ALBERNI-CLAYOQUOT REGIONAL DISTRICT

2024 – 2027 Strategic Plan

West Coast Committee Meeting
Wednesday, June 5, 2024

Zoom/Tofino Council Chambers (Hybrid) – 380 Campbell Street, Tofino, BC
10:00 am

Regular Agenda

Watch the meeting live at: https://www.acrd.bc.ca/events/5-6-2024/

Register to participate via Zoom Webinar at: https://acrd-bc-ca.zoom.us/webinar/register/WN_y3kQLNaNQnO9sLKUJtLLjg#/

PAGE #

1. CALL TO ORDER

Recognition of Territories.

Notice to attendees and delegates that this meeting is being recorded and livestreamed to YouTube on the Regional District Website.

Introductions - Committee Members and Staff present in the Boardroom and via Zoom.

2. APPROVAL OF AGENDA
(motion to approve, including late items requires 2/3 majority vote)

3. DECLARATIONS
(conflict of interest)

4. MINUTES

a. **West Coast Committee Meeting – February 28, 2024** **3-7**

THAT the minutes of the West Coast Committee meeting held on February 28, 2024 be adopted.

5. PETITIONS, DELEGATIONS & PRESENTATIONS (10 minute maximum)

6. CORRESPONDENCE

7. REQUEST FOR DECISIONS

a. REQUEST FOR DECISION **8-11**
West Coast Transit – Schedule Change and Update

THAT the West Coast Committee recommend that the Alberni-Clayoquot Regional District Board of Directors approve a schedule change for the West Coast Transit service to alleviate the labour issues created by the gap in the midday service of the current schedule.

8. REPORTS

a. **Ex-Offico Member Updates**
- Pacific Rim National Park Update
- Ahousaht First Nation Update
- Tla-o-qui-aht First Nation Update
- Hesquiaht First Nation Update

THAT the West Coast Committee receive the verbal reports.

b. **Reports for Information (with staff presentation)** **12-129**
2023 West Coast Landfill Annual Reports

THAT the West Coast Committee receive the reports.

9. LATE BUSINESS

10. QUESTION PERIOD

Questions/Comments from the public:
- **Participating in Person in the Tofino Council Chambers**
- **Participating in the Zoom meeting**
- **Emailed to the ACRD at responses@acrd.bc.ca**

11. IN CAMERA

Motion to close the meeting to the public as per the Community Charter, section(s):

i. 90 (1) (c): labour relations or other employee relations;

ii. 90 (1) (j): information that is prohibited, or information that if it were presented in a document would be prohibited, from disclosure under section 21 of the Freedom of Information and Protection of Privacy Act;

ii. 21 (1) (a) (ii) of FOIPPA: commercial, financial, labour relations, scientific or technical information of or about a third party.

12. REPORT OUT - RECOMMENDATIONS FROM IN-CAMERA

13. ADJOURN

Alberni-Clayoquot Regional District

MINUTES OF THE WEST COAST COMMITTEE MEETING
HELD ON WEDNESDAY, FEBRUARY 28, 2024, 10:00 AM

Hybrid - Zoom/Board Room, 3008 Fifth Avenue, Port Alberni, BC

MEMBERS PRESENT:	Tom Stere, Chair, Councillor, District of Tofino Marilyn McEwen, Vice-Chair, Mayor, District of Ucluelet Vaida Siga, Director, Electoral Area "C" (Long Beach) Levana Mastrangelo, Executive Legislator, Yuułuʔiłʔatḥ Government Kirsten Johnsen, Member of Council, Toquaht Nation
REGRETS:	John Rampanen, Chief Councillor, Ahousaht First Nation Dave Tovell, Park Superintendent, Pacific Rim National Park Jim Chisholm, Administrator, Tla-o-qui-aht First Nation Bob Anderson, Administrator, Hesquiaht First Nation
STAFF PRESENT:	Daniel Sailland, Chief Administrative Officer Jenny Brunn, General Manager of Community Services Mark Fortune, Airport Manager Heather Zenner, Manager of Administrative Services Janice Hill, Executive Assistant Alisha Feser, Airport Projects Planner Teri Fong, Chief Financial Officer

The meeting can be viewed on the Alberni-Clayoquot Regional District website at:
https://www.acrd.bc.ca/events/28-2-2024/

1. CALL TO ORDER

The Chairperson called the meeting to order at 10:03 am.

The Chairperson recognized this meeting is being held throughout the Nuu-chah-nulth territories.

The Chairperson reported this meeting is being recorded and livestreamed to YouTube on the Regional District website.

Introductions – Committee Members and Staff present in the Boardroom and via Zoom.

2. APPROVAL OF AGENDA

MOVED: Director Siga
SECONDED: Director Johnsen

THAT the agenda be approved as circulated.

CARRIED

3. MINUTES

a. **West Coast Committee Meeting Minutes – February 21, 2024**

MOVED: Director Stere
SECONDED: Director Siga

THAT the minutes of the West Coast Committee meeting held on February 21, 2024 be adopted.

4. PETITIONS, DELEGATIONS & PRESENTATIONS

a. **Senior Project Manager, Nick Walters, Avia NG Airport Consultants regarding Tofino-Long Beach Airport Terminal Building Expansion Plan**

Director Mastrangelo entered the meeting at 10:06 am.

b. **Senior Transportation Planner & Transit Lead, Shilpa Panicker, Watt Consulting Group regarding update on West Coast Transit Implementation**

c. **Lease Applicant, Dan Harrison regarding Lease Application at Long Beach Airport**

5. CORRESPONDENCE

6. REQUESTS FOR DECISIONS

a. **Request for Decision regarding Long Beach Airport Terminal Building Expansion Plan**

MOVED: Director Siga
SECONDED: Director McEwen

THAT the West Coast Committee recommends that the ACRD Board of Directors support the recommendations of the Avia NG report 'CYAZ Long Beach Airport Terminal Building Expansion Phase 1 Pre-design Initial Assessment' and directs staff to incorporate the design of a new terminal building into the 2024-2028 workplan.

CARRIED

MOVED: Director Siga
SECONDED: Director McEwen

THAT the West Coast Committee recommends that the ACRD Board of Directors directs staff to seek out grant funding opportunities for design of the new terminal building.

CARRIED

b. **Request for Decision regarding 2024-2028 Draft Financial Plan – West Coast Transit Service**

MOVED: Director Siga
SECONDED: Director McEwen

THAT the West Coast Committee recommend the West Coast Transit proposed budget, as presented, be included in the first reading of the 2024-2028 Alberni-Clayoquot Regional District Financial Plan bylaw.

CARRIED

c. **Request for Decision regarding LBALease-2024-002 (ACRD)**

MOVED: Director Siga
SECONDED: Director McEwen

THAT the West Coast Committee supports the Preliminary Lease Application LBALease-2023-006 from the ACRD (for PWTransit operations) and recommend that the ACRD Board of Directors consider approval of the final application.

CARRIED

d. **Request for Decision regarding Preliminary Lease Application – LBALease-2023-005 (Harrison)**

MOVED: Director Stere
SECONDED: Director McEwen

THAT the West Coast Committee supports the Preliminary Lease Application LBALease-2023-005 from Dan Harrison and recommend that the ACRD Board of Directors consider approval for final application.

CARRIED

e. **Request for Decision regarding Preliminary Lease Application – LBALease-2023-006 (Mayco)**

MOVED: Director Siga
SECONDED: Director McEwen

THAT the West Coast Committee supports the Preliminary Lease Application LBALease-2023-006 from Mayco Noel (Ozzard Environmental) and recommend that the ACRD Board of Directors consider approval of final application.

CARRIED

f. **Request for Decision regarding Preliminary Lease Application – LBALease-2024-001 (Pleune)**

MOVED: Director Siga
SECONDED: Director McEwen

THAT the West Coast Committee supports the Preliminary Lease Application LBALease-2024-001 from Jamie Pleune and recommend that the ACRD Board of Directors consider approval of final application.

CARRIED

g. **Request for Decision 2024 Grant-in-Aid Applications – West Coast Focus**

GIA 08 Redd Fish Restoration Society

MOVED: Director McEwen
SECONDED: Director Siga

THAT the West Coast Committee recommend that the ACRD Board of Directors award a grant-in-aid in the amount of $3500 in 2024 to the Redd Fish Restoration Society with the following areas participating: District of Tofino, District of Ucluelet and Electoral Area "C" (Long Beach).

CARRIED

GIA 09 Surfrider Foundation Pacific Rim Chapter

MOVED: Director Stere
SECONDED: Director Siga

THAT the West Coast Committee recommend that the ACRD Board of Directors award a grant-in-aid in the amount of $2500 in 2024 to the with the following areas participating: District of Tofino, District of Ucluelet and Electoral Area "C" (Long Beach).

CARRIED

GIA 24 Westcoast Community Resources Society

MOVED: Director Stere
SECONDED: Director Siga

THAT the West Coast Committee recommend that the ACRD Board of Directors award a grant-in-aid in the amount of $5000 in 2024 to the Westcoast Community Resources Society with the following areas participating: District of Tofino, District of Ucluelet and Electoral Area "C" (Long Beach).

CARRIED

7. REPORTS

a. **Ex-Officio Member Updates**

- Pacific Rim National Park Update – No Report
- Ahousaht First Nation Update – No Report
- Tla-o-qui-aht First Nation Update – No Report
- Hesquiaht First Nation Update – No report

8. LATE BUSINESS

9. QUESTION PERIOD

Questions/Comments from the public. The Manager of Administrative Services advised there were no questions or comments respecting an agenda topic from public:

- Participating in Person in the ACRD Board Room
- Participating in the Zoom webinar
- Submissions received by email at responses@acrd.bc.ca.

10. ADJOURN

THAT this meeting be adjourned 11:59 am.

CARRIED

Certified Correct:

_____ _____

Tom Stere,
Chairperson

Heather Zenner,
Manager of Administrative Services

ALBERNI-CLAYOQUOT REGIONAL DISTRICT

REQUEST FOR DECISION

To: West Coast Committee

From: Eddie Kunderman, Operations Manager

Meeting Date: June 5, 2024

Subject: West Coast Transit – Schedule Change and Update

Recommendation:

THAT the West Coast Committee recommend that the Alberni-Clayoquot Regional District Board of Directors approve a schedule change for the West Coast Transit service to alleviate the labour issues created by the gap in the midday service of the current schedule.

Desired Outcome:

To create an updated schedule for the West Coast Transit service to help incorporate feedback that has been received from the public, and address labour issues that the current schedule creates.

Summary:

The West Coast transit service launched on April 2, 2024, and was communicated to be an introductory level of service intending to remove barriers and provide a much-needed transportation link to the residents of the West Coast. The service has met those goals to this point, but feedback has been received on some opportunities to optimize the service hours available within the approved budget while addressing some operational issues that have arisen.

Background:

Minor Schedule Change to Address Labour Challenges

While the current schedule contains a good balance of morning and afternoon hours, ridership has proven to be stronger on the afternoon trips. The 6:30 AM round trip from Ucluelet to Tofino and back to Ucluelet, in particular, has seen low ridership. The schedule also has a gap in service in the middle of the day, which has been the source of labour challenges for PWTransit. These challenges have resulted in some service being missed, primarily on Mondays, as the lengthy split-shift can be difficult to fill. There is an opportunity to re-optimize the schedule, removing the lowest ridership trip and adding an additional midday trip to help address the labour issue being faced and stay within the current allotment of budgeted hours. If the recommendation is approved, staff will fine-tune the schedule to remove the 6:30 AM round trip from Ucluelet and add a corresponding trip later in the day.

Optional Service to Millstream

Along with the midday and labour issues the current schedule faces, there has also been feedback regarding the lack of stops for the community of Millstream. Providing stops at the Highway adjacent to

the Millstream community has challenges, largely due to the reduced sightlines in and around Lee Avenue. Staff have communicated with the Ministry of Transportation and Infrastructure (MOTI) and MOTI has confirmed that the sightlines are not appropriate for pedestrian crossings in the vicinity of Lee Road. Due to this, the only way to safely service the community for any trip heading from Tofino to Ucluelet is to deviate off of the highway at Lee Road and provide a loop within the community before turning left back on to the highway. This deviation takes about four (4) minutes depending on passenger activity in the area. Heading from Ucluelet to Tofino, the buses could stop on the side of the highway rather than making the four minute deviation into the Millstream community. While having two different servicing scenarios for Millstream wouldn't be perfect, it would reduce the financial impact of servicing the community. This option would mean an increase of approximately 200 annual service hours to the system.

A potential option to add service to Millstream without increasing the budgeted hours would be to create a "peak" Spring-Summer schedule and an "off-peak" Fall-Winter schedule. The thought behind this would be that you would see a decrease in hours for the off-peak periods, that would allow you to increase the peak period slightly and service Millstream. This option would entail a much more thorough review and overhaul of the current schedule. Staff are recommending that this be considered for implementation later in the year when more data collection has occurred.

Bus Software

It was intended to have real-time information available for the service upon startup, but the bus technology is still waiting to be installed. PWTransit has communicated that their technology provider Passeo will be on site at some point in mid-June to install the routers. The validators from Token Transit are being delivered and will be installed once they arrive and the routers are on board. This will allow passengers to track buses in real-time and allow the service to be as user-friendly as possible. This will also allow for more complete data to be collected and tracked as far as transit use by trip time, fare type and stop location. In discussing potential options with the West Coast Transportation Working Group, it was recommended to not do a drastic overhaul of the schedule without the more detailed ridership information. When this ridership data is available will depend on the installation timelines for the validators and routers. If installed by mid to late June, a suitable sample size of data could be available by the end of the Summer. Currently, total ridership as shown, is being collected by bus operators.

Bike Racks
The current buses came to the service without bike racks and although they had been ordered prior to the start of service, they have still not yet arrived or been installed. There has been a delay in the shipping of the bike racks that have been ordered that the operating company is hoping to have cleared up shortly. The hope is that the bike racks will have arrived and be installed in the next week or two.

Senior Fare Discount
Another of the items that staff have been working on is the implementation of a reduced fare system for Seniors. We have ordered trial reduced fare ticket booklets for Seniors and will distribute them through some of our partner organizations. Staff are trying to continue to reduce as many barriers as possible for accessing the service and are looking at other opportunities or vendors to sell West Coast Transit tickets in order to maximize the accessibility of the service.

Time Requirements – Staff & Elected Officials:

The total staff time required to implement the recommended changes are 12 hours to update transit schedules, communicate changes, update marketing materials, meet with the operating company and make any other necessary updates.

Financial:

The minor schedule change carries limited financial impact. The annual service hours would remain the same, however, the removal of a morning trip and the addition of an afternoon trip could lead to increased ridership and revenue.

The financial impact of providing optional service to Millstream without creating a peak and off-peak schedule would be approximately $20,000 annually.

The financial impact of creating a peak and off-peak schedule to provide service to Millstream would be close to neutral, as annual service hours would be close to the same. There is the chance that ridership and revenue could be negatively affected in the off-peak service periods.

The West Coast Transit service has seen $14,500 in ticket sales to vendors and $7,319 in revenue received through the Token Transit app in the first seven (7) weeks of service.

Strategic Plan Implications:

Strategy 1.3 Viable and Responsive: Complete the West Coast and Regional Transit service reviews.

Policy or Legislation:

As per Establishing Bylaw No. E1062

Options Considered:

While staff are recommending that the West Coast Committee proceed with the resolution presented above, and allow time for more data collection to occur prior to making further modifications, staff also present the following options for the West Coast Committee to consider:

1) The West Coast Committee recommend that the Alberni-Clayoquot Regional District Board of Directors approve a schedule change, to allow for the provision of service to the community of Millstream by increasing annual service hours by 200 hours, for the West Coast Transit service.

Or:

2) The West Coast Committee recommend that the Alberni-Clayoquot Regional District Board of Directors direct staff to develop a peak and off-peak schedule for the West Coast Transit service to alleviate the labour issues created by the current schedule and to allow for the provision of service to the community of Millstream without increasing operating costs.

Alternatively:

3) The West Coast Committee could choose none of the options and continue with the current schedule.

Submitted by: Jenny Brunn
Jenny Brunn, General Manager of Community Services

Reviewed by: Cynthia Dick
Cynthia Dick, General Manager of Administrative Services

Approved by: Daniel Sailland
Daniel Sailland, MBA, Chief Administrative Officer

ALBERNI-CLAYOQUOT REGIONAL DISTRICT

REPORT FOR INFORMATION

To:	West Coast Committee
From:	Paulo Eichelberger, Solid Waste Manager Brenda Sauve, Solid Waste Coordinator
Meeting Date:	June 5th, 2024
Subject:	2023 West Coast Landfill Annual Reports

Background:

As a condition of the West Coast Landfill (WCL) operating certificate, the ACRD is required to submit an annual report on landfill operations and monitoring to the Ministry of Environment and Climate Change Strategy (MOECCS). In recent years, staff have used this requirement as an opportunity to provide a more holistic report on landfill operations and the overall solid waste service for the waste-shed of the West Coast. This includes a review of how the goals and targets as established by the Solid Waste Management Plan (SWMP) are being met and developing an improvement plan to better meet those objectives. This report is created internally by staff and verified by an external Solid Waste Engineer as required by MOECCS. The ACRD's environmental consultants, Piteau and Associates, continue to oversee the environmental monitoring program and produce an annual report to summarize the technical analysis and recommendations based on the field monitoring undertaken by ACRD staff. These two reports are attached for your review with the key points summarized below.

Overview of Landfill Report:

Key takeaways and successes:

- Total landfilled waste in 2023 was 6,240 tonnes, a 12% drop from 2022.
- Revised population estimates, show an estimated increase of 3%[1] to 11,894 in 2023, resulting in a waste generation rate of 524.6 kg/capita, down 14% from 613 kg/capita in 2022. However, disposal was down largely due to the Cameron Bluffs Wildfire which closed Highway 4 for the summer months, temporarily resulting in a decrease in tourist activity.
- Total diversion increased from 22.2% to 26.4%. Approximately 2,235 tonnes of materials were diverted from landfilling in 2023. This increase in diversion was due to:
    - The first full year of 3-stream curbside service, which increased residential diversion of organics and recyclables for 1,870 homes in the communities of hitacu, Esowista, Ty-Hystanis, Ucluelet, Long Beach and Tofino; and

1 Estimate based on sum of BC Populations Stats and equivalent population represented by the tourism industry, averaged over 5 years.

  - New reporting on private commercial recycling not previously captured in other years.
- The volume of airspace consumed at the landfill was approximately 9,757 m^3, slightly higher than in 2022, resulting in an airspace consumption ratio of 640 kg/m^3, lower than previous years. This is being reassessed in 2024 as it is unclear whether this is due to a survey error.
- Capital construction and commissioning of a new tipping wall and organics processing capacity at the West Coast Landfill (WCL) was completed in summer.
- With an estimated 680,626 m^3 of remaining airspace, there is approximately 40 years of landfill life remaining, and it will not reach its originally approved capacity until 2062 at current filling rates. This could be extended well beyond this date with increased organics diversion and improved airspace utilization.
- Financial contributions for closure and capital upgrades were $100,000 and $3 million, respectively. Capital expenditures were up due to construction of the organics facility and new waste tipping area; however, this is due to bulk of this funding from Strategic Priorities Grant funding having been transferred into the 2023 capital budget.
- Supplementary Landfill Gas Assessment was completed, showing an estimated at 393 tonnes of methane per year, which remains below the provincial limit of 1,000 tonnes per year.
- The environmental monitoring program highlighted several overflow events of the existing leachate containment and treatment system, which was not effective at ensuring that all water leaving the property is meeting the Fresh Water Aquatic Life (FWAL) criteria, though the water is consistent with background water quality.

Upcoming work includes, but is not limited to:

- The SWMP will continue to be on ongoing project for 2024. This will consist of more Advisory Committee meetings, along with public engagement events and submission of the final plan to the Ministry.
- Waste Educators – The ACRD has hired a waste education group, “Let’s Talk Trash,” to support in-region waste education efforts and train community champions to expand the ACRD’s outreach presence.
- Operation of the Organics Composting Facility to include additional cover building infrastructure and establishing processes to test and sell Class A Compost to the public.
- Update operational certificate to address site infrastructure upgrades, documentation, additional monitoring requirements and soil disposal requirements.
- Upgrade power to 3-phase to reduce reliance on generator power.
- Minor infrastructure upgrades to the existing leachate system.
- Renewal of the landfill operations contract.

Communications:

The attached reports have been submitted to MOECCS as per our regulations and will be posted on our website once received by the Board of Directors. Staff will work to coordinate presentation of this report to the West Coast Working Group as well as site visits and other engagement initiatives.

Submitted by: Jenny Brunn
Jenny Brunn, General Manager of Community Services

Reviewed by: Cynthia Dick
Cynthia Dick, General Manager of Administrative Services

Approved by: Daniel Sailland
Daniel Sailland, MBA, Chief Administrative Officer

ALBERNI-CLAYOQUOT REGIONAL DISTRICT

West Coast Landfill

2023 ANNUAL REPORT

Submitted to British Columbia Ministry of Environment and Climate Change Strategy

Prepared by the ACRD Community Services Department

Reviewed by: Tetra Tech Canada Inc

Paul Evans P.Eng.

Lauren Quan P.Eng.

Permit #1001972

May 2024

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Report Summary

	Reporting Year 2023	Unit
Waste Tonnage Disposed at WCL	6,240	t
Landfill Airspace Consumed	9,888	m^3
Landfill Airspace Remaining	680,626	m^3
Anticipated Closure Date at Current Fill Rate/Density	Approx. 2062	
Waste in Place at Landfill	173,000	t
Leachate Generated & Treated	Not measured	m^3
Landfill Gas Management	none	
Closure Works Undertaken	none	
Inspection Works	No formal Ministry inspection in 2023. Ongoing internal inspections.	
Changes from Approved Plans	None	
Ministry Non-Compliances	• Requirement for Active OMRR registration. • MOE missing leachate overflow piping documentation and contaminated soil.	
Progress on Non-Compliances	From 2023 • OMRR registration submitted, acknowledged by MOECCS and approved. Ops plan for organics to be updated and submitted. • Leachate overflow docs and contaminated soil to be incl. in 2024 permit amendment.	

WCL Waste Shed Projects Undertaken in 2023	Future Projects/Initiatives Proposed
LF Upgrades/Organics Composting Facility – Phase 1	Organics Composting Facility (2024)
Waste Reduction Education	Waste Educator Onboarding (2024)
Landfill Environmental Monitoring Improvements	Update of Solid Waste Management Plan-Phase 2 (2024)
Rope and Netting Project (begun in 2019)	Landfill Contract Renewal (2024)
Update of Solid Waste Management Plan-Phase 1	Installation of Flow Monitoring (2024)
Waste Composition Study	3-phase power upgrade (2024)
Tipping Fee Review	Operational Certificate Update (2024-2025)
Landfill Gas Supplementary Report	Organics Ban (Future Initiative)
	Construction and Demolition Waste Diversion (Future Initiative)
	Design Operations and Closure Plan Update (Future Initiative)
	Leachate Treatment Facility (Future Initiative)
	Explore Temporary Cover Options (Future Initiative)

	Target	Actual
1 - Waste Disposal Rate	< 400 kg/capita	525 kg/capita
2- Diversion of Waste	>50%	26%
3 - Airspace Consumption Ratio	>750 kg/m^3	631 kg/m^3
4 – Capital Contributions	>$70,000/year	$100,000
5 – Water Quality	Meet FWAL	Within envelope defined by FWAL
6 – Landfill Gas Generation	<1,000 tonnes CH_4/year	Est. 339 tonnes CH_4/year

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Background

The Alberni-Clayoquot Regional District (ACRD) operates the West Coast Landfill (WCL) under the British Columbia Waste Management Act Operational Certificate Number OC-5634, issued April 12, 2005. The "waste shed" for municipal solid waste destined for the WCL includes the District of Tofino, District of Ucluelet, Parks Canada, ACRD Electoral District C - Long Beach, Millstream and Port Albion and the First Nations communities of the Toquaht, Yuułuʔiłʔatḥ, Ahousaht, Tla-o-qui-aht, and Hesquiaht. The WCL is located approximately 9 km northwest of the Tofino-Ucluelet junction, on the east side of the highway, along Alaska Pine Road. The WCL has been operational since 1980.

This report was prepared by staff at the ACRD to satisfy the annual reporting requirements for the WCL, as required by the Operational Certificate and the 2016 Landfill Criteria for Municipal Solid Waste published by BC Ministry of Environment and Climate Change Strategy (MOECCS). The report has been reviewed by solid waste engineers from Tetra Tech Canada Inc. that are familiar with the facility and operations. The content of the Annual Report and supporting materials were reviewed by Tetra Tech Canada Inc. in conjunction with the ACRD staff prior to the report being finalized.

Mission Statement

"To protect human health and the environment and maximize value of service by effectively managing the region's solid waste in an environmentally, socially and economically responsible manner."

Waste Quantification

Landfilled

In 2023, the WCL accepted 6,240 tonnes of municipal solid waste (MSW) and construction and demolition (C&D) waste as shown in Table 1. The cumulative waste in place at the WCL as of the end of 2023 is 173,007 tonnes.

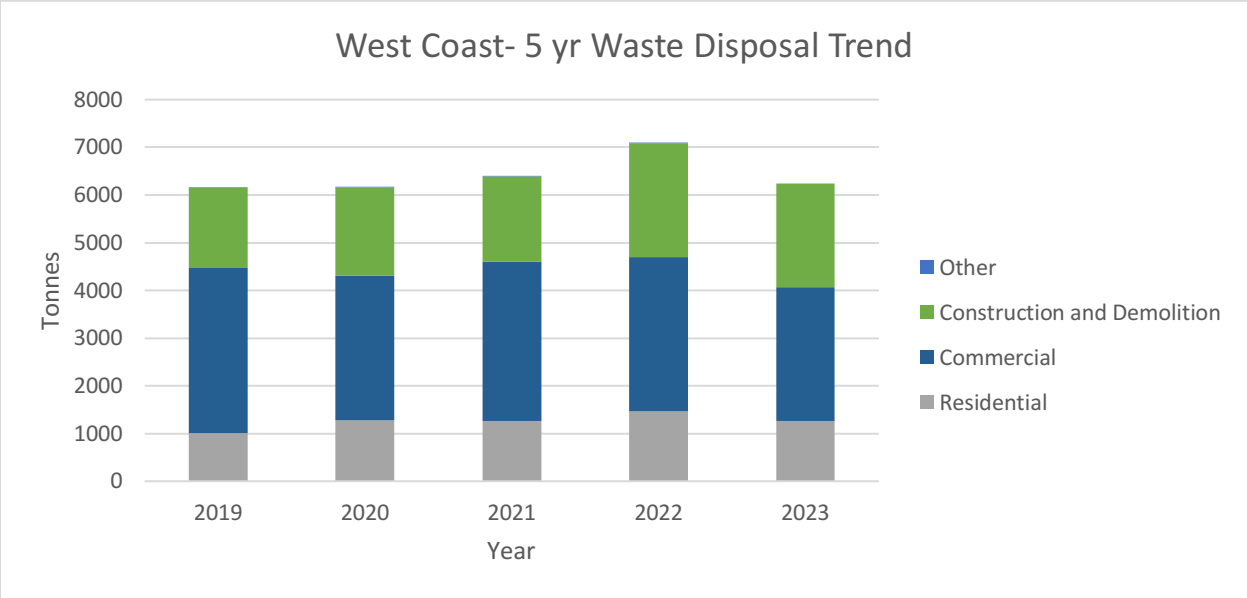
Table 1 - Waste disposed in 2023

Waste Breakdown	Tonnes	Percentage
Residential Garbage	1,262	20%
Commercial Garbage	2,803	45%
Construction and Demolition	2,174	35%
Other Garbage	0	0%
TOTAL	**6,240**	100%

The largest source of solid waste disposed on the West Coast from a single sector is commercial waste. This sector includes resorts, hotels, restaurants, retail and other businesses; making up 45% of all waste that is landfilled. The residential sector produces 20% of the waste and includes materials collected at the curbside and materials self-hauled by residents to the landfill. Construction and demolition (C&D) waste makes up a relatively large portion of the waste stream at 35% (higher than the Alberni Valley Sort'nGo Centre rate of 24%). It includes roofing, drywall, and wood materials. A year over year comparison of waste processed through the WCL over a five-year period is presented in Chart 1 below. The key trends are:

- The total waste tonnage accepted in 2023 was back down to the tonnage received five years ago.
- The quantity of residential waste disposed has decreased slightly from the 2022 level.
- Commercial waste tonnages have reduced slightly compared to five years ago.
- C&D Waste tonnage has decreased since last year.

Chart 1 – 5 Year Waste Disposal Trend on the West Coast



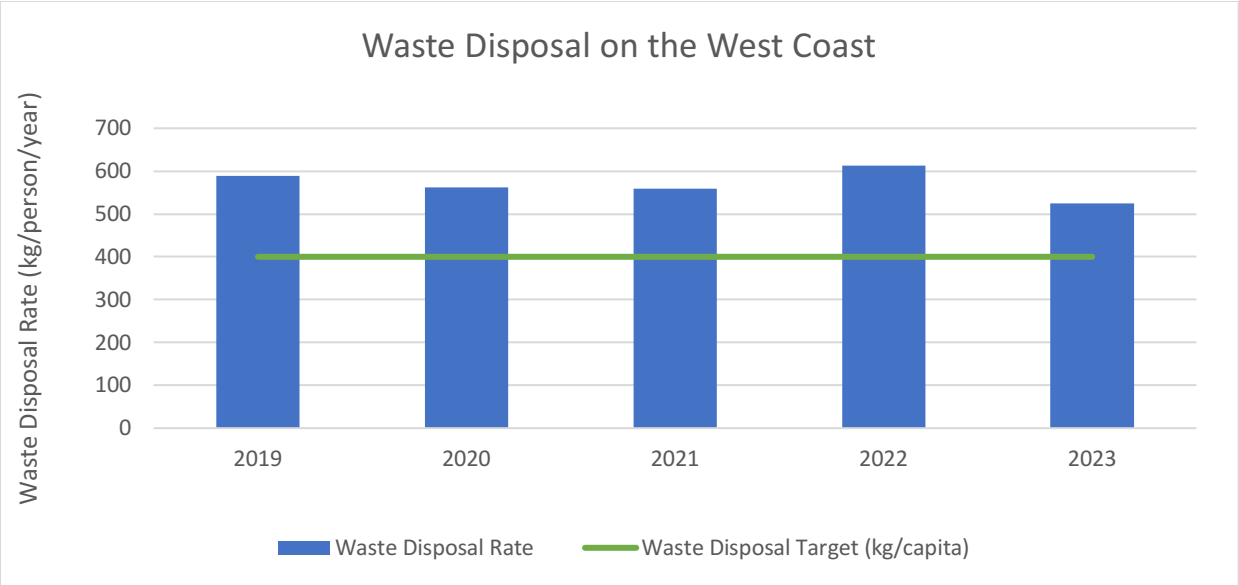
The estimated permanent population served by the landfill was 7,250[1] in 2023. However, the West Coast has a significantly higher equivalent population due to the strong tourism sector. Equivalent population estimates put the total population to be 40% higher. With an average 3% increase in permanent population over the last five years[2], the revised equivalent population was 11,894 in 2023. This results in a disposal rate of 525 kg/capita per year which is markedly less than 2022 (613 kg/capita). This is a significant reduction and the lowest generation rate in years. However, it is still well in excess of the target of 400 kg/capital as shown in Chart 2.

There was an external factor that affected waste generation in 2023. Highway links to the west coast were severely disrupted in the summer of 2023 resulting from the Cameron Bluffs fire and subsequent stabilization works on Highway 4 to the east of Port Alberni. Ground transportation was greatly impacted for most of the summer months causing the hospitality industry to be greatly curtailed. Visitor numbers were reduced and there was less economic activity from June to September.

Target–1 - Reduce waste disposal to less than 400 kg/capita

[1] BC Population Statistics 2022, factoring 3% population increase.
[2] BC Population Statistics, Districts of Tofino & Ucluelet.

Chart 2- Waste Disposal 2023



Several projects are planned or have been implemented to assist in the goal of reducing per capita waste disposal, including:

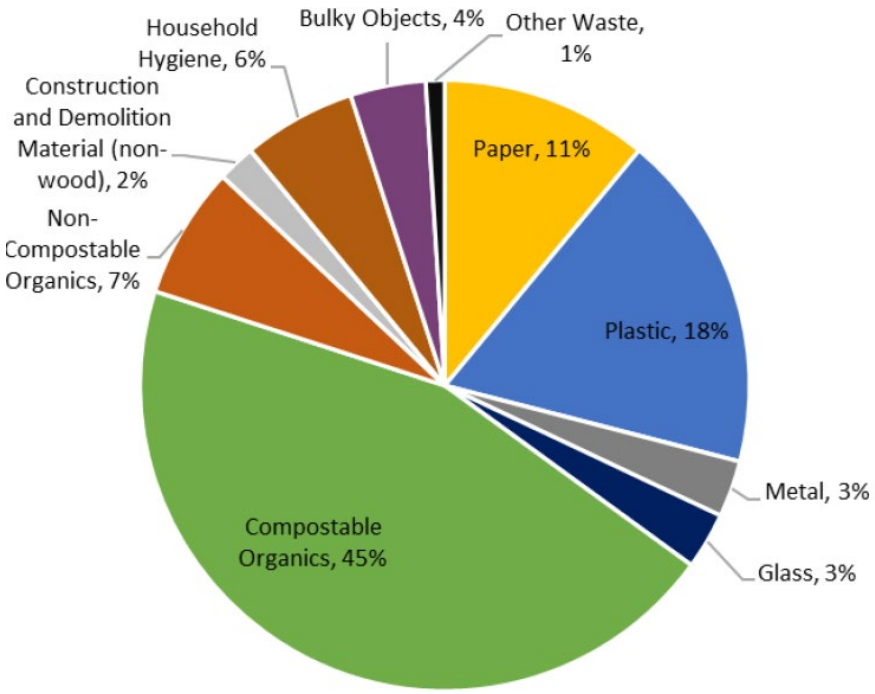
- The rollout of 3-stream curbside collection to over 1800 homes in December 2022;
- The recent installation of a new organics processing facility commissioned in Spring 2023;
- A waste composition audit in 2023; and
- The update of the Solid Waste Management Plan that will investigate other options for waste management, such as Construction and Demolition waste diversion.

These projects are described later in this report.

Waste Composition Audits

In 2023, the ACRD completed a Waste Composition Study to determine the make-up of materials in the "garbage" streams for curbside residential, self-haul and commercial waste. Charts 2 & 3 illustrate the weighted average material composition for commercial and residential curbside garbage with compostable organics as the single biggest contributor to landfill waste at the time of the study in 2023.

Chart 2 - WCL Commercial Waste Composition 2023



ICI waste composition for materials taken to West Coast Landfill. ICI waste was primarily composed of compostable organics (45%), plastic (18%), paper (11%), and non-compostable organics (7%). These four primary categories represent 81% of the materials.

Chart 3 - WCL Residential Curbside Waste Composition 2023

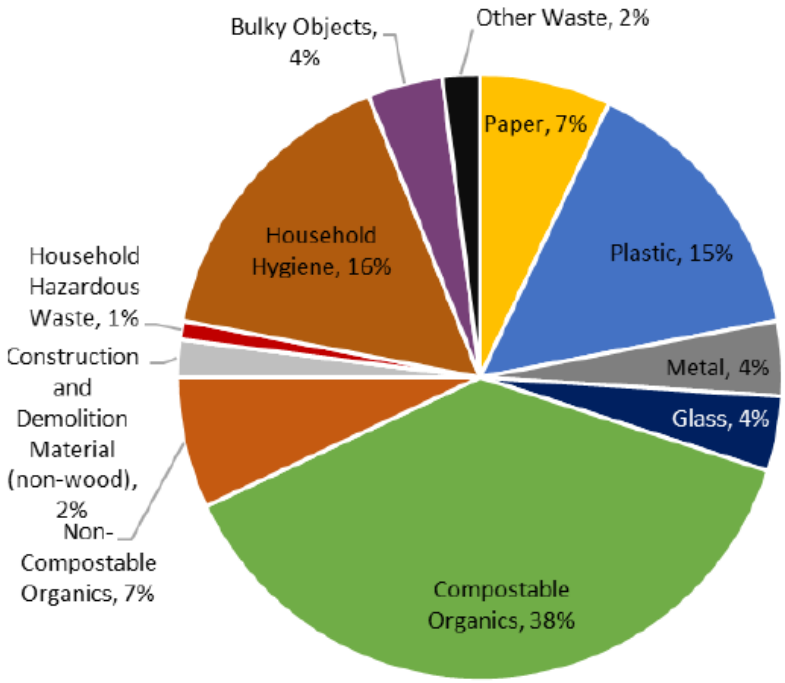
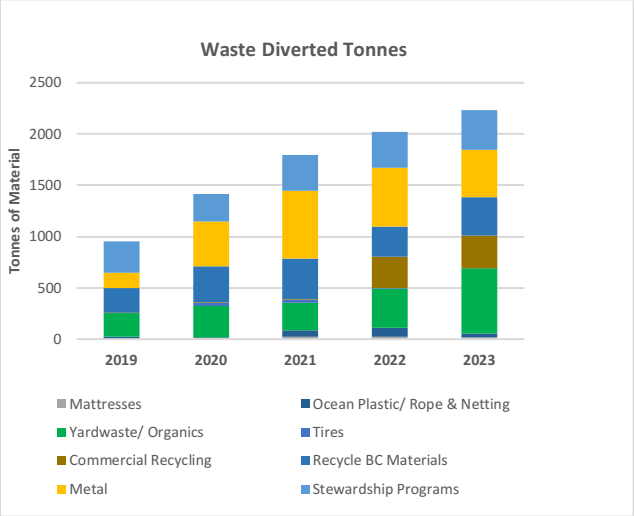


Chart 3 represents the average Single Family waste composition for materials delivered to the West Coast Landfill. SF waste was primarily composed of compostable organics (38%), household hygiene (16%), plastic (15%), paper (7%), and non-compostable organics (7%). These five primary categories represent 83% of the materials.

Diverted

In 2023 good progress was made in improving the collection of data on waste diverted from disposal. This progress was made largely outside of the EPR programs. The quantity of materials diverted from landfilling in 2023 was 2,234 tonnes, of which 1,171 tonnes was collected directly at the landfill. The diversion rate is influenced by both the quantities of materials collected through recycling programs and the amount of waste going to landfill, as shown in Chart 5, below. The diversion rate has improved both by way of the reduced tonnage of waste accepted for landfill and the increased tonnages of materials recovered.

Charts 5A & B- Annual Waste Diversion Rates 2023



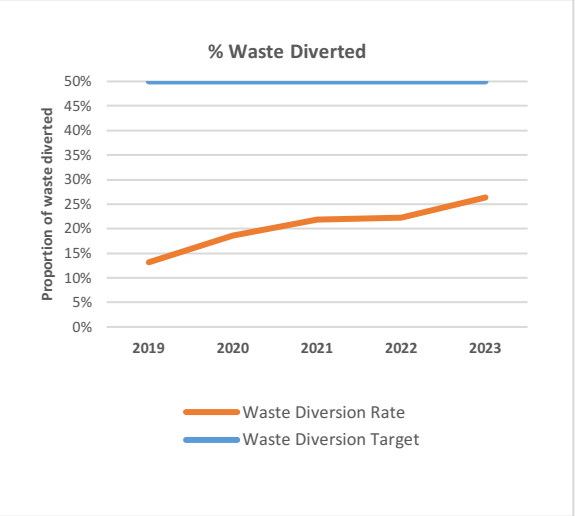


Table 1 – 5 Years By the Numbers

Population	9897	10099	10323	10647	10966	11445	11548	11894	
Population growth		2.0%	2.2%	3.1%	3.0%	4.4%	0.9%	3.0%	
Waste	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	Prop in 2023
Residential	1031.48	1049.84	912.52	1003.10	1276.98	1268.40	1464.66	1262.36	20%
Commercial	3284.38	3424.26	3568.26	3462.80	3029.61	3333.24	3229.14	2803.38	45%
Other	168.21	77.67	84.71	136.26	0.00	0.00	0.00	0.00	0%
Construction and Demolition	1530.95	1917.11	1468.16	1675.63	1860.67	1793.26	2388.30	2174.27	35%
Total	**6015.011**	**6468.88**	**6033.647**	**6277.79**	**6167.26**	**6394.9**	**7082.1**	**6240.01**	100%
Diversion	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	Prop in 2023
Mattresses	0.00	0.00	0.00	0.00	10.30	25.23	21.54	18.84	1%
Ocean Plastic/ Rope and Netting	0.00	0.00	0.00	26.68	6.10	61.13	86.89	34.12	2%
Yardwaste/ Organics	204.08	295.57	216.45	227.57	307.43	269.31	383.29	635.98	28%
Tires	0.00	0.00	0.00	3.69	32.62	27.17	3.55	0.00	0%
Drywall	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0%
Commercial Recycling	0.00	0.00	0.00	0.36	4.12	6.04	307.92	322.00	14%
Recycle BC Materials	133.96	189.24	221.39	240.33	352.01	397.37	296.49	371.02	17%
Metal	105.97	79.91	149.53	148.94	432.86	660.71	569.29	466.69	21%
Stewardship Programs	307.85	300.49	303.57	304.35	268.62	347.87	354.26	386.13	17%
Total	**751.86**	**865.21**	**890.94**	**951.92**	**1414.06**	**1794.83**	**2023.23**	**2234.78**	100%
Waste Disposal Rate (kg/capita)	607.76	640.55	584.49	589.63	562.38	558.75	613.28	524.64	
Waste Diversion Rate	11%	12%	13%	13.2%	18.7%	21.9%	22.2%	26.4%	
Waste Diversion Target	50%	50%	50%	50%	50%	50%	50%	50%	
Waste Diversion Target (kg/capita)	400	400	400	400	400	400	400	400	

Key takeaways include:

- Metal recycling remains high since 2019, though tonnage dropped from 2022-2023.
- There was an increase in the Recycle BC material tonnages diverted in 2023.
- There was a slight improvement overall in stewardship tonnages diverted from landfill.
- A new category of commercial recycling was noted, due to data not previously available from private haulers. ACRD staff have established connection with local haulers to track this data starting with this annual report.
- An increase in organics waste being diverted, covered in the next section.

West Coast Sort'nGo - 3-Stream Curbside Collection and Organics

In 2022, the ACRD launched the Sort'nGo program on the West Coast, targeting organics diversion. This initiative, which originated in the Alberni Valley, aimed to add organics collection to residential curbside programs and expand processing capacity at the West Coast landfill. Funding of $6 million from the Federal Strategic Priorities Gas Tax Fund supported landfill upgrades and organics processing, along with Phase 2 implementation of the regional organics project.

A Sort'nGo working group, including stakeholders from various organizations, collaborated during the planning stages. Post-implementation activities involved monitoring contamination through operator feedback and communicated to the public through social media and local news outlets to support ongoing education and improvement efforts.

Ozzard Environmental manages curbside recycling collection, transitioning to automated trucks for organics, recycling, and garbage cart collection. Benefits of automation include standardized carts, enhanced waste diversion, reduced litter, and improved community aesthetics. Each truck is equipped with AI technology to identify and monitor contamination and address missed collections, with staff undergoing training to maximize its use.

Cart sizes were determined based on waste audits, with options offered to accommodate different needs. Residents were engaged in selecting cart sizes, and requests for larger garbage carts are being honored while inventory lasts. Ongoing engagement and technological advancements are integral to the success of the Sort'nGo program, ensuring efficient waste management and community satisfaction.

This new program achieved many successes, including:

- Onboarding 1,870 homes with new carts (and counting);
- Working with language specialists in Yuułuʔiłʔatḥ (UFN) and Tla-o-qui-aht (TLFN) First Nations to develop new outreach material with traditional language terms for waste diversion;
- Diversion of 636 tonnes of organics.
    - 312 tonnes of which came from curbside collections

See Charts 6 and 7 below, which show preliminary data for 2023.

Chart 6 –3-Stream Curbside Collection 2023 (by Tonnes)

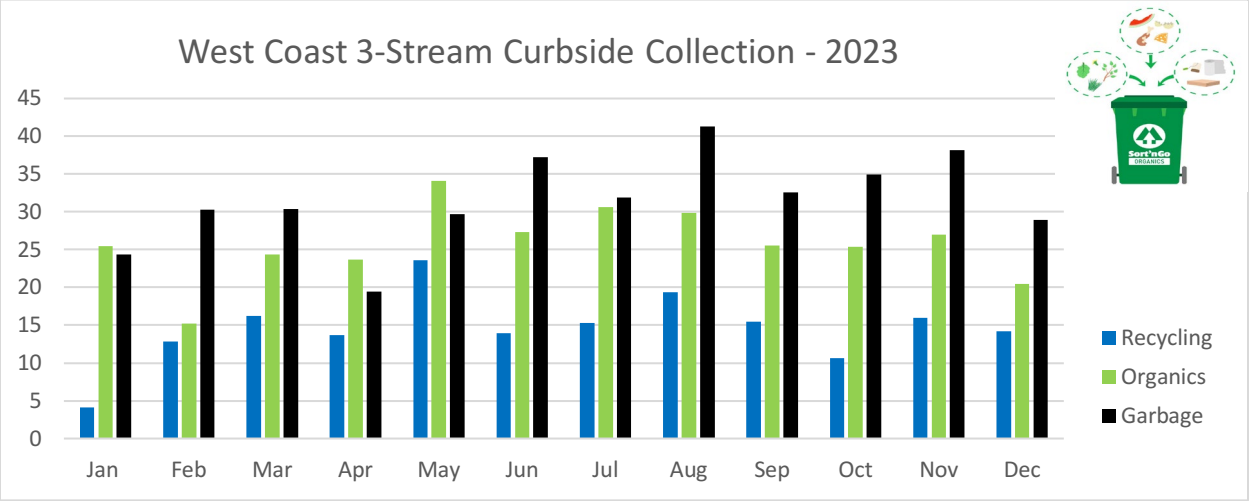
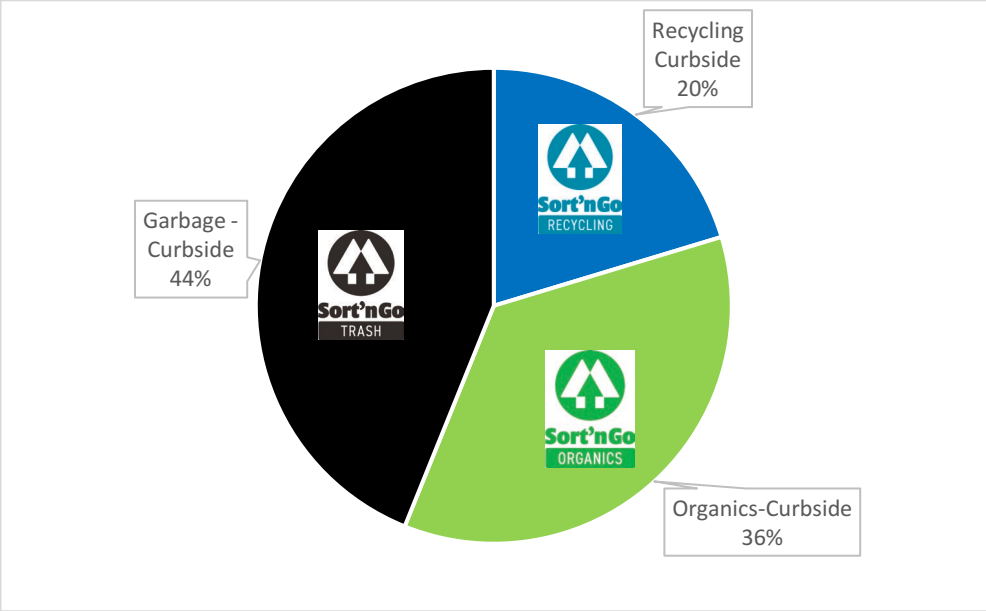


Chart 7 –3-Stream Curbside Collection 2023 (% by Mass)



Other expanded waste diversion programs also contributed to the increased diversion trends including the recycling of ocean plastic debris, begun in 2021. This program continued in 2023 through partnerships between the ACRD and the Ocean Legacy Foundation as well as the ACRD and Surfrider Foundation. Surfrider spearheads ocean debris collection from coastline clean up events, feeding rope, netting and ocean plastics debris through the WCL for diversion to Ocean Legacy. From there, Ocean Legacy take diverted material and recycle it into feedstock for new products such as signboards. As a result of these efforts:

- 34 tonnes of ocean plastics and rope and netting were collected in 2023, compared to 87 tonnes in 2022.

Mattress recycling, begun in mid-2021 in partnership with Recycle Matters, saw another 19 tonnes of mattresses diverted from landfilling in 2023, compared to 22 tonnes the previous year. This diversion

is important not only for environmental reasons, but mattresses are also difficult to manage in landfill disposal. To date, nearly 2,534 mattresses have been diverted from landfilling, an important success in a region in with a strong hospitality industry.

Bicycles are also diverted for reuse. A dedicated storage shed is provided so that bikes may be reused whole or in part. The tonnages are small, but it is an important statement that they may be reused and are not disposable items.

The ACRD contracted the WCL waste reduction education services to Surfrider Pacific Rim Chapter which is present in both Tofino and Ucluelet. The waste reduction education program run by Surfrider has three main thrusts:

1. eliminating single-use and unnecessary plastics;
2. materializing a localized circular economy; and
3. engaging youth, businesses, the public and all levels of government in ocean-friendly initiatives.

These additional diversion efforts have resulted in a diversion rate of approximately 26%, which is up significantly from 2022 at 21%. However, this diversion rate is still low compared to the target set in the solid waste management plan of 50% and now reflects at least some commercial recycling data that was not previously available. Staff continue to investigate additional diversion options and monitor the organics program dating from late 2022 for possible improvements to help towards this goal.

Target 2 - Increase Diversion of Waste to 50%

The largest diversion opportunities on the West Coast are capturing commercial organics, increasing residential organics diversion and improving commercial recycling. Other opportunities for additional diversion streams on the west coast could include construction and demolition waste - residual drywall wood, gypsum and other building materials.

Landfill Capacity

Airspace Utilization

In 2023 the WCL consumed 9,757 m^3 of airspace. This value is based on the annual topographical survey completed at year end. With a total tonnage disposed of 6,240 tonnes, the airspace consumption ratio is 640 kg/m^3, which is much lower than in 2022. Although this is down from the higher density achieved in 2022 it remains above the five-year average of 560 kg/m^3. It is unclear whether there is a discrepancy in the survey data or filling work on the crest could have affected this calculation and as such, will be reassessed in 2024 and during the survey that will occur at the end of 2023.

Target 3 – Minimum Airspace Consumption Ratio of 600 kg/m3

The use of cover soils is a necessary and important part of safe landfill operations, but it consumes airspace within the landfill footprint. The volume of cover material used in 2023 was estimated at 2,376 m^3 which is a slight reduction over that of 2022 (2,662 m^3).

Remaining Life

Based on the airspace consumed in 2023, there is an estimated 680,626 m^3 of airspace remaining at the WCL. Based on the current population growth rate of 3%, waste generation of 525 kg/capita and airspace consumption ratio of 631 kg/m^3, the landfill will reach capacity near 2062. However, if the target for reducing waste disposal to 400 kg/person is met and minimum airspace consumption ratios continues to be met or exceeded, the landfill lifespan has the potential to extend to approximately 2070 and beyond.

Operations

Variations from DOCP

The last Design, Operations and Closure Plan (DOCP) was completed in 2012 by McGill and Associates Engineering and requires an update.

Exceptions from the 2012 plan include overflow (“decant”) events from the leachate holding lagoon. The current system was designed to capture the leachate generated on site. That leachate is then applied to an irrigation field. In 2015 Solinst Leveloggers were installed in the overflow pipes from the leachate lagoon to record overflow events. In 2023 there were seven decant events as detailed in the Environmental Monitoring completed by Piteau and Associates. By comparison, there were 16 events in 2022. These overflow incidents consistently happened during winter months following winter storms. However, in 2023, it's noteworthy that the bulk of precipitation occurred during, rather than preceding, each event. The pumping system has not had sufficient capacity to discharge the lagoon to accommodate the inflow of leachate coupled with extreme amounts of surface run-off that are experienced across the site and especially in the irrigation area.

Surface water discharged at the time of the decant events is to be sampled and analyzed as part of the environmental monitoring program, as soon as safely possible. Improved procedures are to be in place for managing the leachate pond and monitoring events for later in 2024.

Conformance to SWMP

The existing Solid Waste Management Plan (SWMP) (2008[3]), listed several initiatives to meet the first two targets in the report;

1) reduce per capita waste generation to 400 kg/person; and
2) increase diversion to 50%.

Most of these initiatives have been implemented, including the adoption of curbside organics diversion in late 2022. In addition, the West Coast Organics Processing Facility is now able to accept commercial material to increase organics diversion for the commercial sector. This is an important step and was especially welcomed by the hospitality sector. Options for remote communities are being considered however this initiative is still outstanding.

The ACRD initiated the process to begin SWMP renewal in 2023 to review and update the strategies, goals and targets to set a new direction for 2024/25 and beyond (see projects section of this report).

Compliance Resolutions

The ACRD received an inspection on March 16, 2022. The WCL was shown to comply with the Hazardous Waste Regulation but later received an advisory notice for 3 items:

- Registration with the Organic Matter Recycling Regulation (OMRR) for the time of the inspection. While minor, the MOECCS noted that small volume composting operations are required to have a registration on file, though these operations will not trigger a permit due to their relatively small size. A registration was submitted to capture the new organics facility and response was received from the MOECCS in August, 2022. A new operations plan was submitted as per the regulation however, that plan is to be updated in 2024 to reflect changing and improved operations at the site.
- Use of previously accepted soils that do not meet the Contaminated Sites Regulation standards for Industrial Land Use as interim cover materials. These soils were legitimately accepted but the requirements for their reuse as cover in the landfill had changed before they had been reused. This will be addressed during the update of the operating permit, slated to begin in 2024.
- Instances of leachate at the property boundary not meeting British Columbia Approved Water Quality Guidelines and Working Water Quality Guidelines. Continued monitoring of leachate lagoon overflow (decant) events including acute toxicity to fish will be completed as recommended in the 2022 Annual Environmental Monitoring Report. Design for an upgraded leachate treatment system will be completed in 2025/2026 with construction to follow, pending securing funding.
- Documentation for leachate overflow piping not captured in MOECCS records including the WCL Operational Certificate No. 5634. Staff is working to establish a timeline and expectations for updating documentation and infrastructure upgrades. The Operational Certificate is expected to be amended if required following completion of the DOCP update in 2024/2025.

[3] Reviewed in 2014 and 2017.

Public Feedback on Landfill Operations

The ACRD received no documented community complaints regarding the operation of the landfill in 2023. It is beneficial that the landfill is located a significant distance from any residential communities, though staff engage with Parks Canada as the immediate neighbour to the landfill site. Typical complaints associated with other landfills are often due to odor and noise, but these are not an issue at the WCL. A formal feedback tracking system was created in 2021 with an enhanced program launched in 2022 to encourage more customer input, via feedback@acrd.bc.ca. This information was distributed at the ACRD's local waste disposal sites as well as the Tseshaht and Hupačasath First Nations offices. While initially utilized by the public and still advertised, the feedback email address saw no activity in 2023.

Inspections

There were no formal inspections by the MOECCS in 2023. Internally, the Solid Waste team conducted regular site visits in 2023. This is done primarily for capital planning as well as oversight inspections to ensure compliance with the contract, operations certificate and ministry requirements. These internal site visits are conducted at least monthly.

Finances

Operating Expenses

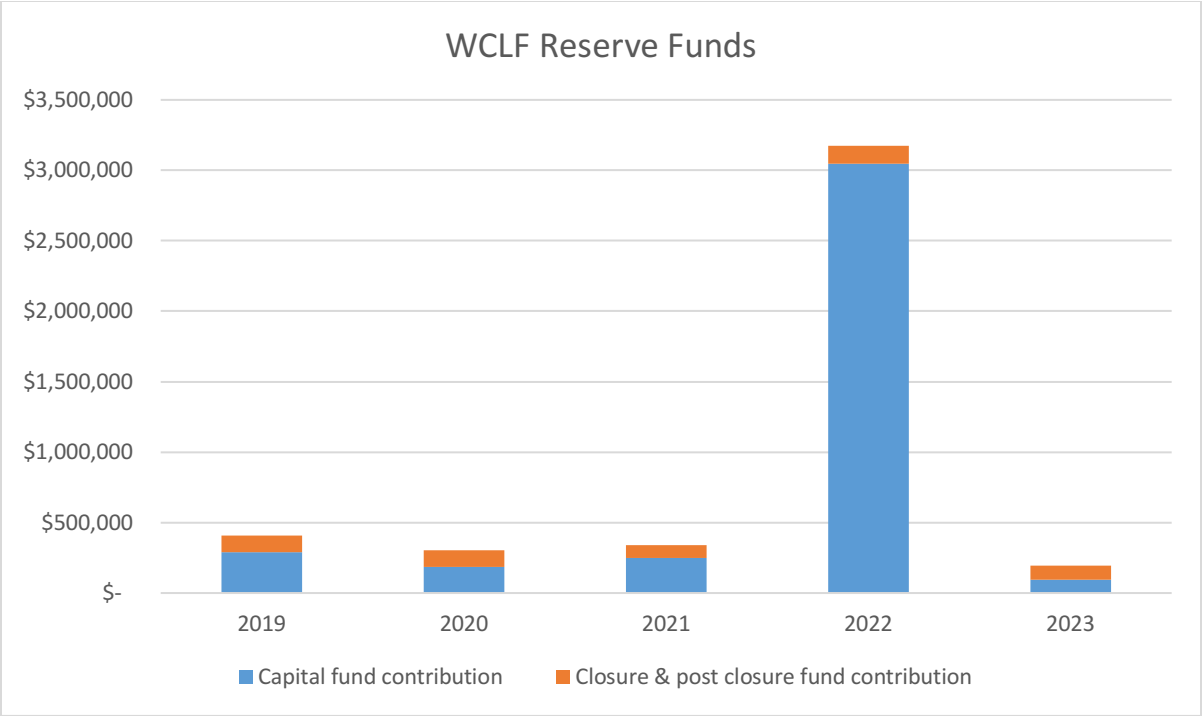
In 2023, the operating expenses for the WCL (inclusive of the composting facility) were:

Table 3 - Operating Expenses	2023
Landfill Operating Costs	$757,763
Admin & Education Costs	$168,004
Recycling	$615,746
Total Costs	$1,541,513
Recoveries	$628,130
Net Cost	$913,383
Reserve Funds Allocation	$196,756

Capital and Closure Funding

Regarding the closure/post-closure fund, the 2012 West Coast Landfill Design, Operations and Closure Plan (DOCP) identified the need for a fund of $5,600,000 for closure and post-closure activities. There was $1,388,393 in the closure and post closure reserve fund at the end of 2023. Contributions to this fund have exceeded the recommended minimum contribution of $70,000 in each of the past four years. The capital fund (Chart 8) shows a significant decrease from 2022-2023 to reflect a capital contribution for the construction for the first phase of the West Coast Organics Facility. This temporary jump in the capital fund reflects the transfer of $3 million dollars from the Federal Strategic Priorities Gas Tax Fund (referenced earlier in this report), to complete the Organics Facility and rollout the 3-stream program.

Chart 8 - Reserve Fund Annual Contributions



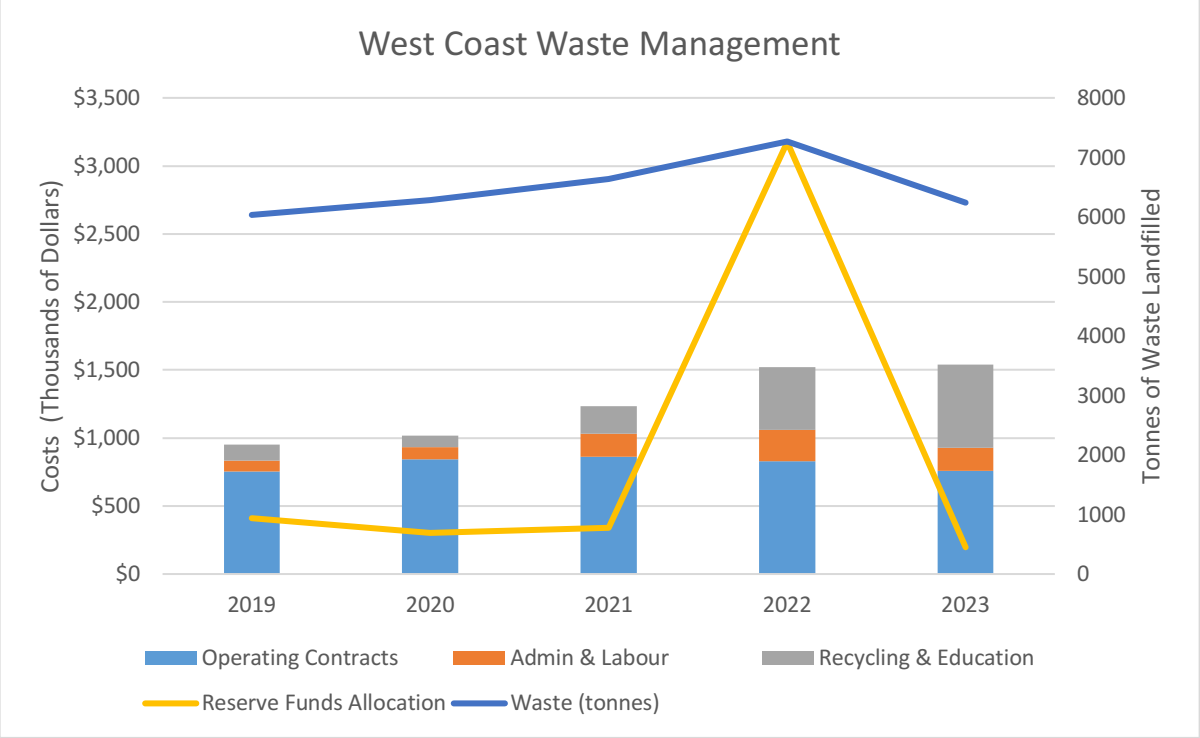
Target 4 – Annual Capital Contributions meet Funding Requirements

The 2012 DOCP assumed an estimated lifespan of 50 years and the potential to extend to 75-80 years with improved diversion and operation, the annual contribution should be between $65,000 to $115,000 per year. With the rollout of organics diversion being completed, the DOCP will need to be updated (see projects section). When the DOCP is updated, it will include a review of capital requirements and closure costs to provide an updated estimate of reserve fund requirements. Until the DOCP is finalized, the contribution to closure/post closure will be kept at least $90,000 to continue building reserves.

Operational Efficiency

Chart 9 below drills down further into the total operating costs including contracts, administration, and support to manage solid waste on the west coast. It covers operation of the WCL, the curbside collection program and education programs. The costs are influenced by inflation and directly influenced by the volume of material landfilled and diverted.

Chart 9 - Annual Costs and Tonnages



Reserve funds reduced by $2.9 million which reflects the previous year's contributions from the grant funding to complete the Organics Facility (phase 1) and roll-out of 3-Stream curbside collection. Additionally, cost increases for administration and waste education were also linked to those efforts. Finally, inflation from operating/recycling/education contracts and improving landfill operations to meet regulatory criteria have also contributed to increasing costs. Collectively these efforts have resulted in improved diversion of materials from the waste stream.

Environmental Monitoring

Leachate Monitoring

Leachate is generated when rain falls on the waste mound and comes in contact with the buried waste. The leachate is contained within the waste mound because of the low hydraulic conductivity of the marine clay foundation soils. The leachate is collected by ditches located at the perimeter of the waste mound. These ditches collect leachate that seeps from the edges of the landfill and transport it to a lagoon located on the southwest side of the property. The contents of the lagoon are pumped to the north of the landfill to a spray irrigation field. This field is designed to allow the leachate contaminants to attenuate prior to entering the eventual receiving waters of Sandhill Creek.

Since the marine clay sediments that make up the foundation are of such low hydraulic conductivity, environmental monitoring is focused on surface water and leachate. The ACRD monitors multiple sites in the leachate collection and irrigation field as well as background locations. The samples were analyzed by an independent laboratory for metals, VOCs, inorganic compounds, pH levels, conductivity, and other water quality parameters from the FWAL (Fresh-Water Aquatic Life) protection criteria. All monitoring data is directly reported to our environmental consultants, Piteau Associates Consulting, for

their review and reporting to MOECCS. The Piteau report (2023 Monitoring Report West Coast Landfill) accompanies this report.

Leachate Pond Overflow Monitoring

The west coast of Vancouver Island receives some of the largest recorded annual rainfall in Canada. Much of this precipitation occurs during winter storms. The leachate pond is subject to overflowing (decant events) during, and immediately following, these intense winter storm events. When this occurs, the lagoon decants to the north through pipes installed for that purpose but bypassing the irrigation field. Information from dataloggers that are downloaded twice per year record the number of overflow events and the duration. Seven overflow events from the leachate storage lagoon were recorded at WCL in 2023 following periods of intense 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. A future design project is planned for the proposed enhanced leachate management system and will build upon the previously executed feasibility study.

Overview of the Monitoring Program

Target 5 – All water leaving the site meets the FWAL criteria

Detailed analysis of monitoring data (provided in the 2023 Monitoring Report West Coast Landfill, Piteau and Associates) concludes “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.”. However, there are no long-term increasing trends apparent that would suggest the effects of the landfill are increasing over time. This means that the target for having all water leaving the site meet the FWAL criteria was not met, but the water quality still remains in inline with background water quality. The report recommends continuing the environmental monitoring program with the following commitments:

1. To keep the leachate lagoon at as low level as possible during the winter months
2. Decant event sampling to be conducted near the mid-point of the event with one set of samples completed for each week within an event.
3. Temporary installation of a cumulative flowmeter on the leachate irrigation systems, as well as surveys of the culvert inlets, and continued records of leachate storage lagoon levels

These recommendations have been adopted, with the proviso that the leachate area is safe to access for sampling purposes.

Piteau also recommends partial capping of the landfill to reduce leachate quantity, the frequency of overflow events and impacts to the receiving waters. The landfill design does not lend itself to installing final cover at this time. However, partial temporary cover is to be considered during the update of the DOCP.

The design objective of the new leachate treatment project is that all water leaving the site meet the FWAL criteria. The recommendations of the monitoring report regarding flow gauging will be reviewed jointly with the project design team. The outcome of those discussions will be

incorporated into the project which is being designed to ensure that this target will be met once the new system is commissioned. Monitoring of leachate volumes sent to the spray irrigation system will begin in 2024.

Until a new leachate treatment system is commissioned, staff are working with consultants to develop assess, plan, and implement operational and infrastructure changes to improve performance of the leachate management system. Additional monitoring and sampling will be completed per the recommendations of the 2023 Annual Environmental Monitoring Report to assist in the design of the new leachate treatment system.

Landfill Gas Monitoring

Target 6 - Landfill Gas Generation Less than 1,000 tonnes/year of methane

A supplementary gas report was completed in 2023 as per Section 15 of the Landfill Gas Management Regulation. Using the required provincial model, the report estimated that the WCL produced 393 tonnes of methane in 2023. In the absence of the actual landfill composition data, this report used the average rural waste characterization data in the Landfill Gas Assessment Tool to calculate these volumes. This methane is generated by the waste in place. However, the diversion of current and future organic wastes from landfill will reduce emissions over time.

Other Greenhouse Gas Emissions

Landfilling operations require the use of motorized equipment including small machinery such as power washers, small utility vehicles (ATVs), and pickup trucks, as well as heavy duty machinery such as compactors, graders, and excavators. The fuel used for this equipment is primarily diesel. In 2023, the contractor burned approximately 14,617 liters of diesel in the operation of the landfill which produced the equivalent of 39.2 metric tonnes of CO_2.

Illegal Dumping

The west coast experiences illegal dumping. Many different types of wastes are involved including yard waste, such as leaves and branches, as well as household wastes, abandoned RV's and cars. These items are often found on logging roads surrounding the communities. In 2022 the WCL received 22.4 tonnes of illegally dumped wastes that were suitable for landfill disposal. These wastes had all been collected at community clean-up events. Community clean-up programs will continue to be supported with financial support from the ACRD and other community sponsors.

Projects Undertaken In 2023

Landfill Upgrades/Organics Composting Facility – Phase 1

Phase 1 of the new facility was completed and commissioned in 2023 in alignment with Ministry Regulations. Organics is now being collected and processed at the Facility. The transfer station/tipping area has also been opened to the public and is now in use.

With facility upgrades wrapping up in Spring 2023, staff worked with the landfill operator to transfer operations from the old tipping wall to the new transfer station area. Additionally, commissioning and testing of the new organics facility took place early in 2023. A phased approach to receiving and processing organics was followed to include residential curbside sources and by commercial sources later in the year.

Waste Reduction Education Program

In 2023, waste education aimed at the waste prevention hierarchy and was generally carried out through contractors and partnerships on the West Coast using different approaches and strategies. Focus was on public engagement through presentations and community booths, along with building online interaction through the application of social media and other tools .

Landfill Environmental Monitoring Improvements

Piteau and ACRD field staff continued to work together to sample surface water in various locations around the landfill.

Rope and Netting Project

This is a continuation of a 5-year pilot project with Ocean Legacy to sort and ship out rope and netting for recycling. This project is intended to establish an effective diversion system for these materials that can be used as a template for other coastal landfills in BC. 25.68 tonnes of Rope & Netting and 8.44 tonnes of Ocean Plastics have been collected by Ocean Legacy and utilized as plastic feedstock for manufacturing signboards.

Update of Solid Waste Management Plan Phase-1

The first step of the Solid Waste Management Plan (SWMP) was completed in 2023 with the establishment of the SWMP Advisory Committee (the Committee),which is made up of public and technical members representing the various ACRD services areas including First Nations, to ensure important perspectives and priorities are represented. Four Advisory Committee meetings took place in 2023 that were facilitated in different locations around the ACRD. They were held as a means for the Committee to gain perspective on the current operations including challenges and opportunities of existing waste management services will be incorporated into the updated SWMP.

Step 1 also included the first phase of public engagement, where a survey was launched that provide residents an opportunity to provide feedback on current solid waste disposal and diversion practices, waste management services and future priorities.

An information portal was also established at letsconnectacrd.ca/SWMP that will continue to be updated with SWMP project related information and progress including the Solid Waste Overview technical memo, the Phase 1 Engagement summary, Advisory Committee Meeting summaries and other resources.

Waste Composition Study

The study looked at waste from the entire region, separating it into the two major waste sheds within the ACRD, namely the West Coast and the Alberni Valley. Each waste shed was further separated by commercial (ICI), residential curbside from single-family homes (SF) and self-hauled waste (SH). The composition is further broken down into multiple materials that are generally grouped as:

- Recycling (from curbside or drop-off)
- Compostable (organics from curbside or drop-off)
- Product stewardship (divertible materials under extended producer responsibility (EPR) programs)
- Reuse (divertible materials such as textiles and furniture)
- Garbage

Tipping Fee Review

Staff conducted a rate review of tipping fees vs costs of management of waste materials which resulted in a tipping fee increase for most materials, this was established in our Tipping Fee Bylaw.

Landfill Gas Supplementary Report

The landfill gas supplementary report was completed in 2023, as referenced earlier in this report.

Projects Upcoming

Organics Composting Facility (2024)

In 2024 additional cover buildings will be installed to protect the compost from weather and improve the curing process. Additional work will include prepping the site for the sale of Class A Compost to the public in the Fall.

Waste Educator Onboarding (2024)

The ACRD has hired a waste education group, Let's Talk Trash, to support in-region waste education efforts and train community champions to expand our outreach presence.

Update of Solid Waste Management Plan-Step 2-4 (2024)

Progress on updating of the SWMP across the Regional District has been good and the work will continue in 2024. There will be further Advisory Committee meetings and significant SWMP development followed by phase 2 of public engagement tentatively scheduled for fall 2024 . The finalized SWMP is expected to be available in 2025 and will be submitted to the Ministry upon completion.

Landfill Contract Renewal (2024)

The operating contract for Berry and Vale Contracting will end on June 30, 2024. Through public procurement, Berry & Vale successfully bid on and was awarded a new 5-year contract to operate the landfill, from July 1, 2024 until June 30, 2029, with an option to renew.

Installation of Flow Monitoring (2024)

As referenced in the Environmental Monitoring section, until future upgrade of the leachate treatment facility can be completed, staff are working with ACRD's environmental consultant to determine the best interim method of monitoring flow of the leachate discharge. As recommended a flow meter will be installed on the discharge pipe for the leachate system.

3-Phase Power Upgrade (2024)

With the installation of landfill upgrades, the compost facility, as well as a new cell tower, the landfill site requires power upgrades. Staff will be working with Parks Canada, BC Hydro and other entities to install 3-phase infrastructure along Alaska Pine Rd. The goal is to ensure sufficient power to support all current and future anticipated infrastructure upgrades to the site.

Operational Certificate Update (2024-2025)

As referenced earlier in the report, there have been multiple changes to the infrastructure on site as well as identified non-compliance advisories, which will be addressed through an amendment of the site operating permit. This process is expected to take 2 years based on procurement needs and Ministry timelines.

Organics Ban (Future Initiative)

With the success of the Organics diversion program in 2023, the next step is to move forward with banning organic wastes for disposal at the site. Staff is working on this and other initiatives as part of the Solid Waste Management Plan update.

Construction and Demolition Waste Diversion (Future Initiative)

As part of the Solid Waste Management Plan Update, there will be engagement with generators of this material to investigate options to divert as it makes up 30% of the waste stream on the West Coast.

Design Operation and Closure Plan Update (Future Initiative)

The current DOCP was created in 2012 and requires updating to address the leachate system operation, cover usage concerns and generally provide enhanced direction for the development of the landfill. The Province has created new landfill criteria and there are several areas identified that need to be improved to meet the new criteria. An important part of the new DOCP will look at runoff diversion with the completion of each stage of final cover as well as the addition of contact water from the Organics facility. The Water Balance Report estimates that the impact of precipitation on leachate generation will be significantly reduced when portions of the landfill are capped.

Leachate Treatment Facility (Future Initiative)

With the conceptual design complete and ongoing baseline sampling underway, the next step is to secure funding to complete the detailed design as well as capital construction of the leachate treatment facility. As capital costs are expected to be between $1.5 million and $2.6 million, there is insufficient funding available in reserves to complete the project. As such, funding is being pursued through grants as well as borrowing under the forthcoming Solid Waste Management Plan, pending approval from the Ministry.

Explore Temporary Cover Options (Future Initiative)

Options and costs for temporary cover will be assessed in cooperation with Berry and Vale and in alignment with a future Design Operation and Closure Plan Update. The goal of temporary cover would be to decrease leachate generation from portions of the site that will not be disturbed for several years. This work should be aligned with the plans for landfill development and progressive closure.

PITEAU ASSOCIATES
Geotechnical and Water Management Consultants
A TETRA TECH COMPANY

ALBERNI-CLAYOQUOT REGIONAL DISTRICT

2023 MONITORING REPORT
WEST COAST LANDFILL

Prepared for

ALBERNI-CLAYOQUOT REGIONAL DISTRICT

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Piteau Associates Engineering Ltd.
Suite 300 – 788 Copping Street
North Vancouver, BC, Canada V7M 3G6
Tel: +1.604.986.8551

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,

PITEAU ASSOCIATES ENGINEERING LTD.

Rebekah Manning, P.Eng
Intermediate Hydrogeologist

Jennifer Mancer, P.Eng.
Senior Hydrogeologist

Reviewed by:

David Tiplady, P.Eng.
Vice President – Hydrogeology

RM/JM/DT/ld
Att.

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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

DWG. NUMBER: K:\1576\Cadd\1576-047.dwg (Fig 1)

303800 E | 304000 E | 304200 E | 304400 E

5437000 N | 5436800 N | 5436600 N

PROPERTY LINE

BUFFER ZONE (15m)

WATER

DIVIDE

ABANDONED SKIDDER ROAD

CULVERT

Dry/19.3
Dry/0.014
Dry/0.008
SW-7

CREEK SURVEYED WITH COMPASS AND HIP CHAIN. FIRST 100 m CREEK MEANDERS THROUGH RELATIVELY OPEN WOODS AND IS APPROXIMATELY 1 m WIDE. THE REST OF THE CREEK IS 0.4-0.6 m WIDE AND IS COVERED WITH THICK BUSH. AT THE END THERE IS NO VISIBLE RUNNING WATER, ONLY SCATTERED PUDDLES OF WATER. LOTS OF LOGGING DEBRIS THROUGHOUT WHOLE AREA.

APPROXIMATE CREEK

Dry/43.3
Dry/10.3
Dry/0.013
SW-9

SPRAY IRRIGATION AREA

IRRIGATION LINE

Dry/43.7
Dry/8.7
Dry/0.038
SW-6

OVERLAND FLOW

Dry/48.2
Dry/10.9
Dry/0.297
SW-8

MW02-3

NOTE:
CREEK LOCATION MAPPED WITH CHAIN AND COMPASS BY McGILL & ASSOCIATES ENGINEERING LTD. IN 2001.

SURVEY CUT LINE ALONG ORIGINAL PROPERTY BOUNDARY

LEACHATE DITCH #2 AND FORCE MAIN

SW-2

ORIGINAL PROPERTY BOUNDARY

CONTAMINATED SOILS SITE

LEACHATE DITCH #1

DRAINAGE DITCH #2

DRAINAGE DITCH #1

42.7/–
0.037/–
0.024/–
SW-10US

7.16
<0.005
<0.01
SW-10BG
* SAMPLED APR 2015

CREEK CHANNEL TRAVELLED IN APR 2015

SANDHILL CREEK

SW-3

PERFORATED OVERFLOW PIPES

* SAMPLED 20 m UPSTREAM STARTING SEPTEMBER 2022

42.6/16.9
0.031/0.647
0.019/0.006
SW-10

Dry/29.4
Dry/0.116
Dry/0.033
SW-11

APPROXIMATE LOCATION OF NEW OVERFLOW CULVERT INSTALLED AUGUST 2018

Dry/74.5
Dry/1.14
Dry/18.1
SW-2

Dry/17.2
Dry/0.652
Dry/0.007
SW-1

SW-4

EXISTING TRANSFER STATION

COMPOSTING FACILITY ON CONCRETE TRAILER PAD

Dry/57.4
Dry/0.454
Dry/21
SW-4

SW-5

Dry/17.5
Dry/0.245
Dry/0.049
SW-14

SW-15

MW02-2

155/55.4
1.93/0.359
8.12/19.4
SW-3

LEACHATE STORAGE LAGOON

WEIGH SCALES

61.2/15.9
0.062/0.214
0.022/0.013
SHC (~1km SW AT 303608E, 5435670N)

SW-5

BUFFER ZONE (15m)

SW-13

43.3/–
0.005/–
–/–
PW-SS

MW02-1

SW-12
(2006-2015)

Dry/16.4
Dry/0.282
Dry/0.015
SW-12

PACIFIC RIM NATIONAL PARK RESERVE BOUNDARY

CULVERT

Dry/10.5
Dry/0.005
Dry/0.007
SHC-East Tributary (~800m S AT 304506E, 5435702N)

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:	FIG:
JM	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**	**<u>36.2</u>**		**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. <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-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. 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-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

H:\Project\1576\Chem\2023\[Tables-2023.xlsx]Table A-6

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. 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-7

WATER CHEMISTRY DATA FOR SW-7

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	-	-	**6.28**			**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			**<u>0.00124</u>**
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. <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-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. 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-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>

H:\Project\1576\Chem\2023\[Tables-2023.xlsx]Table A-10

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. 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-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. 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-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. 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.

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. 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.

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.
Italics denotes parameters which exceed CSR DW standard.
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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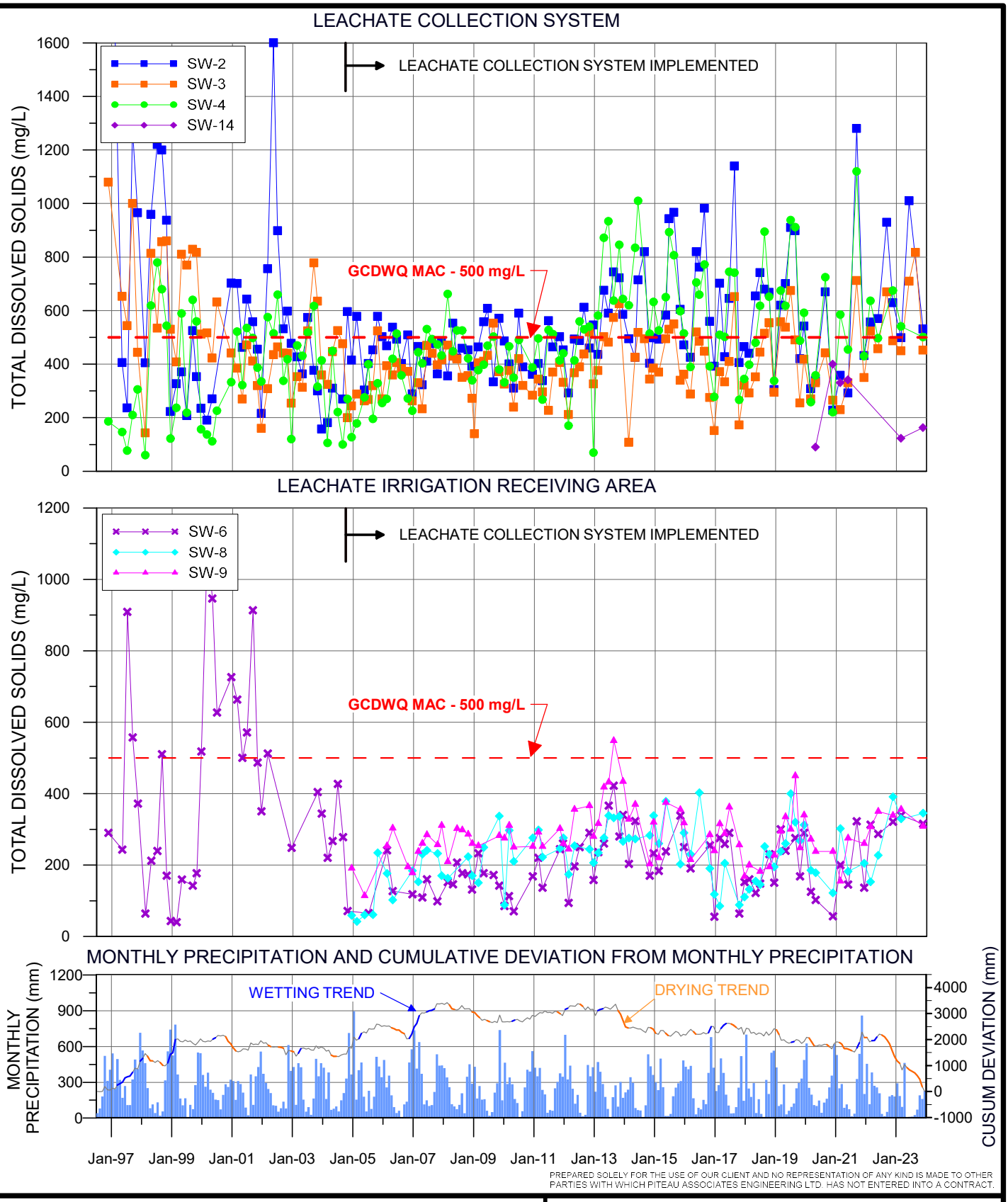

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TOTAL DISSOLVED SOLIDS CONCENTRATION TIME-SERIES PLOTS FOR LEACHATE COLLECTION SYSTEM AND LEACHATE IRRIGATION RECEIVING AREA

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

101

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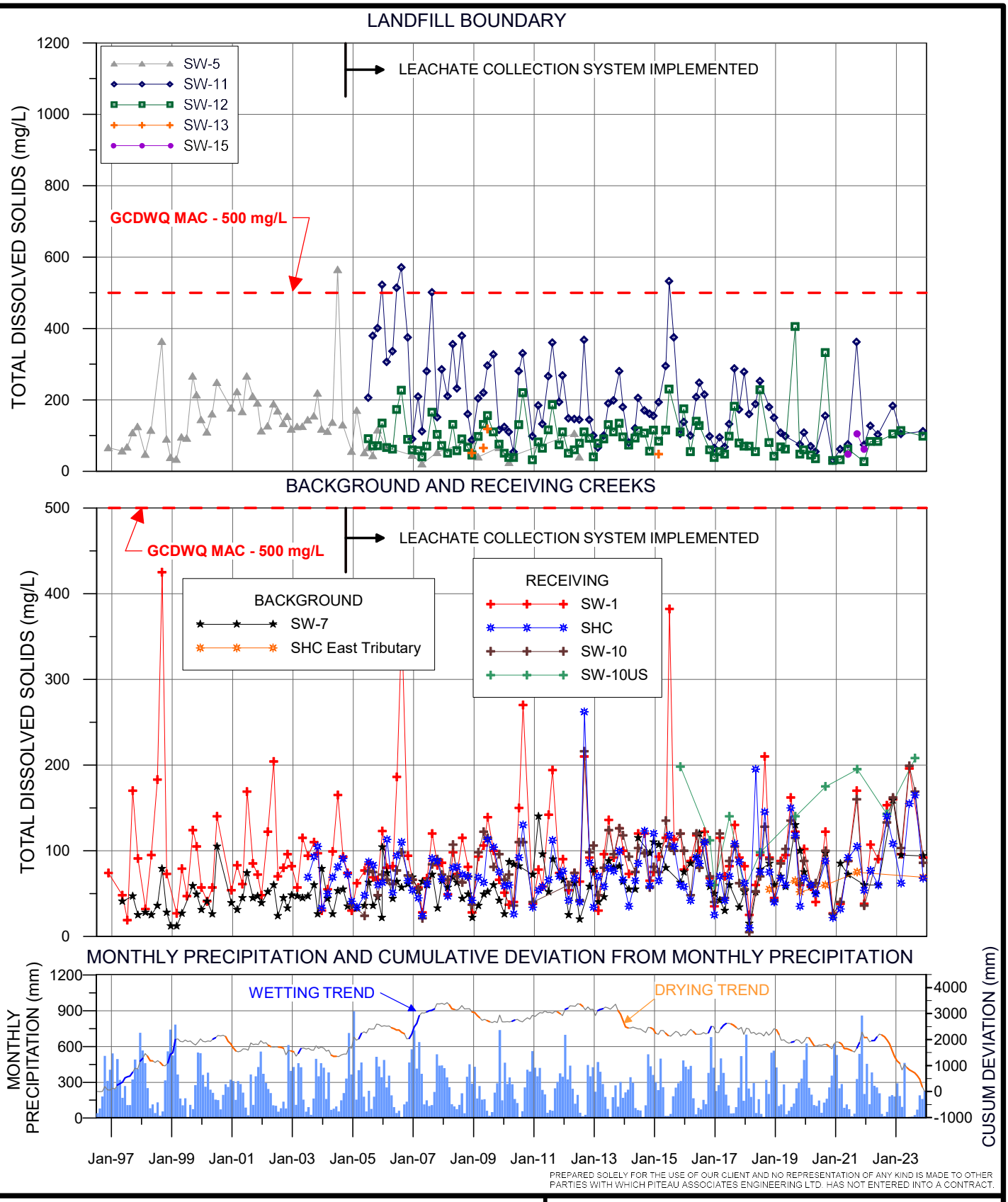

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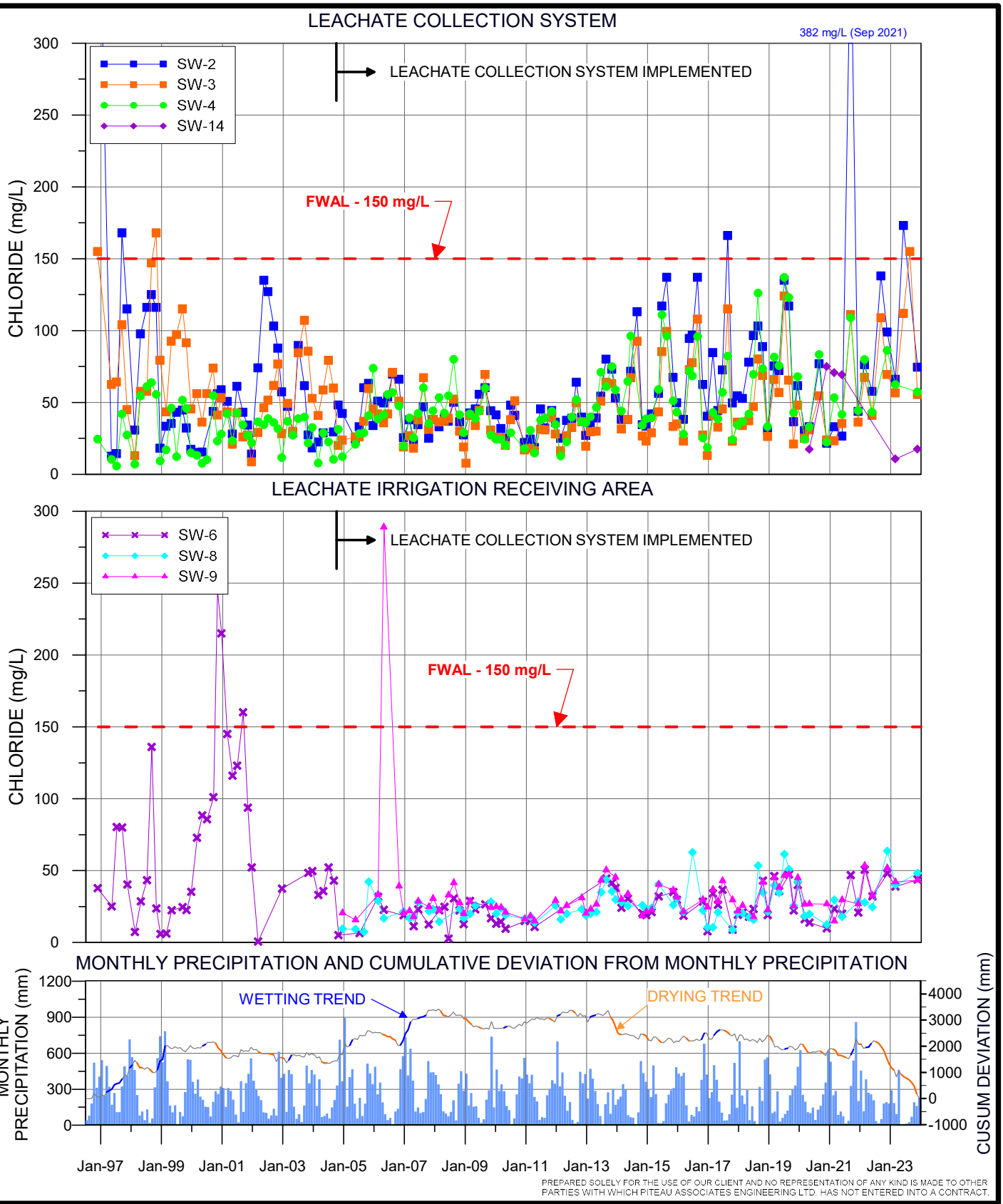

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BY:	DATE:
OB	MAR 24
APPROVED:	FIG:
JM	B-3

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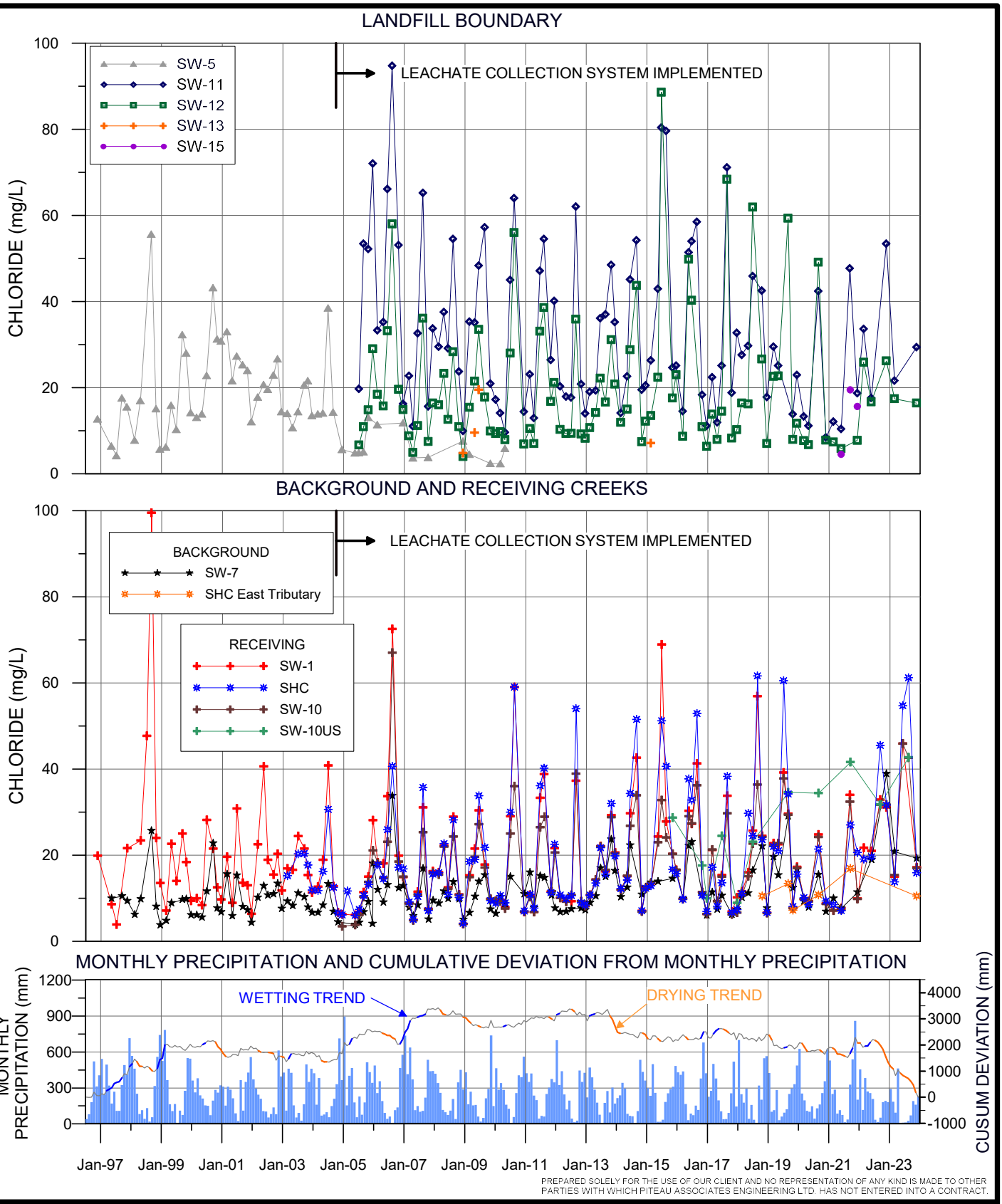

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BY:	DATE:
OB	MAR 24
APPROVED:	FIG:
JM	B-4

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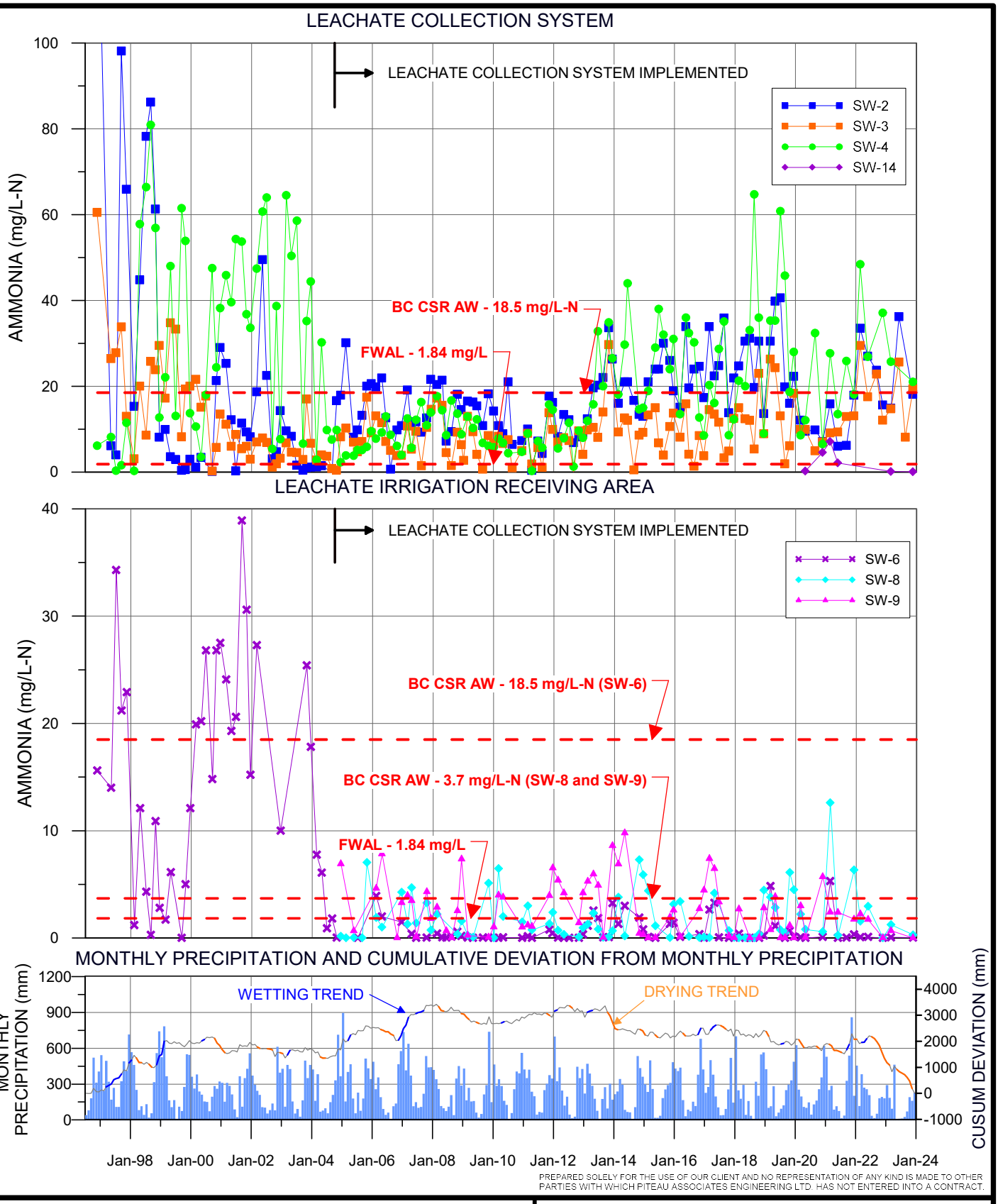

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BY:	DATE:
OB	MAR 24
APPROVED:	FIG:
JM	B-5

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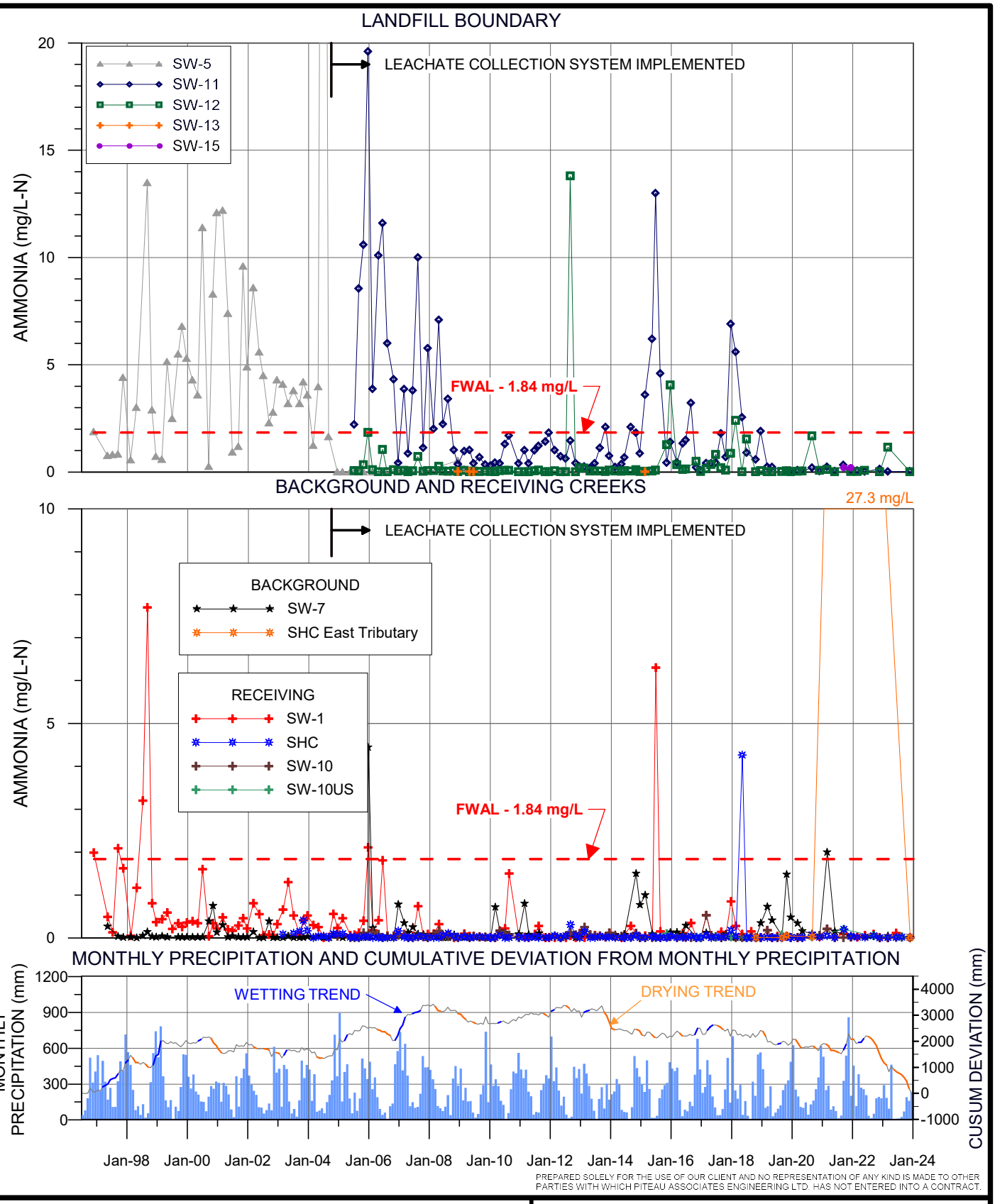

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BY:	DATE:
OB	MAR 24
APPROVED:	FIG:
JM	B-6

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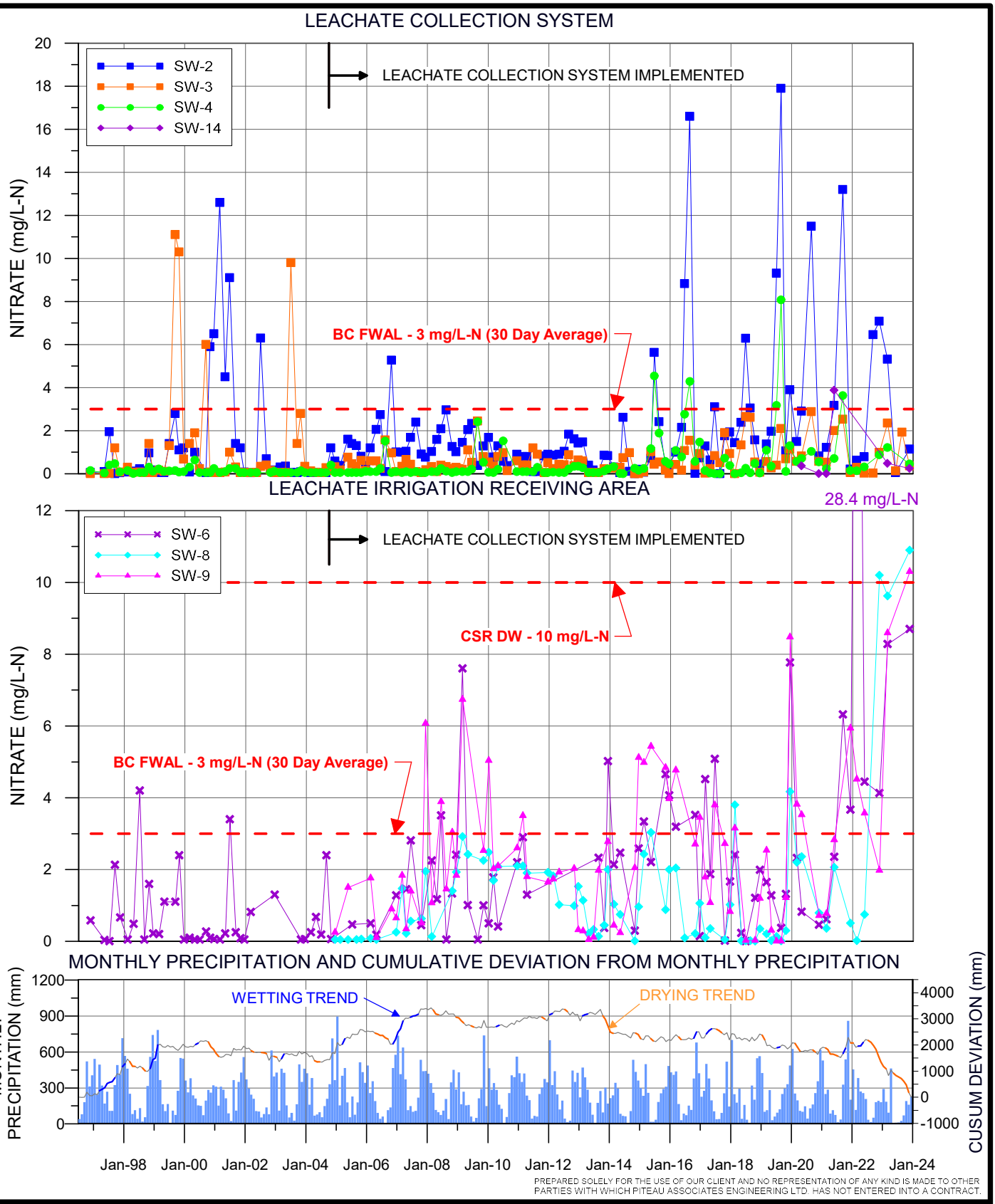

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NITRATE CONCENTRATION TIME-SERIES PLOTS FOR LEACHATE COLLECTION SYSTEM AND LEACHATE IRRIGATION RECEIVING AREA

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

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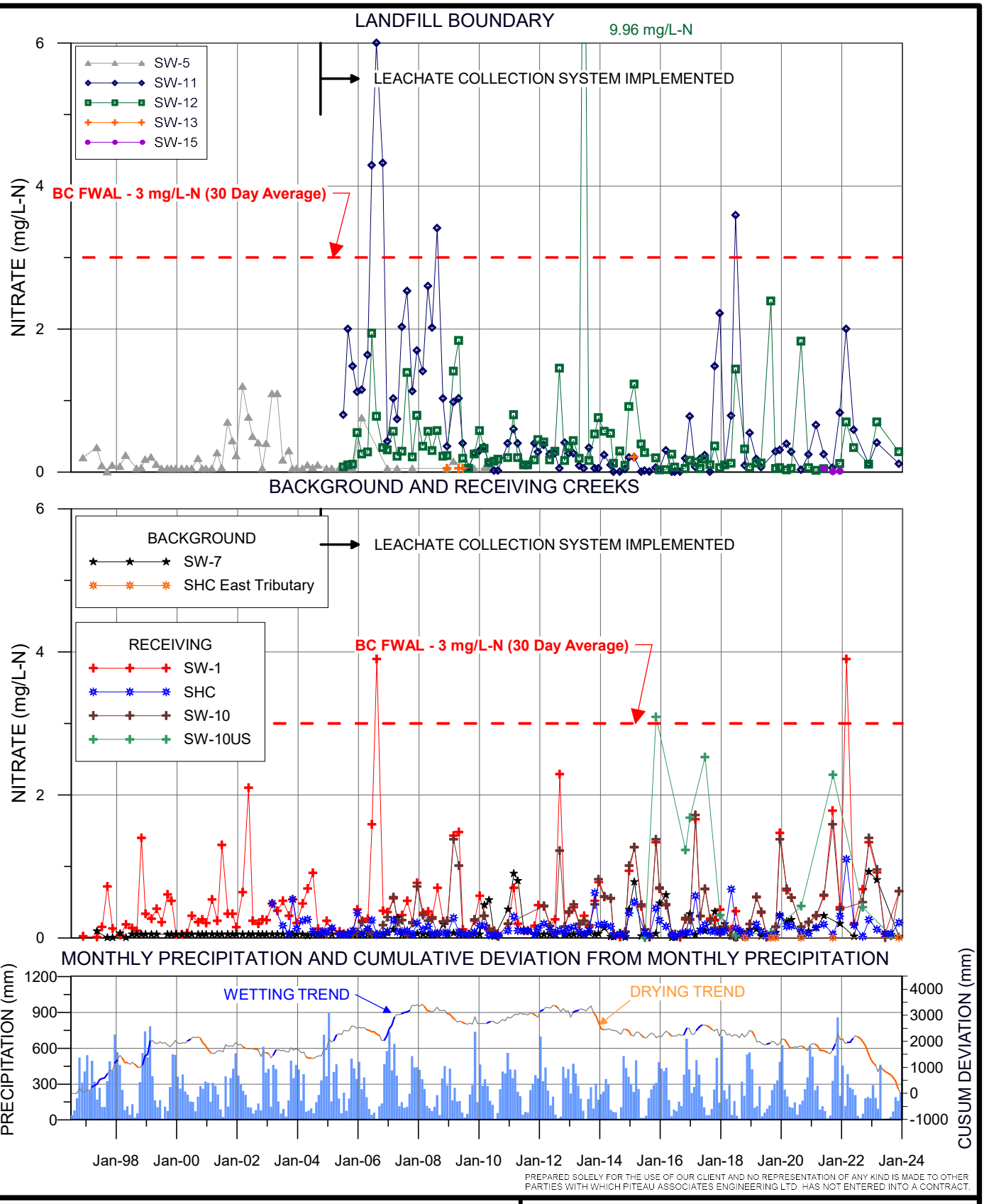

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NITRATE CONCENTRATION TIME-SERIES PLOTS FOR LANDFILL BOUNDARY AND BACKGROUND AND RECEIVING CREEKS

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

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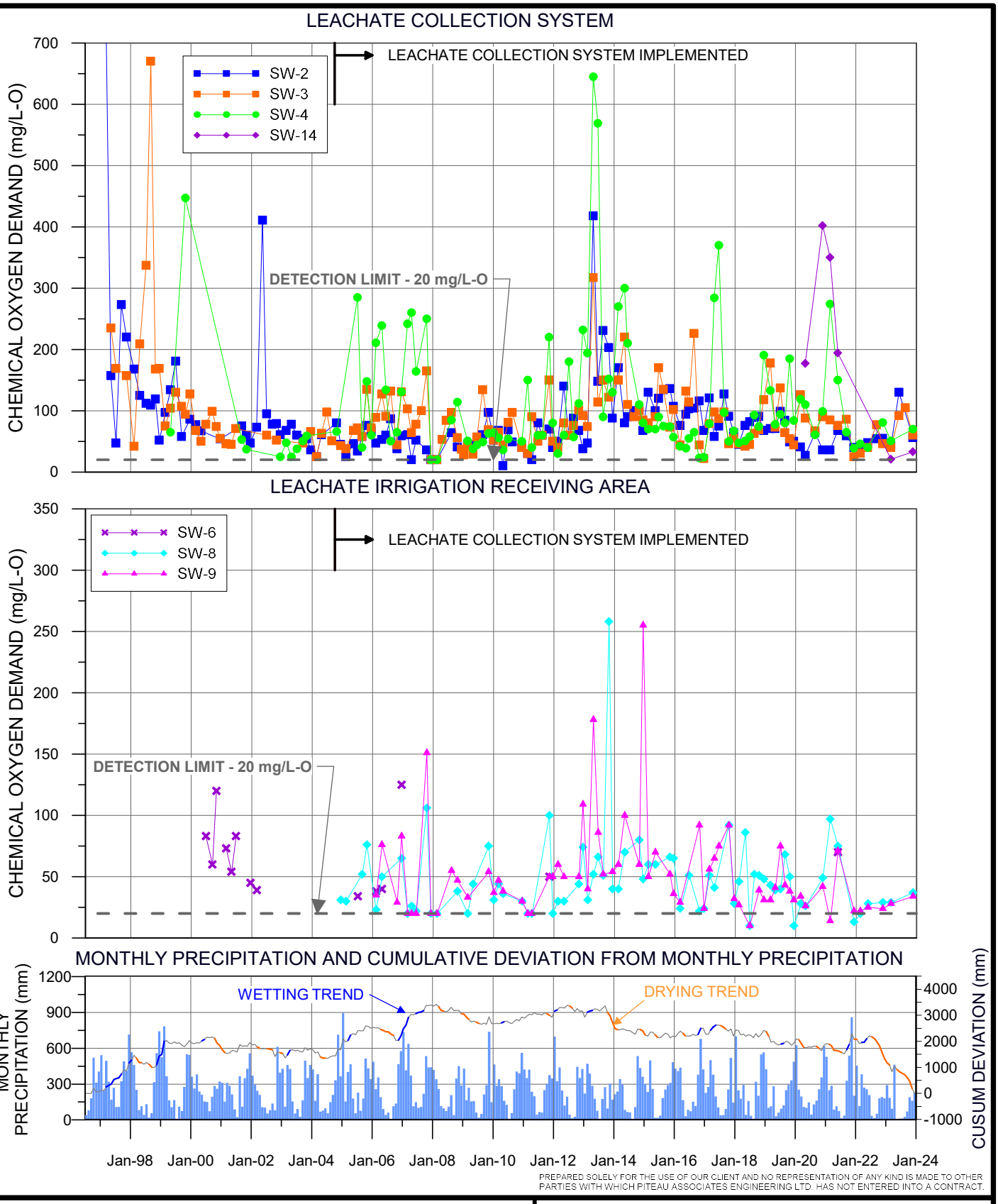

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CHEMICAL OXYGEN DEMAND CONCENTRATION TIME-SERIES PLOTS FOR LEACHATE COLLECTION SYSTEM AND LEACHATE IRRIGATION RECEIVING AREA

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

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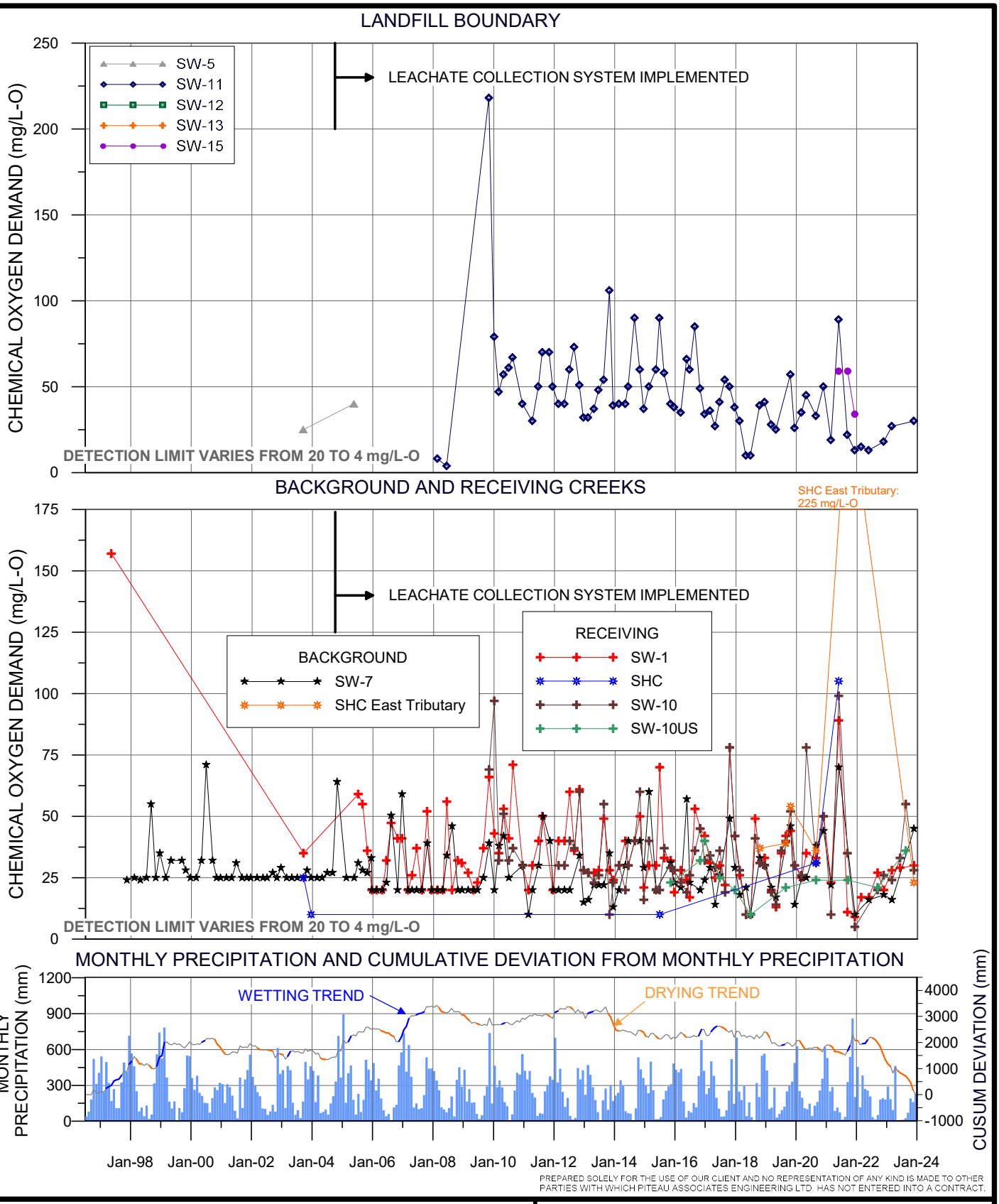

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CHEMICAL OXYGEN DEMAND CONCENTRATION TIME-SERIES PLOTS FOR LANDFILL BOUNDARY AND BACKGROUND AND RECEIVING CREEKS

BY:	DATE:
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JM	B-10

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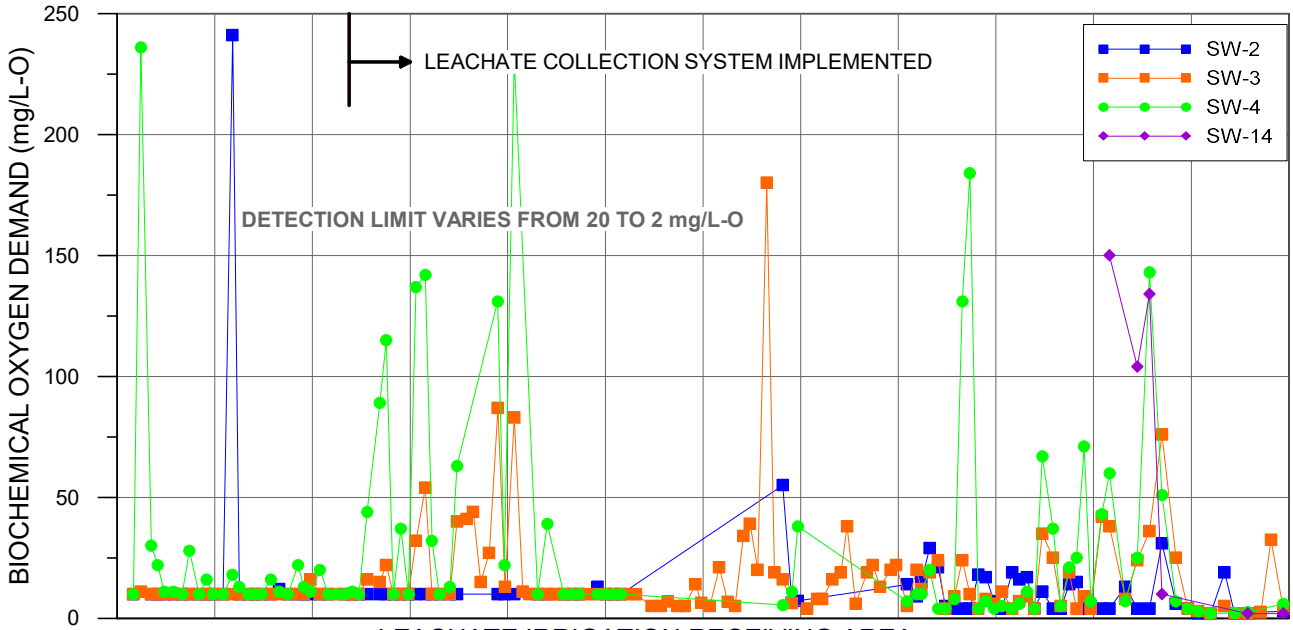
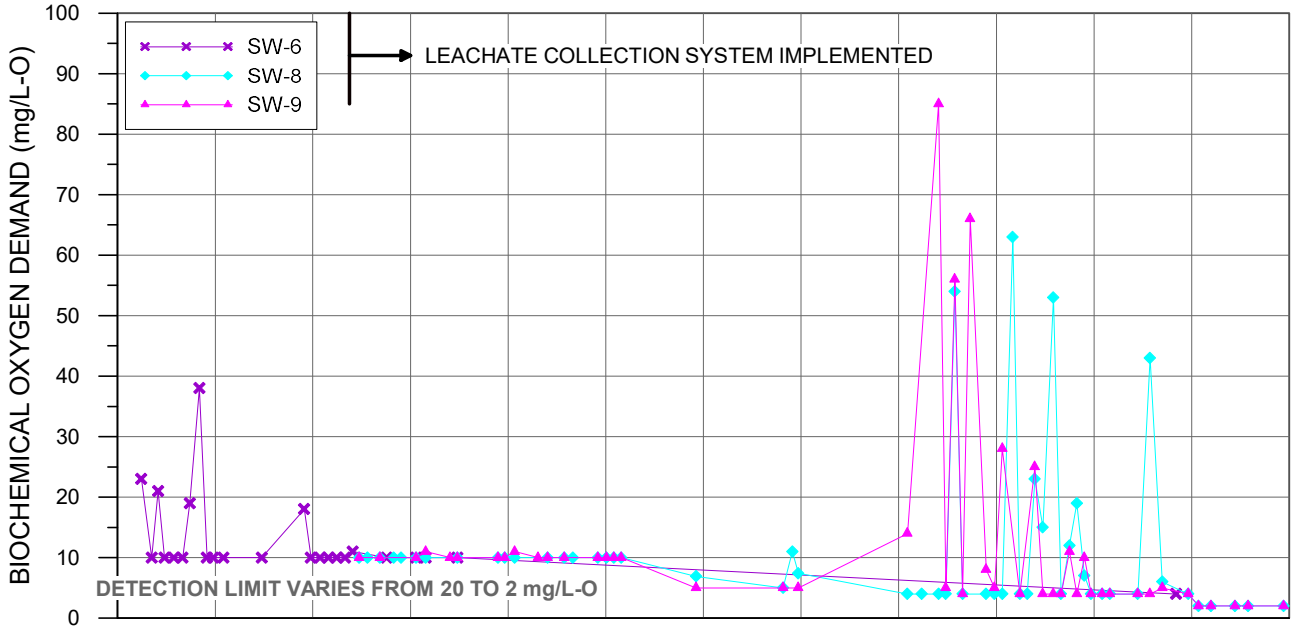
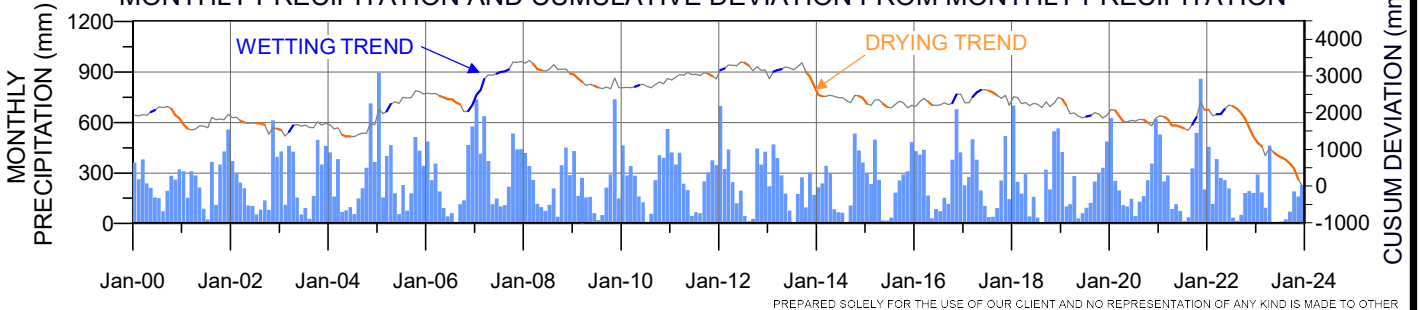
LEACHATE COLLECTION SYSTEM



LEACHATE IRRIGATION RECEIVING AREA



MONTHLY PRECIPITATION AND CUMULATIVE DEVIATION FROM MONTHLY PRECIPITATION



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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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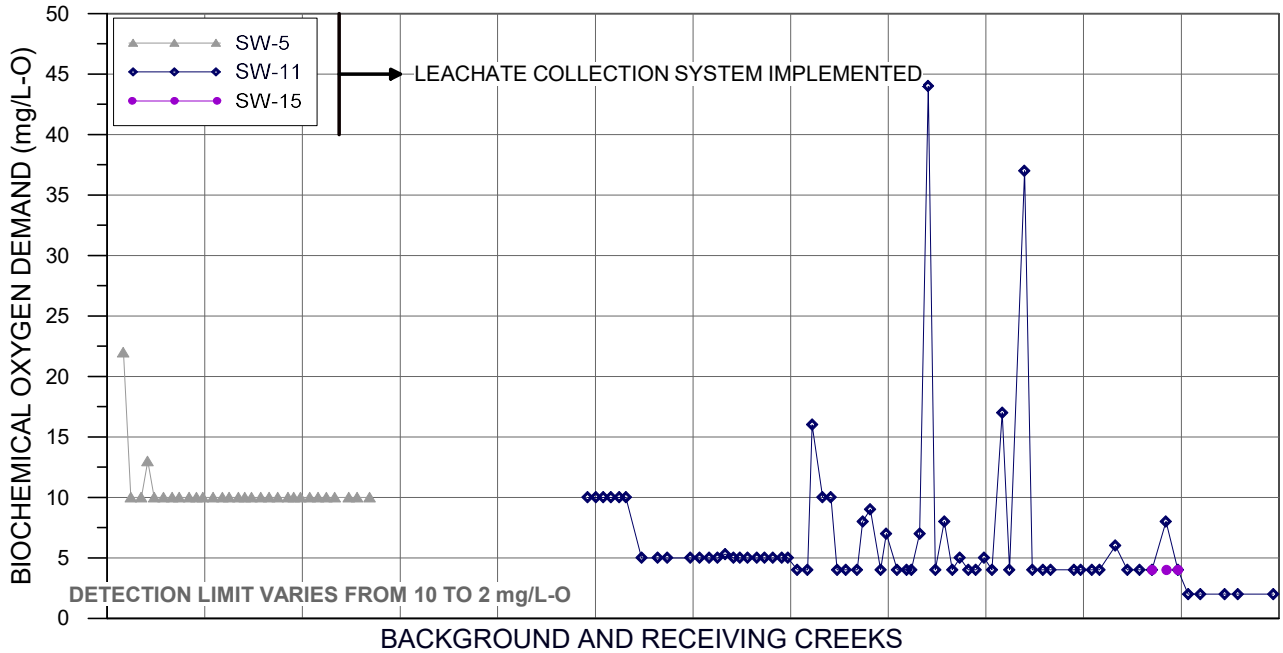
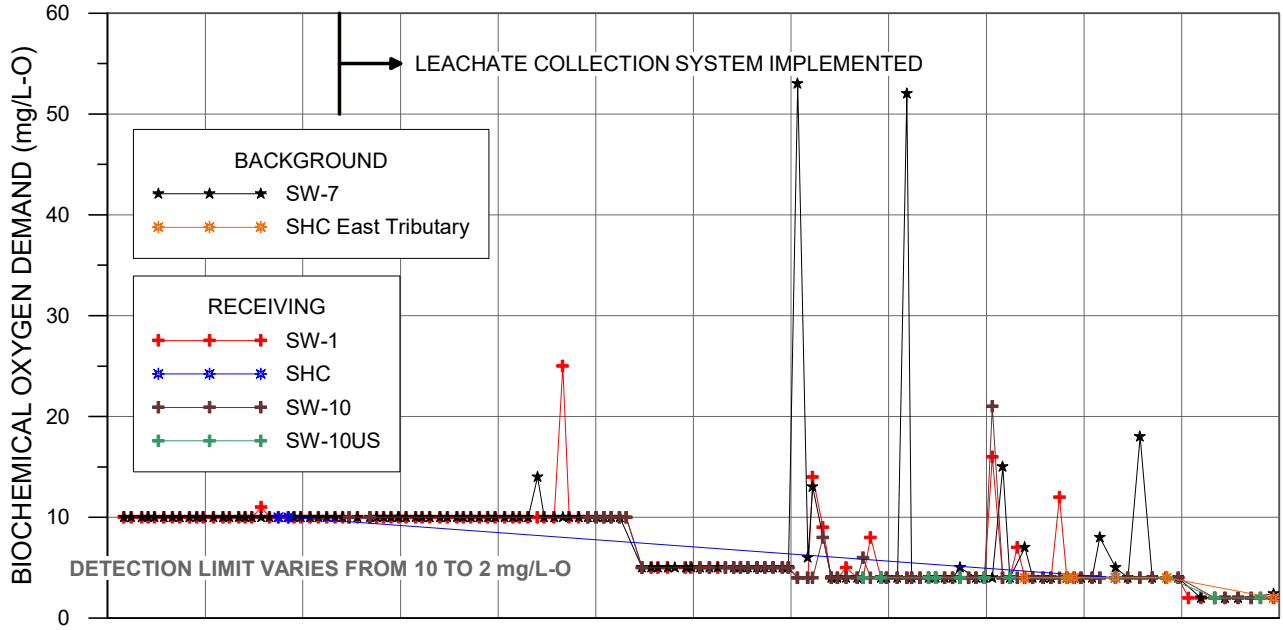
LANDFILL BOUNDARY



BACKGROUND AND RECEIVING CREEKS



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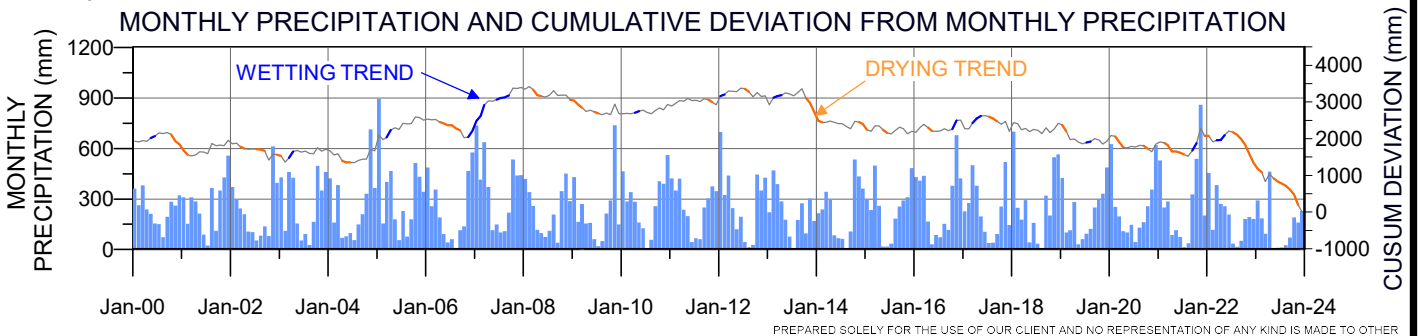

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BIOCHEMICAL OXYGEN DEMAND CONCENTRATION TIME-SERIES PLOTS FOR LANDFILL BOUNDARY AND BACKGROUND AND RECEIVING CREEKS

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

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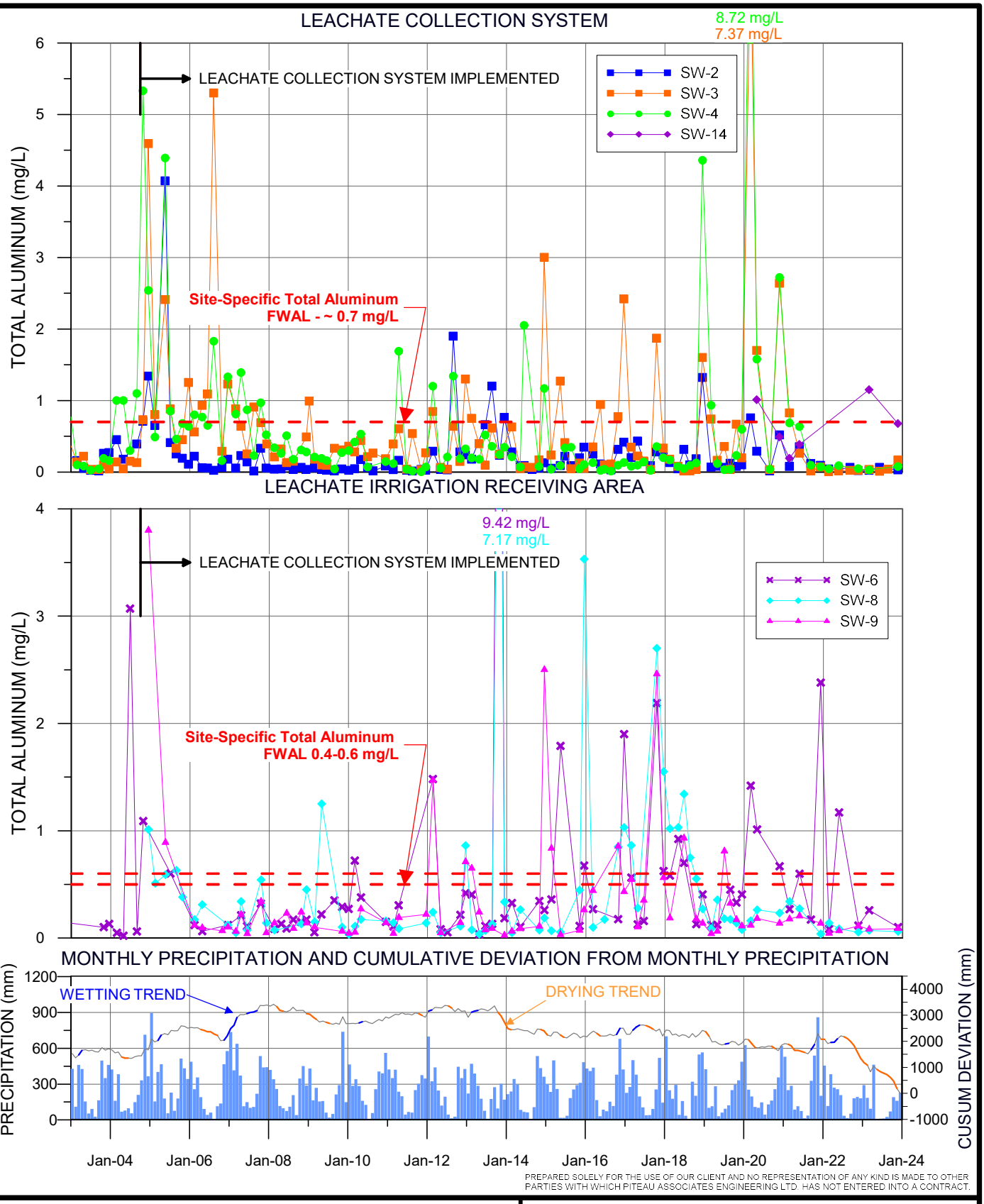

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TOTAL ALUMINUM CONCENTRATION TIME-SERIES PLOTS FOR LEACHATE COLLECTION SYSTEM AND LEACHATE IRRIGATION RECEIVING AREA

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

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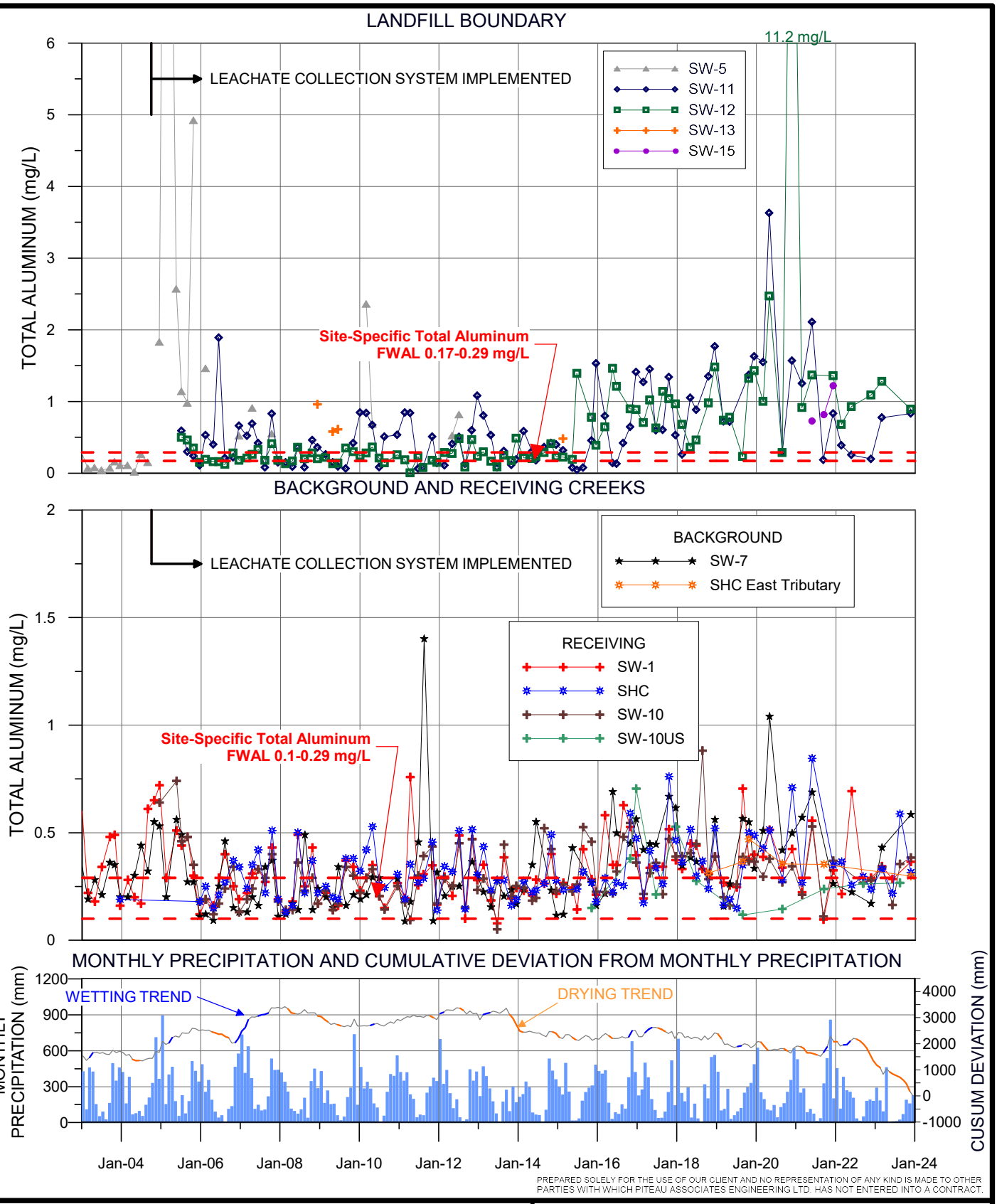

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TOTAL ALUMINUM CONCENTRATION TIME-SERIES PLOTS FOR LANDFILL BOUNDARY AND BACKGROUND AND RECEIVING CREEKS

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

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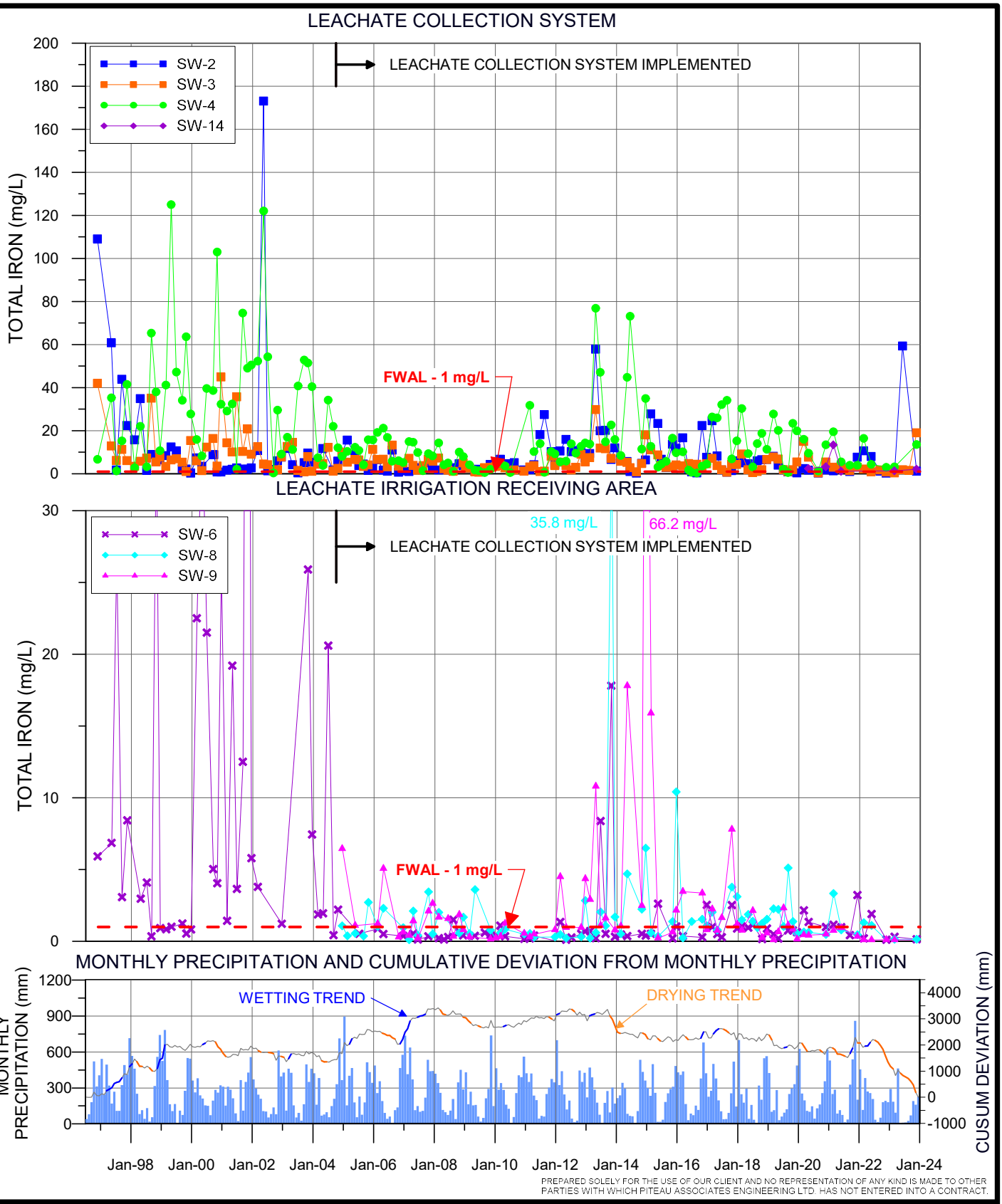

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TOTAL IRON CONCENTRATION TIME-SERIES PLOTS FOR LEACHATE COLLECTION SYSTEM AND LEACHATE IRRIGATION RECEIVING AREA

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

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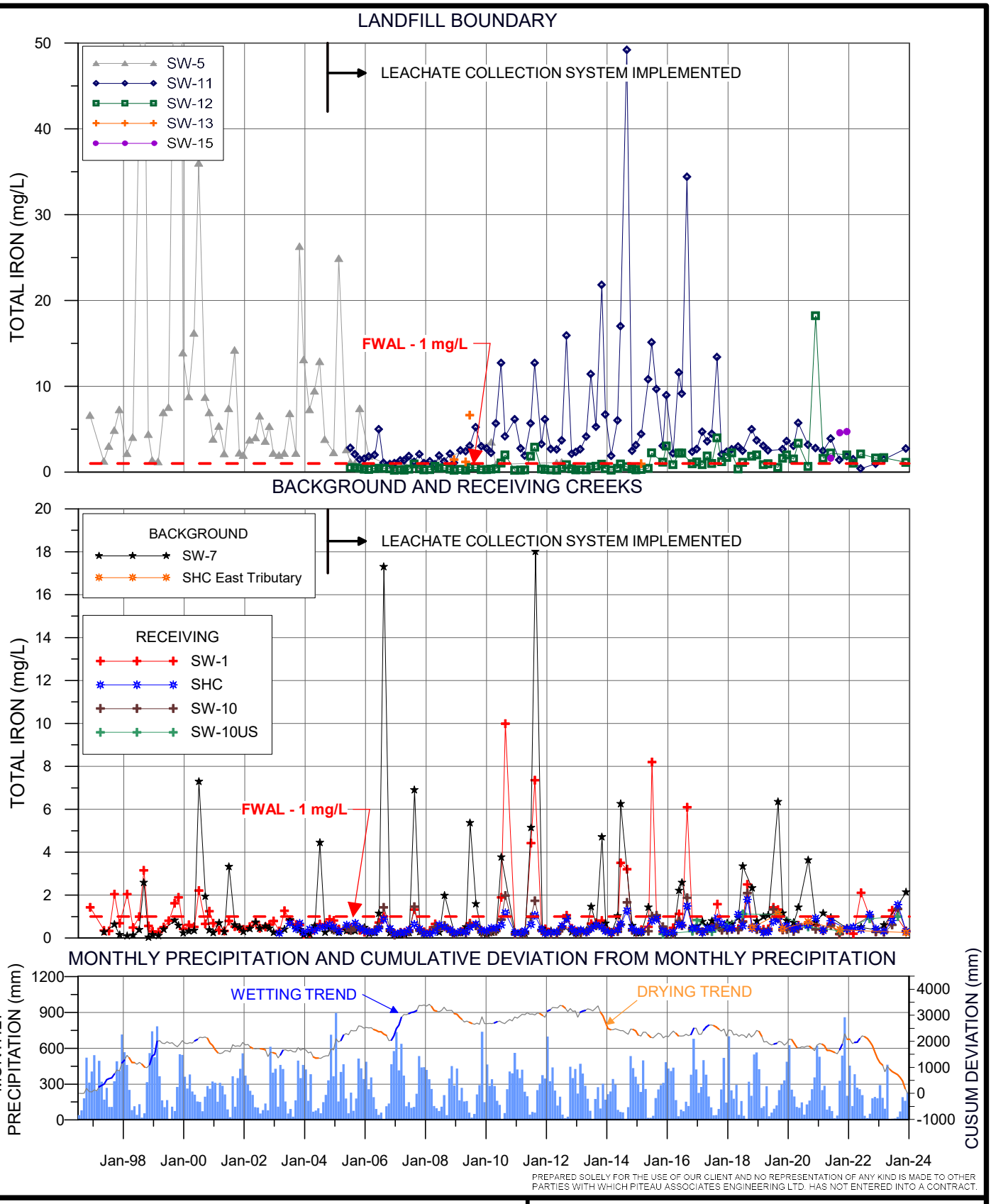

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GEOTECHNICAL AND WATER MANAGEMENT CONSULTANTS
A TETRA TECH COMPANY

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

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

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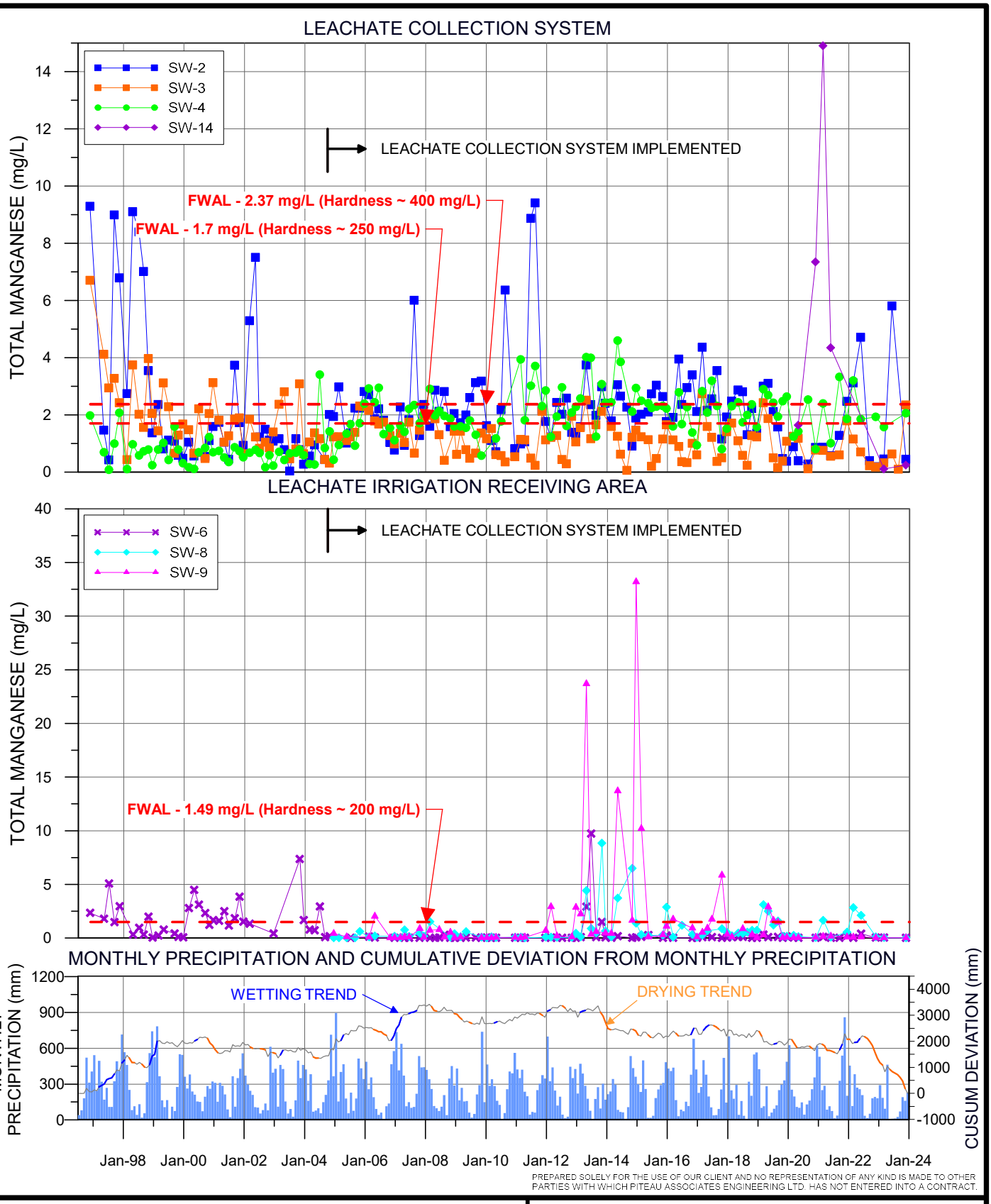

ALBERNI-CLAYOQUOT REGIONAL DISTRICT
WATER QUALITY MONITORING PROGRAM
WEST COAST LANDFILL, UCLUELET, B.C.

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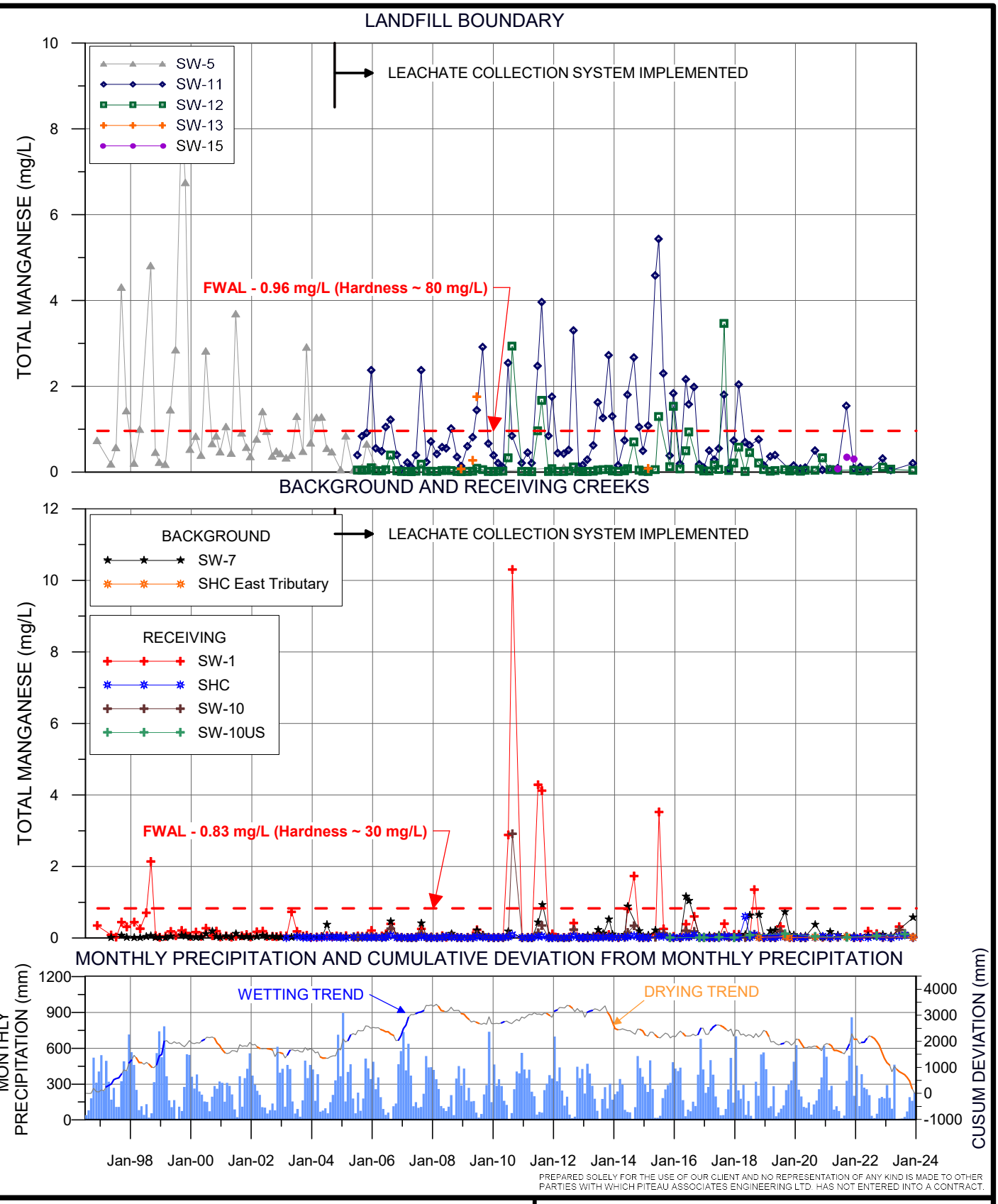
TOTAL MANGANESE CONCENTRATION TIME-SERIES PLOTS FOR LEACHATE COLLECTION SYSTEM AND LEACHATE IRRIGATION RECEIVING AREA

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



ALBERNI-CLAYOQUOT REGIONAL DISTRICT
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TOTAL MANGANESE CONCENTRATION TIME-SERIES PLOTS FOR LANDFILL BOUNDARY AND BACKGROUND AND RECEIVING CREEKS

BY:	DATE:
OB	MAR 24
APPROVED:	FIG:
JM	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

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

H:\Project\1576\WL_Monitoring\[Pond_Overflow_SW-1.xlsx]Overflow summary_2023

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
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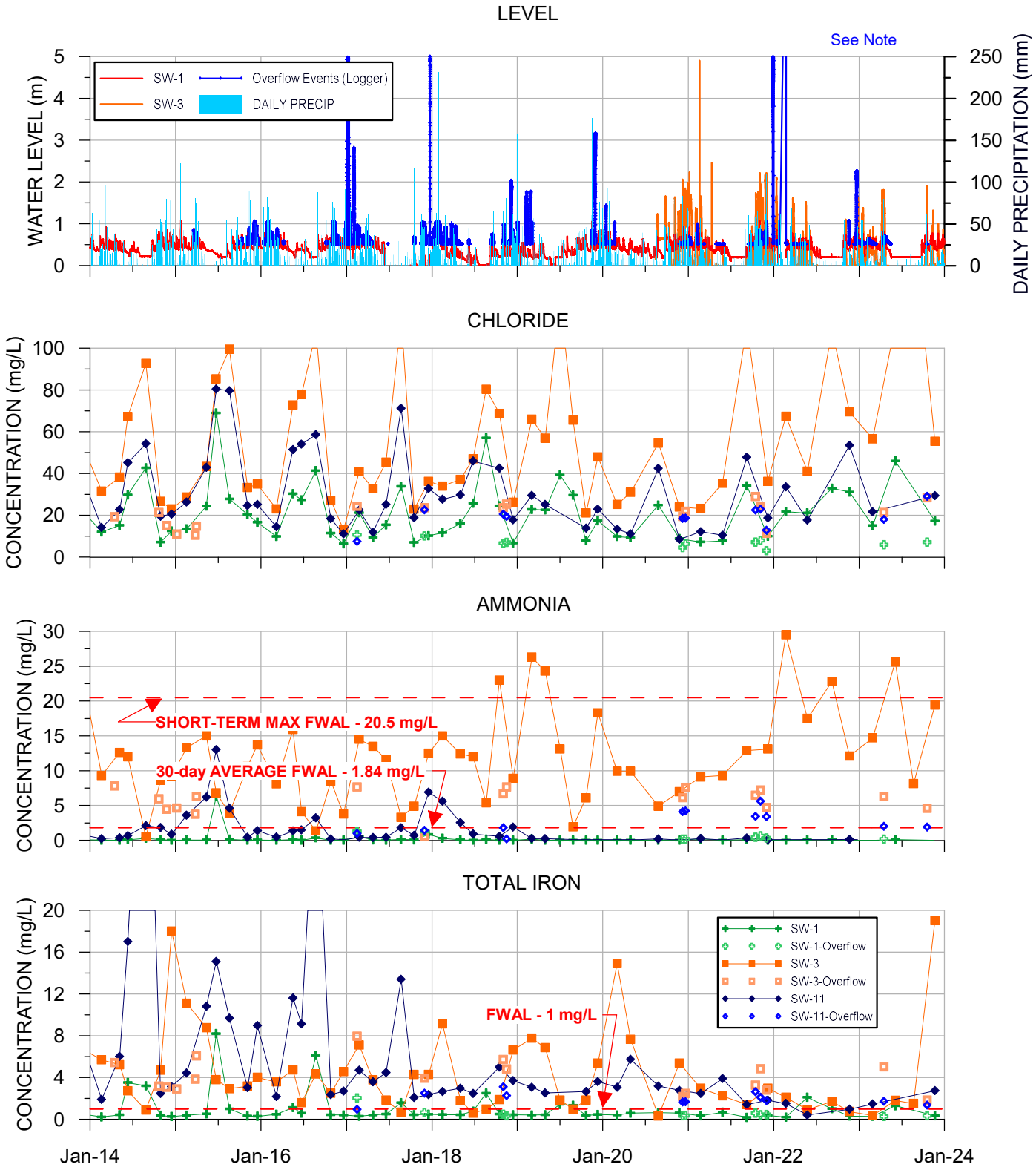

Note: Datalogger not installed from January 26, 2022 to February 22, 2022.

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

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