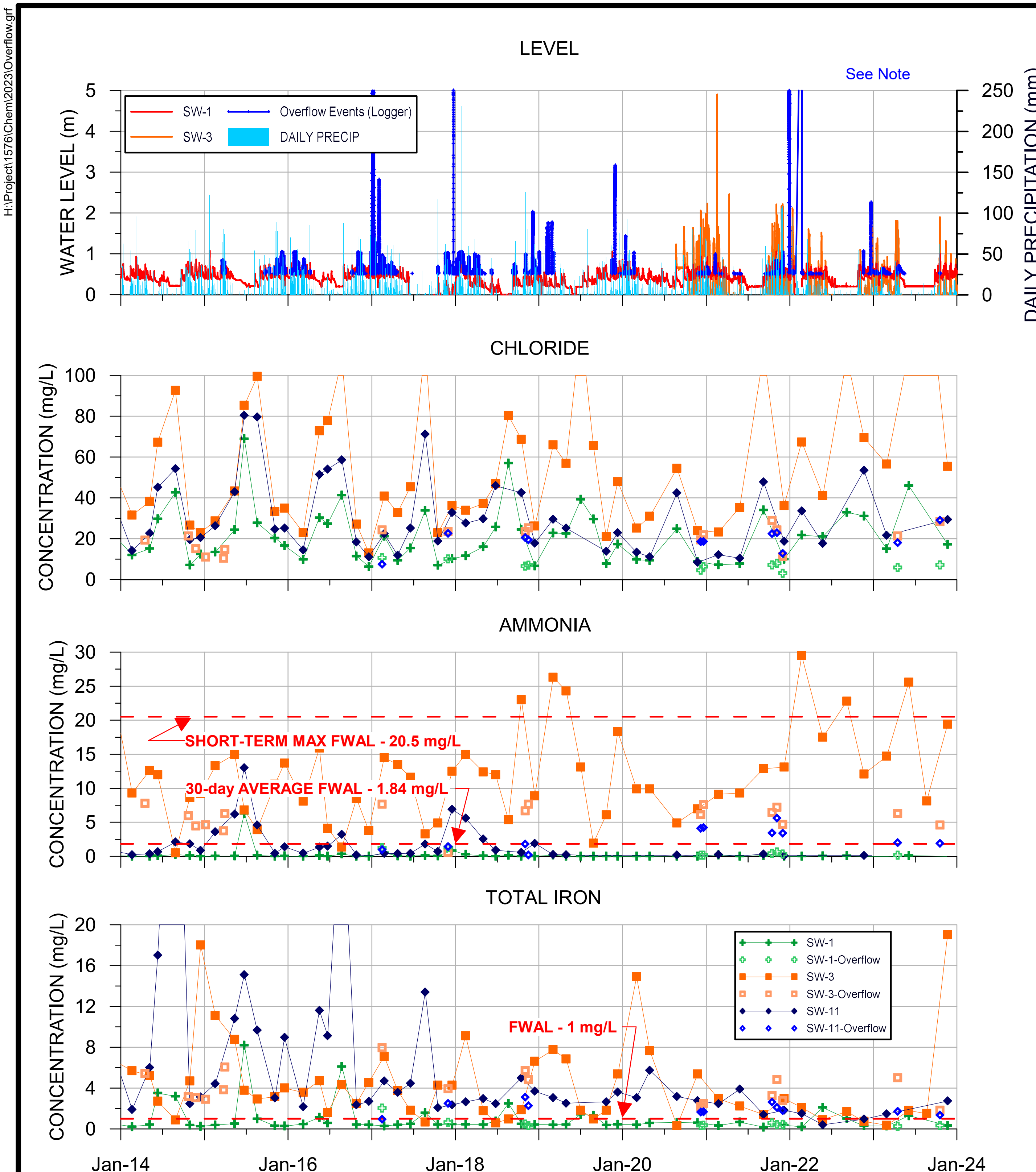
NOTES:
1. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.
https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf
https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/bc_env_working_water_quality_guidelines.pdf
Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). Maximum guidelines are shown (ie. short term acute if applicable).
2. Bolding denotes parameters which exceed 30-day FWAL water quality guideline. Yellow highlight denotes parameters which exceed maximum FWAL water quality guideline where a separate guideline has been developed.
3. *Italics* denotes parameters which exceed the CSR DW standard.
4. Single underline denotes parameters which exceed the CSR AW standard.
8. Per Schedule 3.2 of Stage 13 Amendment to Contaminated Sites Regulation (CSR), March 2023. AW standards assume minimum 1:10 dilution is available. As such, samples collected from SW-1-Overflow are compared against CSR AW standards/10. https://www.bclaws.gov.bc.ca/civix/document/id/lc/statreg/375_96_08
6. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.
7. Green highlight denotes parameters which are above the detection limit.

TABLE D-4
WATER CHEMISTRY SUMMARY FOR OVERFLOW EVENTS - VOLATILE ORGANICS (CONTINUED)

PARAMETERS	UNITS	RECEIVING WATER CRITERIA				SW-3-Overflow	SW-11-Overflow	SW-1-Overflow
		Aquatic Life (FWAL)[1] (30 day)	Aquatic Life (FWAL)[1] (Max)	CSR AQUATIC LIFE (AW)[4]	CSR DRINKING WATER (DW)	19-Oct-23	19-Oct-23	19-Oct-23
Length of Overflow Event based on datalogger record						3 days	3 days	3 days
VOCs (DRY CLEANING)								
Carbon Tetrachloride	µg/L	-	-	130	2	<1.0	<1.0	<1.0
Chloroethane	µg/L	-	-	-	-	<1.0	<1.0	<1.0
1,1-Dichloroethane	µg/L	100	100	-	30	<1.0	<1.0	<1.0
1,1-Dichloroethene	µg/L	-	-	-	14	<1.0	<1.0	<1.0
cis-1,2-Dichloroethene	µg/L	-	-	-	8	<1.0	<1.0	<1.0
trans-1,2-Dichloroethene	µg/L	-	-	-	80	<1.0	<1.0	<1.0
Dichloromethane	µg/L	-	-	980	50	<1.0	<1.0	<1.0
trans-1,3-Dichloropropene	µg/L	-	-	-	1.5	<1.0	<1.0	<1.0
Tetrachloroethene	µg/L	-	-	1100	3	<1.0	<1.0	<1.0
1,1,1-Trichloroethane	µg/L	-	-	-	8000	<1.0	<1.0	<1.0
Trichloroethylene	µg/L	-	-	200	5	<1.0	<1.0	<1.0
Vinyl Chloride	µg/L	-	-	-	2	<0.40	<0.40	<0.40
VOCs (FUEL)								
BTEX+Styrene, total	µg/L	-	-	-	-	<1.5	<1.5	<1.5
BTEX, total	µg/L	-	-	-	-	<1.0	<1.0	<1.0
Benzene	µg/L	40	40	400	5	<0.50	<0.50	<0.50
Butadiene, 1,3-	µg/L	-	-	-	1	<0.20	<0.20	<0.20
Cymene, p-	µg/L	-	-	-	-	<1.0	<1.0	<1.0
Decane, n-	µg/L	-	-	-	-	<1.0	<1.0	<1.0
Dibromoethane, 1,2-	µg/L	-	-	-	0.5	<0.20	<0.20	<0.20
1,2-Dichloroethane	µg/L	100	100	1000	5	<1.0	<1.0	<1.0
Ethylbenzene	µg/L	200	200	2000	140	<0.50	<0.50	<0.50
Heptane, n-	µg/L	-	-	-	-	<1.0	<1.0	<1.0
Hexane, n-	µg/L	-	-	-	-	<1.0	<1.0	<1.0
Isopropylbenzene	µg/L	-	-	-	400	<1.0	<1.0	<1.0
Methyl t-Butyl Ether	µg/L	3400	3400	34000	95	<0.50	<0.50	<0.50
Methylcyclohexane	µg/L	-	-	-	-	<1.0	<1.0	<1.0
Nonane, n-	µg/L	-	-	-	1	<1.0	<1.0	<1.0
Propylbenzene, n-	µg/L	-	-	-	400	<1.0	<1.0	<1.0
Styrene	µg/L	72	72	720	800	<0.50	<0.50	<0.50
Toluene	µg/L	0.5	0.5	5	60	<0.40	<0.40	<0.40
Trimethylbenzene, 1,2,3-	µg/L	-	-	-	-	<1.0	<1.0	<1.0
Trimethylbenzene, 1,2,4-	µg/L	-	-	-	-	<1.0	<1.0	<1.0
Trimethylbenzene, 1,3,5-	µg/L	-	-	-	40	<1.0	<1.0	<1.0
m&p-Xylene	µg/L	-	-	-	-	<0.40	<0.40	<0.40
o-Xylene	µg/L	-	-	-	-	<0.30	<0.30	<0.30
Xylenes	µg/L	30	30	300	90	<0.50	<0.50	<0.50
VOCs (THMs)								
Bromodichloromethane	µg/L	-	-	-	100	<1.0	<1.0	<1.0
Bromoform	µg/L	-	-	-	100	<1.0	<1.0	<1.0
Chloroform	µg/L	1.8	1.8	20	100	<1.0	<1.0	<1.0
Dibromochloromethane	µg/L	-	-	-	100	<1.0	<1.0	<1.0
Trihalomethanes [THMs], total	µg/L	-	-	-	100	<2.0	<2.0	<2.0

H:\Project\1576\Chem\Overflow\2023\[1576_OverflowEvents_ChemistrySummary.xlsx]TABLE D-5

NOTES:
1. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.
https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf
https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/bc_env_working_water_quality_guidelines.pdf
Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). Maximum guidelines are shown (ie. short term acute if applicable).
2. Bolding denotes parameters which exceed 30-day FWAL water quality guideline. Yellow highlight denotes parameters which exceed maximum FWAL water quality guideline where a separate guideline has been developed.
3. *Italics* denotes parameters which exceed the CSR DW standard.
4. Single underline denotes parameters which exceed the CSR AW standard.
8. Per Schedule 3.2 of Stage 13 Amendment to Contaminated Sites Regulation (CSR), March 2023. AW standards assume minimum 1:10 dilution is available. As such, samples collected from SW-1-Overflow are compared against CSR AW standards/10. https://www.bclaws.gov.bc.ca/civix/document/id/lc/statreg/375_96_08
6. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.
7. Green highlight denotes parameters which are above the detection limit.



Note: Datalogger not installed from January 26, 2022 to February 22, 2022.

ALBERNI-CLAYOQUOT REGIONAL DISTRICT
WATER QUALITY MONITORING PROGRAM
WEST COAST LANDFILL, UCLUELET, B.C.

PITEAU ASSOCIATES
GEOTECHNICAL AND WATER MANAGEMENT CONSULTANTS
A TETRA TECH COMPANY

TIME SERIES PLOT OF WATER LEVELS AND SELECTED LEACHATE INDICATOR CONCENTRATIONS AT SW-1, SW-3 AND LEACHATE POND OVERFLOW

BY:	DATE:
OB	MAR 24
APPROVED:	FIG:
JM	D-1