PEACE RIVER REGIONAL DISTRICT

Solid Waste Committee Meeting
Agenda

April 5, 2024, 10:00 a.m.

1981 Alaska Avenue, Dawson Creek, BC

PEACE RIVER REGIONAL DISTRICT

SOLID WASTE COMMITTEE MEETING

MINUTES

January 19, 2024, 10:00 am
1981 Alaska Avenue, Dawson Creek, BC

Present:	Director Hiebert, Electoral Area D, Committee Chair Director Kealy, Electoral Area 'B' (via Zoom) Alternate Director Parslow, City of Dawson Creek Director Zabinsky, City of Fort St. John, Committee Vice-Chair
Absent:	Director Dober, City of Dawson Creek Director Krakowka, District of Tumbler Ridge Director Sperling, Electoral Area C Director Quibell, District of Hudson's Hope
Staff Present:	Tyra Henderson, Corporate Officer Joanne Caldecott, Deputy Corporate Officer Annette Andrews, Communications Manager Kari Bondaroff, GM of Environmental Services Daris Gillis, Environmental Services Manager Gerritt Lacey, Solid Waste Manager Colin Bates, Solid Waste Foreman Loryn Day, Solid Waste Coordinator Anndrea Kellestine, Solid Waste Coordinator Suzanne Garrett, Recorder
Others Present:	1 member of the public

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1. CALL TO ORDER

Before calling the meeting to order, the Corporate Officer explained that an election had been held for the positions of Chair and Vice-Chair of the Solid Waste Committee for 2024. She announced that Director Hiebert was elected Chair and Director Zabinsky was elected Vice-Chair. Director Hiebert assumed the Chair and called the meeting to order at 10:07 am.

2. DIRECTORS' NOTICE OF NEW BUSINESS

None

3. ADOPTION OF AGENDA

MOVED Director Zabinsky
SECONDED Alternate Director Parslow

That the Solid Waste Committee adopt the January 19, 2024, meeting agenda:

1. **Call to Order**
2. **Directors' Notice of New Business**
3. **Adoption of Agenda**

(continued next page)

4. Gallery Comments or Questions
5. Adoption of Minutes
5.1 Solid Waste Committee Meeting Minutes of October 12, 2023
6. Business Arising from the Minutes
7. Delegations
8. Correspondence
9. Reports
9.1 Public Technical Stakeholder Committee (PTSC) 2024-2025, ENV-SWC-143
9.2 Tumbler Ridge Extended Hours during Spring and Fall Cleanup, ENV-SWC-141
9.3 Agricultural Plastics Pilot Program Extension, ENV-SWC-142
9.4 Taylor Closed Landfill Permit Ownership - Update, ENV-SWC-144
9.5 Function 500 Regional Solid Waste Draft 2024 Budget, ENV-SWC-145
10. New Business
11. Diary
12. Item(s) for Information
12.1 Terms of Reference
13. Adjournment

CARRIED

4. GALLERY COMMENTS OR QUESTIONS

5. ADOPTION OF MINUTES

5.1 Solid Waste Committee Draft Meeting Minutes of October 12, 2023

MOVED Director Zabinsky
SECONDED Director Kealy

That the Solid Waste Committee Meeting minutes of October 12, 2023, be adopted.

CARRIED

6. BUSINESS ARISING FROM THE MINUTES

7. DELEGATIONS

8. CORRESPONDENCE

9. REPORTS

9.1 Public Technical Stakeholder Committee (PTSC) 2024-2025, ENV-SWC-143

MOVED Director Zabinsky
SECONDED Alternate Director Parslow

That the Solid Waste Committee confirms that the Chair and Vice-Chair of the Solid Waste Committee are also the Chair and Vice-Chair of the Public Technical Stakeholder Committee.

CARRIED

9.2 Tumbler Ridge Extended Hours during Spring and Fall Cleanup, ENV-SWC-141

MOVED Director Zabinsky
SECONDED Alternate Director Parslow

That the Solid Waste Committee recommend that the Regional Board authorize the Tumbler Ridge Transfer Station be open an additional four days per year, as part of the Peace River Regional District's Spring and Fall Cleanup campaign.

CARRIED

In response to a question staff advised that currently the Tumbler Ridge Transfer Station is open Tuesday to Saturday from 10 am to 6 pm and does not have extended hours during the Spring and Fall Cleanup campaign. In the past extended hours were not offered at the site since residents were not charged tipping fees when using the site during normal operating hours.

It was noted that Hudson's Hope Transfer Station is the only other site where the Regional District could change the operating hours. The Regional District will be negotiating a new agreement with Hudson's Hope. For consistency staff will review contractor hours of operation during Spring and Fall Cleanup campaigns.

9.3 Agricultural Plastics Pilot Program Extension, ENV-SWC-142

MOVED Alternate Director Parslow
SECONDED Director Kealy

That the Solid Waste Committee recommend that the Regional Board extend the Agricultural Plastics Pilot Program to accept grain bags and twine at regional solid waste facilities for recycling, in partnership with Cleanfarms, for a three-year term ending June 2027, at a maximum cost not exceeding $156,172.

Concern was expressed that funding for this program is a growing expense. Staff advised this program has been funded 50% by the Regional District and 50% by Cleanfarms through a grant from Agricultural and Agri-Food Canada (AAFC). At this time program funding is uncertain, therefore the Regional District may have to cover 100% of the costs of the next three years. Cleanfarms is investigating other funding sources to assist in offsetting the costs to the Regional District. Should Cleanfarms be successful in obtaining funding the program will revert to 50/50.

Amendment:

MOVED Director Zabinsky
SECONDED Alternate Director Parslow

That the motion be amended to reflect a one-year term at a cost of $63,477.

CARRIED

Motion as Amended:

MOVED Director Zabinsky
SECONDED Alternate Director Parslow

That the Solid Waste Committee recommend that the Regional Board extend the Agricultural Plastics Pilot Program to accept grain bags and twine at regional solid waste facilities for recycling, in partnership with Cleanfarms, for a one-year term ending June 2025, at a maximum cost not exceeding $63,477.

CARRIED

9.4 Taylor Closed Landfill Permit Ownership – Update, ENV-SWC-144

MOVED Director Zabinsky
SECONDED Director Kealy

That the Solid Waste Committee recommend that the Regional Board send a letter to the District of Taylor requesting that they split the cost of remediation to complete the bulky waste cleanup and cover repairs as identified in the 2023 Taylor Closed Landfill Closure Report (Tetra Tech, November 16, 2023) which are estimated to total $100,000, with the Peace River Regional District, prior to the Peace River Regional District considering the request for support of the transfer of ownership of Landfill Permit 1837, from the District of Taylor to the Peace River Regional District.

CARRIED

9.5 Function 500 Regional Solid Waste Draft 2024 Budget, ENV-SWC-145

MOVED Director Zabinsky
SECONDED Director Kealy

That the Solid Waste Committee recommend that the Regional Board approve the business case for the 2024 Dawson Creek and Taylor Closed Landfill Monitoring Well Installations project; further, that $80,000 be allocated to the project as part of the 2024 Solid Waste Capital Budget.

CARRIED

MOVED Director Zabinsky
SECONDED Alternate Director Parslow

That the Solid Waste Committee recommend that the Regional Board approve the business case for the 2024 Mile 62.5 and Taylor Closed Landfill Remediation project; further, that $235,000 be allocated to the project as part of the 2024 Solid Waste Capital Budget.

CARRIED

MOVED Director Zabinsky
SECONDED Director Kealy

That the Solid Waste Committee recommend that the Regional Board include the draft 2024 budget totalling $18,889,171 for Function 500 – Regional Solid Waste, in the 2024 Financial Plan, with an estimated 2024 tax rate of $0.3232/$1,000 for this function, which is an estimated requisition increase of 24%.

CARRIED

10. NEW BUSINESS

11. DIARY

12. ITEMS FOR INFORMATION

12.1 Terms of Reference.

13. ADJOURNMENT

The Chair adjourned the meeting at 11:18 am

Leonard Hiebert, Committee Chair

Suzanne Garrett, Recorder

PEACE RIVER REGIONAL DISTRICT

REPORT

To: Solid Waste Committee Report Number: ENV-SWC-149

From: Gerritt Lacey, Solid Waste Manager Date: April 5, 2024

Subject: 24 Hour Pilot Expansion Update at Rolla and Cecil Lake Transfer Stations

RECOMMENDATION:

That the Solid Waste Committee recommend that the Regional Board develop an "Illegal Dumping Policy" to inform decision making objectives around re-occurring illegal dumping at PRRD solid waste sites.

BACKGROUND/RATIONALE:

Pilot Expansion Update:

On August 10, 2022 the Regional Board passed the following resolution:

> *MOVED, SECONDED, and CARRIED*
> *That the Regional Board initiate a new 24-hour access pilot for no-charge disposal of bagged household waste outside of operating hours at the Rolla and Cecil Lake transfer stations.*

The purpose of this report is to provide an update on the first quarter of operating the 24-hour access pilot at the Rolla and Cecil Lake Transfer Stations (TS). The after-hour bins became operational December 1, 2023 for the Cecil Lake TS and December 4, 2023 for the Rolla Transfer Station.

Table 1 below outlines the bag counts received and any illegally dumped incidents for the first three months of operation.

Table 1: Compactor tonnage and Bag Counts

	Rolla Transfer Station	Cecil Lake Transfer Station
Compactor Tonnage	6.39	7.1
Bags of waste disposed during operating hours	1,011	490
Bags of waste disposed during after hours	318	93
Illegal dumping incidents	1	1

Illegal Dumping Policy

Occurrences of illegal dumping are not new to the PRRD. Unattended sites are more difficult to monitor and when bins are full, or items are too large, the public often leaves waste outside the collection bins thus leaving the trucking contractor to clean-up the inappropriately disposed waste.

With the attended sites allowing 24-hour access for bagged waste during unattended time periods, there are again instances where non-household waste is being disposed of and items are being left outside of the fence due to the large size of the items. In 2022, at the Moberly Lake 24-hour access bins, a resident disposed of a whole deer carcass in the after-hour access bins. For the new pilot sites at Rolla and Cecil Lake, the 24-hour bins received instances of illegal dumping activities within two weeks of the bins being brought to each site. At Cecil Lake two armchairs were left in front of the bins outside of business hours, and at Rolla, a small business brought many large garbage bins to site and emptied all the contents into the bins causing them to be overfilled with loose waste. Both occurrences were caught on camera thanks to the newly installed CCTV system at the sites, and to date no further instances have been reported.

With the development of an illegal dumping policy, staff would be better equipped to make operational decisions on how to respond to the occurrences. Public educational materials have been developed and displayed to help inform the public on acceptable disposal of bagged household waste at both attended and unattended sites. However, there are no consequences for re-occurring misuse of services through illegal dumping activities.

Some suggested items to be investigated and potentially included within the illegal dumping policy are:
1. Addition of a strike board that allows for photos of unacceptable disposal methods to be displayed at each site.
2. Ability to suspend services due to re-occurrences of unacceptable disposal methods.
3. How the PRRD responds to reports of illegal dumping occurrences outside of PRRD's jurisdiction.

ALTERNATIVE OPTIONS:

1. That the Solid Waste Committee provide further direction.

STRATEGIC PLAN RELEVANCE:

☒ Not Applicable to Strategic Plan

FINANCIAL CONSIDERATION(S):

Instances of illegal dumping at unattended transfer stations come at a cost of $185.00/hour for the hauling contractor to remove items from the site, in 2023 the estimated cost in extra cleanup at unattended transfer stations was $42,000.

Instances of illegal dumping at attended transfer stations are handled in two ways. At tier 1 stations, most of the items seen in instances of illegal dumping can be taken into the transfer station and disposed of in the correct bin. At tier 2 stations, all waste items, other than household waste, need to be transported to the nearest tier 1 facility or landfill.

COMMUNICATIONS CONSIDERATION(S):

Staff will continue to educate residents on the proper use of the 24-hour access program through social media post and flyers at the site.

There are numerous messaging signs on the after-hours bins that display what types of waste materials are accepted. Figure 1 below shows what messaging is placed on the bins.

Figure 1. After-Hours Bin and Signage

Handouts were also developed outlining the purpose of the bins, how they work, what materials are accepted, and what materials are not accepted, figures 2-4 below. Attendants began handing these out to residents a week prior to the bins being installed.

Figure 2. Residential Handout - Front Page

Figure 3. Residential Handout - Back Page for Rolla and Moberly TS

Figure 4. Residential Handout - Back Page for Cecil Lake and Prespatou TS

OTHER CONSIDERATION(S):

Piloting 24-hour access programs at PRRD Solid Waste Sites is in accordance with the Regional Solid Waste Management Plan Strategy 11: Improve accessibility and efficiency of the solid waste network.

PEACE RIVER REGIONAL DISTRICT

REPORT

To: Solid Waste Committee Report Number: ENV-SWC-150

From: Gerritt Lacey, Solid Waste Manager Date: April 5, 2024

Subject: Solid Waste Sites Property Update

RECOMMENDATION:

That the Solid Waste Committee receive the report entitled "Solid Waste Sites Property Update-ENV-SWC-150" which updates committee members on the compliance of properties within the Solid Waste function, for information.

BACKGROUND/RATIONALE:

The purpose of this report is to provide an update on Solid Waste (SW) properties and perform a gap analysis around compliance with agreements, contracts, permits, and approvals.

There are 66 properties in the Solid Waste function; this includes active landfills, closed landfills, attended transfer station, unattended transfer stations, and recycling sites. In 2023, staff completed a review of all Solid Waste properties which included:

- identifying all lands associated with the Solid Waste function, determined land status (owned, leased, ALR approvals),
- identifying agreements, permits, and statutory right of ways, and
- determining any gaps that need to be rectified.

From this review it was determined that there were ten properties that were not 100% compliant with agreements, contracts, permits, or approvals; these properties are presented in Table 1 below:

Table 1: SW Sites Compliance Matrix

Type of Sites	Number of Sites	Number in Compliance	Number out of Compliance
Active Landfills	3	3	0
Attended Transfer Stations	19	19	0
Unattended Transfer Stations	11	5	6
Closed Landfills	29	25	4
Unattended Recycling Stations	4	4	0
Total	**66**	**56**	**10**

The rectification of these sites range from renewing license of occupations, applying for MOTI permits, or applying for non-farm use within the ALR approval. Table 2 outlines the sites, the compliance issue, the rectification plan to ensure compliance of these sites moving forward.

Table 2: Compliance Solution Matrix

Site	Compliance Issue	Rectification Plan
Hasler Flats Unattended Transfer Station	Located in a MOTI Highway Right of Way with no approved permit on record.	Follow up with MOTI regarding the 2018 Application. Apply for new permit if the 2018 application is no longer valid
	Located in the ALR with no approval for non-farm use.	Apply for non-farm use
Lebell Unattended Transfer Station	Located in a MOTI Highway Right of Way with no approved permit on record.	Apply for permit through MOTI
	Located in the ALR with no approval for non-farm use.	Apply for non-farm use through ALC
Upper Cache Unattended Transfer Station	Located in a MOTI Highway Right of Way with no approved permit on record.	Apply for permit through MOTI
	Located in the ALR with no approval for non-farm use.	Apply for non-farm use through ALC
Osborn Unattended Transfer Station	Located in the ALR with no approval for non-farm use.	Apply for non-farm use through ALC
Milligan Creek Unattended Transfer Station	Located in the ALR with no approval for non-farm use.	Apply for non-farm use through ALC
Sukunka Unattended Transfer Station	Located in the ALR with no approval for non-farm use.	Apply for non-farm use through ALC
Goodlow Transfer Station and Closed Landfill (both located on the same property)	Located in the ALR with no approval for non-farm use.	Apply for non-farm use through ALC
Brassey Creek Closed Landfill	Located on Crown Land and the License of Occupation expired in 2008	Apply/renew License of Occupation through the Province.
Clayhurst Closed Landfill	Located in the ALR with no approval for non-farm use.	Apply for non-farm use through ALC
Progress Closed Landfill	Located in the ALR with no approval for non-farm use.	Apply for non-farm use through ALC

The ten properties represent 13 compliance issues which are broken out as:

- three MOTI permit applications
- nine None Farm Use applications through the Agricultural Land Commission (ALC).
- one Liscense of Occupation renewal application

Staff has already initiated conversations with each agency to bring the ten properties into compliance.

ALTERNATIVE OPTIONS:

1. That the Solid Waste Committee provide further direction.

STRATEGIC PLAN RELEVANCE:

☒ Asset and Infrastructure Management

FINANCIAL CONSIDERATION(S):

Table 3 outlines the cost of each application and the anticipated cost to apply for necessary permits.

Table 3: Application Costs

Permit Type	Cost	Number Required	Total Cost
ALR Permit	$750-$1,500	9	$6,750 to $13,500
License of Occupation Permit	$262.50	1	$262.50
MOTI Highway Right of Way Permit*	$0	3	$0
		Total Cost	**$7,012.50 - $13,762.5**

**For the majority of permits and approvals no fees apply.*

COMMUNICATIONS CONSIDERATION(S):

Not applicable

OTHER CONSIDERATION(S):

Not applicable

PEACE RIVER REGIONAL DISTRICT

REPORT

To: Solid Waste Committee Report Number: ENV-SWC-151

From: Gerritt Lacey, Solid Waste Manager Date: April 5, 2024

Subject: Partnership with Interchange Recycling at Chetwynd Landfill

RECOMMENDATION:

That the Solid Waste Committee recommend that the Regional Board enter into a partnership with Interchange Recycling to offer residential waste oil and antifreeze collection at the Chetwynd Landfill.

BACKGROUND/RATIONALE:

In October 2023, the PRRD was approached by Interchange Recycling, a stewardship organization responsible for the collection of used residential oil and antifreeze, to see if the PRRD had a facility in the Chetwynd area that could provide waste oil collection. This request was made following the cancellation of Interchange Recycling's prior partnership in the area, and a desire to fill a service gap for residents in the Chetwynd area (the Chetwynd Landfill is approximately 3km northeast of the community). Previously Interchange Recycling was partnered with Chetwynd Recycling and the new owners of the Recycling Center do not have the resources or capacity to continue with this partnership.

The PRRD expressed interest in setting up a program with Interchange Recycling at the Chetwynd Landfill, as operation of such a program in partnership with Interchange Recycling aligns with the PRRD Regional Solid Waste Management Plan, under Strategy 5: Improve collection of hazardous waste and targeted EPR materials.

ALTERNATIVE OPTIONS:

1. That the Solid Waste Committee respectfully decline to partner with Interchange Recycling at the Chetwynd Landfill.
2. That the Solid Waste Committee provide further direction.

STRATEGIC PLAN RELEVANCE:

☒ Not Applicable to Strategic Plan

FINANCIAL CONSIDERATION(S):

Interchange Recycling is offering to supply the infrastructure required to collect used oil and antifreeze as part of their grant program. This would include relocating the 20' seacan that was used at the Chetwynd Recycling Depot to the Chetwynd Landfill, after a period of 5 years the PRRD will own the seacan.

Additionally, Interchange Recycling offer incentive rates for collecting material which are:

Used Oil	Used Antifreeze	Used Oil Filters and Metal Oil Containers	Used Oil and Antifreeze Containers
$0.186 per litre	$0.420 per litre	$1.602 per kg	$2.668 per kg

COMMUNICATIONS CONSIDERATION(S):

Social media and website posts will be created to notify residents of this additional service at the Chetwynd Landfill.

OTHER CONSIDERATION(S):

None at this time.

PEACE RIVER REGIONAL DISTRICT

REPORT

To: Solid Waste Committee Report Number: ENV-SWC-153

From: Gerritt Lacey, Solid Waste Manager Date: April 5, 2024

Subject: Kelly Lake Transfer Station Break-in Events and Generator Replacement

RECOMMENDATION:

That the Solid Waste Committee receive the report titled "Kelly Lake Transfer Station Break-in Events and Generator Replacement ENV-SWC-153" that updates committee members on break-in events that have occurred at the Kelly Lake Transfer Station from fall 2022 to March 2024 for information.

BACKGROUND/RATIONALE:

This report has been brought forward to update the Solid Waste Committee members on the recent break-in events that have taken place at the Kelly Lake Transfer Station. The first break-in event was discovered in 2022 following the evacuation of the Kelly Lake area due to the Bearhole Lake wildfire. Since then, seven additional break-in events have taken place. A list of dates has been provided below in Table 1.

Table 1: Kelly Lake Transfer Station Break-in Events

Date	Damages	Theft
October 6, 2022	Walked in, cut wildlife fencing, fuel lines cut	Diesel taken ~20L
November 26, 2022	Road gate lock cut	None
February 25, 2023	Walked in, cut wildlife fencing, fuel lines cut	Diesel taken ~20L
December 15, 2023	Walked in, squeezed through gate, siphoned fuel from tank	Diesel taken ~20 - 50L
January 10, 2024	Entered from rear of site by lagoons, squeezed through gate, attempted to siphon fuel from tank but hose was not long enough.	None
January 27, 2024	Drove in to site, road gate lock cut, entrance gate lock cut, siphoned fuel from tank	Diesel taken ~20 - 50L
February 6, 2024	Used ATV to drive around gate, cut wildlife fencing, siphoned fuel from tank	Diesel taken ~20 - 50L
February 16, 2024	Used truck to force road gate open, cut lock on entrance gate, drove into the site, siphoned fuel from tank, spilt approximately 20 - 50L on ground requiring vac truck to clean the area	Diesel taken ~50 - 100L

The Kelly Lake Transfer Station is powered by an onsite diesel generator as there is no Hydro connection available near the site. During all the break-in events, the target has been diesel fuel which is stored in

an above ground tank. To date, the quantity of diesel taken during each event is estimated to be between 20 and 100L.

Police Reports have been initiated for each of the events, and staff have corresponded with local RCMP regarding the string of break-ins seen in 2024. Removing the attractant of the diesel fuel is suggested to be the best option to try curb the break-ins. The generator that currently powers the site is approaching its end of service life. As such, replacement options such as replacing the diesel generator with a propane unit, are being investigated.

ALTERNATIVE OPTIONS:

1. That the Solid Waste Committee provide further direction.

STRATEGIC PLAN RELEVANCE:

☒ Asset and Infrastructure Management

FINANCIAL CONSIDERATION(S):

To date, the 8 break-in events have cost the PRRD approximately $15,000. This includes 1-2 days of staff time at each event for repairs or upgrades to the site, repair materials, and a vac truck to remove and dispose of the diesel that was spilt on the ground during the February 16 event.

The existing diesel generator is 12 years old and has approximately 17,600 hours on the unit. These generators are anticipated to be replaced after 20,000 hours; therefore, staff have started planning for the replacement to take place in 2025. The estimated cost to replace the diesel generator with a propane unit is approximately $100,000. The initial purchase price of each unit (diesel versus propane) is comparable.

Should the break-in events pick up again as seen in January and February of this year, there could be a potential to move the replacement up to this year, pending Capital budget availability. Should the need to replace the unit in 2024 arise, a business case and report will be brought forward to a future Solid Waste Committee Meeting for consideration.

COMMUNICATIONS CONSIDERATION(S):

None at this time.

OTHER CONSIDERATION(S):

None at this time.

PEACE RIVER REGIONAL DISTRICT

REPORT

To: Solid Waste Committee Report Number: ENV-SWC-154

From: Gerritt Lacey, Solid Waste Manager Date: April 5, 2024

Subject: Contract 40-2022 PRRD Landfill Environmental Monitoring and Reporting – Cost Increase

RECOMMENDATION:

That the Solid Waste Committee recommend that the Regional Board increase the total spend of Contract 40-2022 "PRRD Landfill Environmental Monitoring and Reporting" held by Matrix Solutions Inc. from the original value of $467,985.75 to a new value of $547,985.75 (excluding taxes) to accommodate the replacement and installation of monitoring wells at the Dawson Creek and Taylor Closed Landfills.

BACKGROUND/RATIONALE:

Contract 40-2022 titled PRRD Landfill Environmental Monitoring and Reporting, was awarded to Matrix Solutions Inc. on February 2, 2023 for a three year term beginning April 1, 2023 and expiring March 31, 2026.

The Peace River Regional District (PRRD) has nine landfills that require environmental monitoring of ground water, surface water, and/or landfill gas. Matrix provides field work services including monitoring and sampling, laboratory analysis, and data interpretation and reporting. Additionally, Matrix performs general maintenance of the PRRD's monitoring infrastructure and creates work plans as needed for larger repairs.

As a result of the 2023 program, Matrix identified two sites; Dawson Creek and Taylor closed landfills, that require either the replacement or addition of monitoring wells to maintain compliance with the requirements of the water monitoring programs. As part of the 2024 budget process, a supplemental request for $80,000 for the project was presented to the Solid Waste Committee on January 20, 2024 and approved by the Regional Board on February 21, 2024. The supplemental request has been attached to this report for reference.

ALTERNATIVE OPTIONS:

1. That the Solid Waste Committee provide further direction.

STRATEGIC PLAN RELEVANCE:

☒ Asset and Infrastructure Management

FINANCIAL CONSIDERATION(S):

The current contract value of $467,985.75 is for the annual monitoring, sampling, laboratory, and reporting costs. When large repairs to infrastructure are required, Matrix provides a work plan for budget consideration and approval within the contract.

As part of the 2024 Budget process $80,000 has been allocated to the Solid Waste Capital Budget for this project.

COMMUNICATIONS CONSIDERATION(S):

None at this time.

OTHER CONSIDERATION(S):

None at this time.

Attachments:

1. 2024 Supplemental Request – Dawson Creek and Taylor Water Monitoring Well Installations

External Links:

1. January 20, 2023 Solid Waste Committee Meeting – See Item 9.1 “RFP Award 40-2022 PRRD Landfill Environmental Monitoring and Reporting – ENV-SWC-127”
2. February 21, 2024 Special Regional Board Meeting – See Item 5.48 “Function 500 Solid Waste Draft 2024 Budget, ENV-BRD-166”

PEACE RIVER REGIONAL DISTRICT

Business Case

2024 Dawson Creek and Taylor Closed Landfill Water Monitoring Well Installations

Executive Summary

Business Need

To install additional groundwater monitoring wells including four at the Taylor Closed Landfill and five at the Dawson Creek Closed Landfill following qualified professional recommendations made by Matrix Solutions as part of the 2023 Water Monitoring program.

Expected Outcome

Taylor Closed Landfill

- Install new monitoring wells in 4 locations.
- Collect and test three sediment samples along the Mason Coulee upgradient, cross gradient, and down gradient of the landfill footprint.

Dawson Creek Closed Landfill

- Decommission monitoring wells DC-BH101 and DC-98 in accordance with BC ENV regulatory procedures.
- Install new monitoring wells at 5 locations.
- Complete a professional survey of all monitoring wells on the site.

Recommendation

That $80,000 be allocated in the 2024 Regional Solid Waste Capital Budget for the installation of four new monitoring wells at the Taylor Closed Landfill and five new monitoring wells at the Dawson Creek Closed Landfill following qualified professional recommendations made by Matrix Solutions as part of the PRRD's 2023 Water Monitoring Program.

Justification

As part of the 2023 Water Monitoring Program, Matrix Solutions has identified that additional monitoring wells are required at both the Taylor and Dawson Creek Closed Landfills to provide additional information of the background water quality coming into and leaving the area of each landfill.

The Team

Team Member	Role
General Manager of Environmental Services	To provide overall program oversight and provide direction and support for implementation, policy and procedure, procurement policies, and budgetary considerations.
Solid Waste Manager	To provide a program outline, work with regulatory bodies to ensure compliance, and oversee the implementation of the project through contract management and operational oversight.
Solid Waste Foreman	To oversee the progress of the project and coordinate with the Matrix Solutions.
Solid Waste Coordinator(s)	To update/create site operation plans to reflect the addition of the equipment.
Procurement Officer	Assist with contracts and purchases.
Matrix Solutions	To perform the necessary work required for completing the project and provide a construction summary report.

Business Need Definition

Problem Statement

Taylor Closed Landfill

The existing well network does not adequately allow for tested water sample parameters to be tracked horizontally or vertically on the site. Additional wells are required to ensure that ground water is not being affected by the landfill.

Dawson Creek Closed Landfill

Due to damage, the current background monitoring wells are not able to be sampled. Without background monitoring wells, data is unable to be collected and checked against water quality down gradient of the landfill.

Impacts

Installation of the additional wells will assist the PRRD's Qualified Professional (QP) determine if elevated chloride parameters experienced in the 2023 program are existing prior to the landfill footprint or as a result of an interaction with leachate within the landfill. Failure to install the wells will lead to gaps in the data being evaluated by the QP which in turn will prevent the QP from being able to determine if the landfill is affecting ground water quality.

PEACE RIVER REGIONAL DISTRICT

Project Overview

Project

2024 Dawson Creek and Taylor Closed Landfill Water Monitoring Well Installations

Project Description

Taylor Closed Landfill

Based on the water quality results from the 2023 groundwater and surface water monitoring program, Matrix identified several high, medium, and low priority data gaps. The objectives of the supplemental program are to laterally and vertically delineate chloride concentration exceedances in monitoring well TAY-MW13-102 and determine if the Mason Coulee is affected by elevated chloride concentrations in the groundwater unit.

To achieve these objectives, Matrix will complete the following:

1. Complete a pre-ground disturbance package including BC One Call and third-party line locates.
2. Repair the access road into site and install a temporary crossing for the drilling rig.
3. Advance three boreholes to laterally delineate chloride concentration exceedances in groundwater at monitoring well TAY-MW13-102 to a maximum depth of 9 m below ground surface (bgs).
4. Advance one borehole to vertically delineate chloride concentration exceedances in groundwater at monitoring well TAY-MW13-102 to a maximum depth of 21 m bgs.
5. Collect three sediment samples along the Mason Coulee upgradient, cross-gradient, and downgradient of the landfill footprint.
6. Submit select soil samples to ALS laboratory in Fort St. John, British Columbia, and analyze for CoCs.
7. Coordinate McElhanney to conduct a professional survey following installation of the groundwater wells.
8. Complete a summary report documenting the results of the program.

Dawson Creek Closed Landfill

Based on the results of the 2023 groundwater and surface water monitoring program, the objectives of the supplemental monitoring well installation program at the closed Dawson Creek landfill are to determine background groundwater quality and determine the risk to nearby receptors based on the potential leaching of impacted groundwater towards Dawson Creek.

To achieve these objectives, Matrix will complete the following:

1. Complete a pre-ground disturbance package including BC 1 Call and third-party line locates.
2. Decommission monitoring wells DC-BH101 and DC-98-5 in accordance with BC ENV regulatory procedures.
3. Advance a borehole to a maximum depth of 12 m bgs in an area north of the landfill footprint to act as a background location. The borehole will be completed as a nested pair to assess shallow (~4.5 m bgs) and deeper (~12 m bgs) groundwater quality.
4. Advance a borehole to a maximum depth of 6 m bgs west of the landfill footprint to aid in determining groundwater flow direction and water quality west of the landfill footprint. The borehole will be completed as a shallow groundwater monitoring well.
5. Advance two boreholes to a maximum depth of 6 m bgs to laterally delineate groundwater quality impacts identified in DC-19-1 and DC-98-1 which may be associated with leachate migration. The boreholes will be completed as shallow groundwater monitoring wells.

6. Advance a borehole adjacent to DC-19-1 and DC-98-1, respectively, to a maximum depth of 12 m bgs to vertically delineate groundwater quality impacts and aid in future risk assessments.
7. Complete a professional survey of all monitoring wells under the supervision of Matrix.
8. Complete hydraulic conductivity measurements using a slug or bailer recovery method on select monitoring wells.
9. Complete a supplemental site investigation summary report documenting the results of the program.

Project Budget

Department: Environmental Services
Division: Environmental Services
Function: 500 – Regional Solid Waste

Capital Expenses	2024	2025	2026	2027	2028	Summary
Dawson Creek Closed Landfill	$40,000					$40,000
Taylor Closed Landfill	$40,000					$40,000
TOTAL	**$80,000**	-	-	-	-	**$80,000**

Capital Funding Sources	2024	2025	2026	2027	2028	Summary
Requisition	$80,000					
TOTAL	**$80,000**	-	-	-	-	**$80,000**

Operational Expenses	2024	2025	2026	2027	2028	Summary
Dawson Creek Closed Landfill Monitoring Costs	$19,425	$24,280	$24,280	$25,000	$25,000	$117,985
Taylor Closed Landfill Monitoring Costs	$9,800	$12,250	$12,250	$12,620	$12,620	$59,540
TOTAL	**$29,225**	**$36,530**	**$36,530**	**$37,620**	**$37,630**	**$177,525**

Operational Funding Sources	2024	2025	2026	2027	2028	Summary
Requisition	$29,225	$36,530	$36,530	$37,620	$37,630	$177,525
TOTAL	**$29,225**	**$36,530**	**$36,530**	**$37,620**	**$37,630**	**$177,525**

Project Goals and Objectives

To remain in compliance with landfill permits.

Project Performance Indicators

1. Costs do not exceed project estimates.
2. Sampling new wells included in the 2024 Water Monitoring Program.

Assumptions

1. Matrix Solutions can be utilized to perform the work.
2. Access to the site is not limited.
3. Ground disturbances will not take place withing 5m of any underground facilities.
4. Costs of installation and professional oversight will be within the budgeted amount.

Constraints

1. Approval(s) and timeline for turnaround.
2. Contractor availability.
3. Inadequate funding.
4. Delays in installation occur due to weather.

Project Milestones

March 2024	- 2024 Budget Approval
April 2024	- Increase Matrix Contract and Obtain Contract Amendment Approvals
August 2024	- Work Complete

Strategic Fit

Asset & Infrastructure Management

Cost Benefits Analysis

The project aligns with the PRRD's permitted requirements and provide will a greater understanding of elevated parameters seen in the 2023 program and potential liabilities.

Alternatives Reviewed

Continue to monitor existing network for the Taylor Closed Landfill as meets the Permitted requirements. Existing data gaps would remain which would make determining the origin of potential leachate parameters difficult. Ground water well testing allows for a proactive approach to identifying changes in the composition of ground water and the potential impact of leachate to surface or groundwater sources.

Approvals

Regional Board Approval Resolution

PEACE RIVER REGIONAL DISTRICT

REPORT

To: Solid Waste Committee Report Number: ENV-SWC-155

From: Gerritt Lacey, Solid Waste Manger Date: April 5, 2024

Subject: Dawson Creek Closed Landfill Impact Assessment & Conceptual Regrading Plan Update

RECOMMENDATION:

That the Solid Waste Committee receive the report titled "Dawson Creek Closed Landfill Impact Assessment Update ENV-SWC-155", which provides committee members an update on works completed for the Dawson Creek Landfill since the completion of the 2021 Closure Plan prepared by GHD, for information.

BACKGROUND/RATIONALE:

The Dawson Creek Landfill stopped receiving waste between 2000 and 2002. In 2021 the Peace River Regional District (PRRD) commissioned a closure plan for the closed landfill as part of the regulatory requirements of closing a landfill. The closure plan was completed by GHD, and recaps the site history, the site setting, the closure design, the existing conditions, the leachate and landfill gas generation potential, and the risks to human health. Upon completion of the closure report, GHD identified 6 recommendations:

1. Remove the scattered litter and cover exposed waste on the landfill;
2. Develop a cover rehabilitation program to ensure a continuous presence of final cover over the waste and a minimum grade of 5%. The final cover rehabilitation program should include an assessment of whether the final cover requires armoring below the 1:200 year return period elevation of Dawson Creek;
3. Complete a focused risk assessment on the impact of leachate migration from the landfill through the creek meander to Dawson Creek;
4. Establish a soil gas monitoring program at the north property boundary;
5. Replace well BH-98-1 as recommended by Matrix; and
6. Continue to perform the current groundwater and surface water monitoring program, as recommended by Matrix.

Through 2022 and 2023, the PRRD worked with GHD to complete the focused risk assessment on the impact of leachate migration from the landfill to surface and ground water sources. The assessment evaluated the condition of the current cover system, the leachate generation potential of the landfill, and the results of the ongoing ground and surface water monitoring program for the site. The results of the water monitoring program note that elevated concentrations of select parameters associated with landfill leachate have been present in the downgradient wells. These elevated parameters have been present since 1999, and while these concentrations have exceeded the regulatory requirements, they have stabilized over the past several years and in some cases are decreasing.

As a result of completing the risk assessment for the site, GHD recommends continuing to monitor the groundwater and surface water programs, to test pit the cover system to determine the hydraulic conductivity, and to implement a cover rehabilitation program. The scope of the cover rehabilitation program would include:

- Test pitting the cover system to confirm hydraulic conductivity;
- Regrading steepened slopes;
- Regrading areas of ponding water;
- Adding additional cover soils;
- Removing or covering exposed waste;
- Developing soil gas monitoring program;
- Assessing and designing of armoring the banks of Dawson Creek if required; and
- Managing and redirecting surface water at the transfer station.

Design work for the rehabilitation plan is planned to take place in 2025.

ALTERNATIVE OPTIONS:

1. That the Solid Waste Committee provide further direction.

STRATEGIC PLAN RELEVANCE:

☒ Asset and Infrastructure Management

FINANCIAL CONSIDERATION(S):

A conceptual regrading plan was prepared by GHD to assist with estimating the cost of the rehabilitation program. At this time, the estimated cost to remediate the cover system is $780,000. However, this is the cost of the repairs to the side slopes only and does not include armoring the creek or paving the transfer station should it be required. Should the paving and armoring be required, the cost of the project could increase to upwards of $2,500,000.

In Q4 of 2024, a formal business case will be presented to the Solid Waste Committee for consideration to design the cover rehabilitation works in 2025 and to repair the site in 2026.

COMMUNICATIONS CONSIDERATION(S):

None at this time.

OTHER CONSIDERATION(S):

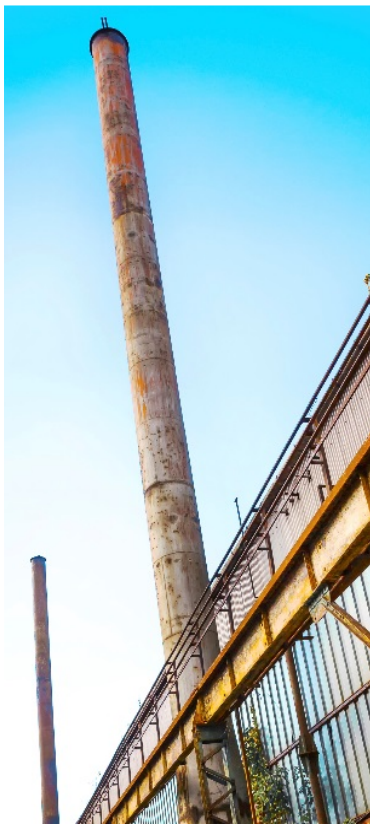
As part of the 2024 Solid Waste Capital program, the PRRD is replacing wells BH-98-1 and DC-BH101 as recommended by GHD and installing 5 new monitoring wells for continuation of the surface and ground water monitoring program. With completion of the rehabilitation program in 2026, all recommendations made through the 2021 closure plan will be completed. Ongoing monitoring of the surface and ground water program will continue until a time that a Qualified Professional can determine the program is no longer required.

Attachments:

1. 2021 Dawson Creek Landfill Closure Plan and Assessment
2. 2023 Dawson Creek Groundwater and Surface Water Impact Assessment
3. 2023 Dawson Creek Landfill Conceptual Regrading Plan Memo

Dawson Creek Landfill Closure Plan and Assessment

Peace River Regional District



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Appendix Index

1. Introduction

GHD was retained by the Peace River Regional District (PRRD) to prepare a Landfill Closure Plan and Assessment for the Dawson Creek closed landfill located at 829 Highway 49, Dawson Creek, British Columbia (BC). The landfill is authorized under Permit 2212 dated January 8, 2020 (Appendix A) issued by the Ministry of Environment and Climate Change (ENV). The Site location is shown on Figure 1, and the Site plan is shown on Figure 2.

The solid waste operations that form the Site today include the closed landfill footprint (landfill), and a transfer station, as shown on Figure 2. For the purposes of this report, the landfill closure assessment and plan have been completed on the landfill only.

GHD has completed the Landfill Closure Plan following the requirements outlined under Section 4.5 of the Permit and Section 10.3.4 of the Landfill Criteria for Municipal Solid Waste (BC ENV, June 2016). Table 1 provides a summary of the Permit Section 4.5 requirements.

2. Site History

The Dawson Creek closed landfill opened in 1974 (SLR consultning (Canada), 2018) and Permit 2212 (permit) was first issued on October 7, 1974. The permit authorized the discharge of municipal solid waste to the landfill, animal refuse to a carcass pit, and the operation of controlled open burning for wood waste. The landfill was constructed over a historical meander of Dawson Creek, which is approximately 20 metres (m) thick and infilled with fluvial sand and gravel. Waste was placed from the pre-existing north bank of Dawson Creek near Highway 49, to the south towards the existing creek.

In 1998, AGRA Earth and Environmental (AGRA) reported that leachate seeps were observed at the Site and a leachate management plan was developed. Additionally, slope instability concerns for the Site have been documented since the late 1990s. Geotechnical instrumentation was installed to measure slope stability in circa 1997. The geotechnical instrumentation has been read annually or biennially since it was installed.

From at least 2019, the PRRD completed voluntary post-closure groundwater monitoring and reporting to the ENV.

The landfill stopped receiving waste between 2000 and 2002. After closure, the Site continued to operate as a transfer station and waste was redirected to the Bessborough Landfill. Additionally, the Site received clean fill material up until January 1, 2020. Historically, the clean fill was placed at the crest of the landfill and pushed down slope by the contractors using the Site.

The permit was amended on January 8, 2020, to reflect the current state of the closed landfill and add two new clauses including annual reporting and a landfill closure plan. Groundwater and surface water monitoring is expected to continue.

Aerial photographs of the Site were requested from Environmental Risk Information Services (ERIS) and the University of British Columbia (UBC) Geographic Information Centre to determine additional information regarding historical landfill operations. The aerial photographs are provided in

Appendix B. Ten aerial photographs were available, which illustrate the Site conditions in 1964, 1966, 1970, 1977, 1981, 1984, 1987, 1990, 1996, and 2007. In the photographs from 1964 to 1970, the Site was undeveloped. In 1977 and 1981, evidence of road development and excavation/soil disturbance (i.e., landfill footprint) at the Site was apparent in the northern half of the Site. From 1984 and 1987, the landfill footprint increased slightly, and excavation and stockpiling can be observed. In 1990, the landfill footprint had expanded to the south, towards the existing creek. In 1996, the landfill footprint occupied the majority of the Site. In 2007, vegetation covered approximately 40 percent (%) of the previously disturbed area indicating that the landfill was in the post-closure phase.

3. Site Physical Setting

3.1 Climate

The climate near Dawson Creek is characterized by mild, wet summers and cold, dry winters. According to the data collected at the Dawson Creek A weather station (Climate ID 1182285), which is located approximately 1 kilometre (km) south of the Site and is in the same biogeoclimatic zone (Boreal White and Black Spruce) as the landfill, the area receives on average 453.2 millimetres (mm) of precipitation per year (307.2 mm is rainfall and 172.2 cm is snowfall). Precipitation is highly seasonal with 62 percent of total annual precipitation occurring from May to September. The daily average temperature is 1.9 degrees Celsius (°C) and ranges from -13.2 °C in January to 15.5 °C in July. The 1981 to 2010 Canadian Climate Normals data recorded at the Dawson Creek A climate station is presented on Figure 3.

3.2 Topography and Drainage

Topography and drainage features are shown on Figure 4. The Site slopes to the south from an elevation of approximately 650 metres above mean sea level (m AMSL) in the northern portion of Site to approximately 630 m AMSL in the southern portion of the Site. Regional topography near the Site slopes towards Dawson Creek.

Precipitation falling onto the landfill either infiltrates into the subsurface and recharges the vegetative cover or flows as overland runoff. Runoff either flows down the landfill side slopes in a west-southwest direction toward Dawson Creek or is captured by the runoff collection ditches constructed around the perimeter of the landfill. The collection ditches discharge clean stormwater into a retention pond located in the southeast corner of the Site.

Dawson Creek is present along the southern boundary of the Site. A recent flood assessment study estimated that the creek can rise by over 4 m from the base flow elevation during a 1:200-year return period storm event.

3.3 Geology

Based on the results of previous drilling investigations, overburden geology underlying the Site can be described as glaciolacustrine deposits of laminated to massive clay and glacial till. Overburden deposits were interpreted to be associated with a former glacial lake. Sand and gravel were encountered as part of the cut off meander of Dawson Creek. Bedrock was encountered in the

northwest area of Site at a depth of approximately 29.5 metres below ground surface (mbgs). Bedrock is of the Kaskapau Formation of the Smokey Group and is Upper Cretaceous in age. The Kaskapau Formation is characterized by fine clastic sedimentary rock, including mudstones, siltstones, and shale. Borehole logs from previous investigations are presented in Appendix C.

3.4 Hydrogeology

Two regional aquifers underlie the Site as identified by iMapBC. Aquifer 851 is a confined overburden aquifer comprised of glacial sand and gravel deposits. This aquifer has moderate productivity and low vulnerability and is overlain by a confining layer of low porosity clay. Precipitation and infiltration from surface water bodies are estimated to be the primary source of recharge for the aquifer. Aquifer 593 is a bedrock aquifer comprised primarily of shale with some sandstone of the Kaskapau Formation. The aquifer has moderate vulnerability and productivity, and precipitation is estimated to be its primary source of recharge.

Five monitoring wells (MW) are installed within the overburden aquifer on the Site. Well DC-95-1 was destroyed within the last few years due to flooding of Dawson Creek. This well was recommended to be replaced by Matrix during the 2019 annual report titled *2019 Groundwater and Surface Water Monitoring Sampling Program* (Matrix Solutions Inc., February 2020). Wells DC-98-5 and DC-BH101 are located upgradient to the north of the landfill and well DC-95-2 is located cross-gradient to the east. Wells DC-98-1 and DC-98-3 are located downgradient to the southeast and southwest, respectively. Well DC-98-1 was installed within sand and gravel of the old creek meander of Dawson Creek. Other wells were installed within the glaciolacustrine clay and till deposits. Waste was placed on top of clay and clay till (AECOM, 2012).

Hydraulic conductivity testing has been completed on Site. Generally, the hydraulic conductivity in the clay till was found to be approximately 4.59×10^{-7} cm/s (SLR, 2016). The sand and gravel in the old creek meander of Dawson Creek was found to have a hydraulic conductivity at approximately 1×10^{-1} cm/s. The old creek meander of Dawson Creek provides a preferential pathway for leachate migration directly to Dawson Creek.

Based on the 2019 well data provided in previous annual reports, the depth of shallow groundwater ranges from approximately 10 to 14 mbgs (at wells DC-98-5 and DC-BH101 to the north) and 1 to 2 mbgs (at well DC-95-1 near Dawson Creek). Elevations of shallow groundwater ranges from approximately 643 mAMSL to the north, to approximately 630 mAMSL to the south. Groundwater elevations to the south are similar to elevations in Dawson Creek. Local groundwater flows to the south, following local topography and towards Dawson Creek.

A horizontal groundwater flow velocity of 0.06 metres per year (m/yr) was calculated for the clay till based on a horizontal gradient of 0.03 m/m (May 2019 water levels at DC-BH101 [642.28 mAMSL] and DC-98-3 [632.34 mAMSL]), an average hydraulic conductivity of 1×10^{-7} cm/s and an estimated porosity of 0.5 percent. Groundwater monitoring wells and flow direction is presented on Figure 5.

It is expected that the groundwater flow velocity would be significantly higher within the sand and gravel of the old creek meander for Dawson Creek. The groundwater flow velocity could not be accurately estimated within the old creek meander because well borehole logs and installation data are not available. However, the hydraulic conductivity of the gravel within the old creek meander was was estimated to be approximately 1×10^{-1} cm/s. It can be assumed that the groundwater velocity

would be multiple orders of magnitude faster in the creek meander compared to the glaciolacustrine clay and till.

SLR reported that the landfill contributes less than 0.1% to stream flow in Dawson Creek and accounts for 0.08% to 0.54% mass loading to the stream (SLR, 2018).

3.5 Surrounding Land Use

The lands surrounding the Site to the north and east are designated as agricultural land reserves (ALR) used for farming. The municipal boundary for the City of Dawson Creek is to the south and west of the Site. A number of commercial properties are located within in the municipal boundary to the east, and sewage treatment lagoons are located to the south. Agricultural land reserve and land zoned I-2 for General Industrial Use, is located to the east of the Site. Land to the North is zoned P-2 for civic, assembly, and institutional use.

There are two residences within 500 m of the Site, one approximately 65 m north (up-gradient), and the other approximately 150 northwest (up-gradient).There are no well sites within a 500 m radius of the Site. The nearest groundwater well is approximately 770 m to the west (cross-gradient).

The nearest aquatic receiving environment is Dawson Creek, which is located adjacent south of the Site. A number of unnamed streams and tributaries to Dawson Creek are also located within a 1 km radius of the Site.

4. Closed Landfill Design

4.1 Final Cover

Final cover was placed on the landfill between 2000 and 2002. It was reported in an Earth Tech letter (Mareese Keane, 2003) from 2003 that the final cover would be sourced locally from a large building construction. The final cover was intended to include a drainage layer below the clay to avoid leachate breakouts.

On May 28, 2020, GHD completed a walkthrough of the Site with the PRRD and confirmed that the current final cover includes:

- Topsoil with sufficient thickness and quality to support vegetation except where recent soil was deposited at the top of slope. Where present, vegetative cover is well established and is dominated by grass (Poacea ssp.), and dandelion (Taraxacum officinale).
- Possible geosynthetic layer overlying waste with the exception of the southeast side slope where exposed waste is present.
- Common fill layer with sufficient thickness to support surface water runoff.
- Erosion prevention controls include vegetative cover and 3:1 landfill side slopes.
- Visual evidence of differential settlement was observed including a large crack at the toe of slope along the west side of the landfill and sloughing on the south landfill side slope.

Photos taken during the Site walkthrough are presented in Appendix D.

4.2 Vector Controls

The landfill is not expected to attract vectors or wildlife due to the placement of final cover across the majority of the landfill. There have been no recorded occurrence or indication vectors or wildlife on Site (e.g., burrows, digging marks, etc.) including along the southeast side slope where exposed waste was observed. If vector and wildlife become problematic, measures will be taken to ensure the protection of the wildlife and the environment.

4.3 Estimate of Waste Landfilled

Based on local census data and the British Columbia average municipal solid waste disposal rates for the PRRD, GHD estimated an average waste disposal of 9,636 tonnes/year over an assumed 26 to 28-year lifespan, and a final total landfilled waste of approximately 250,538 to 269,799 tonnes.The estimate of waste landfilled was calculated using the following equation:

Waste Landfilled = (Disposal Rate x Population) / 1000

Where:

Waste Landfilled (tonnes): the amount of waste discharged to the landfill in tonnes per year.

Disposal Rate (kg/person): Annual municipal solid waste disposed per person for the PRRD from 1990 to 2018, published by the ENV. Per-person disposal rate is an estimate of how many kilograms of solid waste each BC resident sends to a landfill or other disposal site in a given year. The PRRD disposal rates between 1992 and 1996 were not published within the ENV dataset. To account for the data gaps, the 1991 disposal rate was used for 1992, 1993, 1994, and 1995 rates.

Population (): The number of people residing within Dawson Creek from 1974 to 2006, as published by Statistic Canada. Populations between census years were inferred based on population growth rates.

4.4 Lifespan Analysis

The landfill was closed between 2000 and 2002. The 25-year post-closure period ends in 2027.

4.5 Proposed End Use

Currently the proposed end use for the Site is undeveloped land in support of transfer station operations.

5. Existing Conditions

On May 28, 2020, GHD completed a walkthrough of the Site with the PRRD to assess the existing condition of the landfill. The following observations

- Slope inclinometers are present on Site.
- Loose soil mounds were found at the landfill plateau.

- Uncompacted cover soil with no vegetation was found at the top of the west side slope of the landfill.
- Ponded surface water was found at the southwest toe of the landfill.
- Visual evidence of differential settlement was observed including a large crack at the toe of slope along the west side of the landfill and sloughing on the south landfill side slope.
- Scattered litter such as scrap metal and concrete were observed at the west side of the landfill.
- Exposed waste was observed at the southeast side slope of the landfill.
- Exposed geosynthetics near pond on southwest slope.

6. Leachate Generation and Migration Potential

The following section presents a qualitative review of potential leachate derived impacts to the environmental receptors in the vicinity of the Site. The leachate generation potential and the attenuation capacity of the Site are assessed to identify contaminant transport pathways and determine the potential for off-Site migration.

6.1 Leachate Generation

The leachate generation rate for the Site can be estimated using the Water Balance Method (WBM) published in the textbook titled *Solid Waste Landfill Engineering and Design* (McBean et al., 1995) and adopted by the United States Environmental Protection Agency (EPA, 2005). This method is based on the principle of conservation of mass by determining the major segments of precipitation that detract from percolation (e.g. interception by vegetation). Following the WBM, a Site-specific leachate generation rate or potential can be estimated using the equation and inputs provided below.

Simplified WBM equation:

Infiltration = Precipitation – Surface Runoff – Soil Moisture Storage – Evapotranspiration

Site-specific inputs:

- Average monthly temperatures
- Site latitude
- Average monthly precipitation in inches of water
- Landfill surface conditions
- Soil and vegetation type for final cover

The WBM results are summarized in Figure 6. As shown on Figure 6, approximately 12.7 millimetres (mm) or 3 percent of the annual precipitation was estimated to percolate through the landfill cover to generate leachate. Leachate generation at the Site is estimated to be approximately 1016 cubic metres (m^3) per year based on a waste footprint area of 80,000 m^2 (8 hectares) and the estimated annual leachate generation rate of 0.0127 m (12.7 mm). The Site has a low leachate generation potential relative to other closed landfills in BC.

6.2 Leachate Migration and Attenuation

The migration of contaminants from waste to groundwater will occur through three stages:

- Leachate generation resulting from the release of contaminants from refuse into infiltrating water
- Leachate contaminant transport through the underlying soil or unsaturated zone
- Leachate contaminant transport through the underlying aquifer or saturated zone

During leachate migration, attenuation occurs as contaminants move through soil and groundwater and are subject to physical, chemical, and biological processes that result in reduction of contaminant concentrations.

In the unsaturated zone, filtration, oxidation/reduction, precipitation, adsorption and biological degradation processes occur in the unsaturated zone. These processes reduce contaminant levels before reaching the groundwater table. Based on the 2019 environmental monitoring program results (Matrix), the average unsaturated zone across the Site is approximately 1 to 14 m in thickness. The unsaturated zone underlying the Site can be characterized as thin indicating that processes to reduce contaminant levels before reaching the groundwater table is assumed low.

Once leachate has migrated below the water table, leachate contaminants will predominantly migrate by advection, dispersion and diffusion. Leachate constituents are primarily reduced by diffusion and dispersion, however the other attenuation mechanisms listed above can still occur although to a much lesser extent.

6.2.1 Attenuation Mechanisms

The following section briefly describe the attenuation mechanisms specific to the Site within the subsurface that would affect the rate and transport of leachate contaminants.

Advection

Advection is the movement of solutes due to motion of flowing groundwater. Based on the very low groundwater velocity of 0.06 m/yr (see Section 3.4) within the glaciolacustrine clay and till, leachate solutes have migrated approximately 1.5 m over the landfill's 26-year lifespan. The groundwater flow rate can increase or decrease by dispersion, diffusion or adsorption of contaminants to soil.

Note that there is an old creek meander from Dawson Creek that runs under the landfill. The hydraulic conductivity of the creek meander was estimated to be approximately $1x10^{-4}$ m/s, compared to a hydraulic conductivity of approximately $1x10^{-7}$ m/s in the glaciolacustrine clay and till. The groundwater velocity in the creek meander cannot be estimated but it is assumed to be significantly faster than within the clay and till. The creek meander provides a preferential pathway for leachate migration to Dawson Creek.

Sorption and Ion Exchange

Adsorption represents a collection of processes that remove contaminants in or onto solid soil surfaces. Cation exchange capacity (CEC) is a measurement of the soil's ability to hold cations (positive ions) by electrical attraction to clay particles and organic matter, which have negatively

charged surfaces. The CEC of the soil is dependent on the amount of clay and organic matter, as well as the type of clay particles present in the soil matrix.

The CEC for soil in Dawson Creek varies across the Site due to the variation in soil type. Based on the available information on geological characterization (refer to Section 3.3), the surficial soils are primarily of glaciolacustrine clay and till, with sand and gravel within the old creek meander. Typical CEC values, at a pH of 7, are 40 to 80 meq/100 g for 2:1 clays (montmorillonite minerals) and 5 to 20 meq/100 g for 1:1 clays (kaolinite minerals) (McBean et al., 1995).

For the purpose of this report, it is assumed that the CEC is moderate between 20 to 40 meq/100 g due to the type and presence of clay underlying the Site.

Hydrodynamic Dispersion and Diffusion

Hydrodynamic dispersion and diffusion are the processes where leachate contaminants spread out from the expected horizontal flow path and results in the dilution of the leachate solutes. Dispersion is the process of mechanical mixing with uncontaminated water and diffusion is the process of chemical mixing across concentration gradients. As a result of the low groundwater velocity calculated for the Site, the effects of dispersion and diffusion are negligible indicating that the leachate plume is relatively narrow and will not exceed the width of the landfill. Dispersion within the old creek meander is expected to be limited to the channelized sands and gravel.

Biodegradation

Aerobic and anaerobic degradation processes occur as biodegradable organic materials pass through the soil and is typically the dominate attenuation process. Since the landfill has been closed for at least 18 years, leachate strength and the availability of nutrients is poor due to the continuous degradation of landfilled waste.

6.2.2 Summary

Based on the above, the potential for leachate migration and natural attenuation is high within the sands and gravel of the old creek meander, which provides a preferential pathway for leachate transport to Dawson Creek. Limited information is available on the creek meander. The degree of leachate transport to Dawson Creek is monitored through surface water sampling (described in Section 6.3).

The potential for leachate migration within the clay and till over the remainder of the Site would be low largely due to the amount and considerable thickness of silts and clays underlying the landfill. This geologic setting provides a low rate of leachate/groundwater movement.

6.3 Groundwater and Surface Water Quality

The groundwater and surface water quality on Site is monitored three times per year in spring, summer, and fall by Matric Solutions Inc. (Matrix). Based on the 2019 monitoring report, landfill derived impacts are present in groundwater and surface water. Groundwater is currently monitored at five monitoring wells on-Site (Figure 5). Surface water is monitored at four locations within Dawson Creek to the south of the landfill.

Within the last five years (2015 to 2019), groundwater has exceeded the applicable standards at least once for ammonia, nitrate, phenols, chloride, sulphide, sulphate, boron, magnesium, manganese, sodium, arsenic, iron, uranium, cadmium, cobalt, lithium, nickel, strontium, and thallium. Benzene was also detected at well DC-98-1. Landfill-related impacts to groundwater are observed. Generally, well BH-98-1 shows the highest concentrations and most frequent exceedances of applicable standards. Well BH-98-1 is screened within the sand and gravel of the old creek meander, which provides evidence that leachate is migrating within this channel. Well BH-98-1 was recently destroyed by a flood in Dawson Creek, and it was recommended that PRRD replaces this well. In the latest 2019 annual monitoring report by Matrix, it was recommended the current groundwater monitoring program continue.

Surface water concentrations have also been reported above the BC Working and Approved Water Quality Guidelines (WQG) within the last five years. Parameters with elevated concentrations include dissolved oxygen (DO), electrical conductivity (EC), chloride, sulphide, sulphate, nitrate, ammonia, alkalinity, phosphorus, pH, sulphide, total dissolved solids (TDS), beryllium, cadmium, chromium, iron, manganese, aluminum, arsenic, cadmium, vanadium, fecal coliforms, and E. Coli. Landfill-related impacts to surface water are observed. Matrix recommended that the current surface water monitoring program continue.

7. Landfill Gas Generation Potential

Landfill gas generation was estimated for the landfill using the Scholl Canyon Model to quantify the peak methane generated annually. The model is recommended by the ENV to evaluate landfill gas generation and emission rates for the purpose of assessing potential landfill gas impacts (BC Ministry of Environment, 2009).

Use of the model requires two major Site-specific inputs to calculate theoretical methane generation rates:

1. The methane generation potential, Lo, which represents the total potential yield of methane from a mass of waste (m^3 of methane per tonne of waste). The Lo value is dependent on the composition of waste, and in particular, the fraction of organic matter present.

   For the purposes of this report, it is assumed that one third of waste is relatively inert, a third is moderately decomposable, and a third is decomposable.

2. The methane generation rate, k, which represents the first-order biodegradation rate at which methane is generated following waste placement. This constant is influenced by moisture content, the availability of nutrients, pH, and temperature. For determining the value of k, average annual precipitation data should be used.

   The area near Dawson Creek receives on average 453.2 mm of precipitation per year (see Section 3.1), which equates to the following k values: 0.01 for relatively inert waste, 0.02 for moderately decomposable waste, and 0.05 for decomposable waste.

Based on the assumptions above, the model estimates the rate of landfill gas generation in 2020 to be 188.0 tonnes of methane per year. Supporting calculations are presented in Appendix E.

8. Human Health and Environment Risk Evaluation

The evaluation presented below evaluates whether the closed landfill poses acceptable or unacceptable risks to human health and the environment. Per Protocol 13, Screening Level Risk Assessment (SLRA), if a contaminated site is deemed to have no unacceptable risks (i.e., pass the SLRA), then the site is considered to satisfy the risk-based matrix standards of the BC Contaminated Site Regulation, BC Reg. 375/96 (CSR). Using Protocol 13 as a guide, and the known physical, engineered and leachate characteristics of the Site, GHD provided rationale as to whether the existing conditions of the closed landfill poses no unacceptable risks.

Table 8.1 lists each of the potential exposure pathways, as defined by both Protocol 13 and the CSR Section 3.1 matrix standards site-specific factors. Both human and environmental protection exposure scenarios were evaluated.

Table 8.1 Risk Evaluation for the Dawson Creek Closed Landfill

Pathway	Receptor	Risk Evaluation
Human Exposure Scenarios		
Exposure to Contaminated Soils or Waste– Intake of contaminated soil or waste (i.e., ingestion, dermal, dust inhalation, vapour inhalation)	Human – Public, Trespasser, Site Worker	The exposure pathway for human exposure to waste possible due to: • The presence of exposed waste on the southeast landfill side slope Once the waste has been covered, exposure will be eliminated by: • Final cover eliminates the exposure pathway for ground surface to be uncovered and waste to be exposed at surface. Final cover provides a barrier to prevent contact with waste. • The Site is private property with a gate securing the Site entrance. **Based on the above, the human health exposure pathway by ingestion is complete for the public, trespasser or public worker. Therefore, an unacceptable risk to human health exist.**
Exposure to Contaminated Groundwater – Groundwater used for drinking water	Human	The exposure pathways for groundwater used for drinking water becoming contaminated by leachate exists based on the following: • Dawson Creek is located to the south of the Site and may be used for drinking water. • The groundwater velocity underlying the Site is estimated at 0.06 m/yr in the glaciolacustrine clay and till. Groundwater velocity is estimated to be significantly faster in the old creek meander, which acts as a preferential pathway for leachate migration to Dawson Creek.

Pathway	Receptor	Risk Evaluation
		• Groundwater flow also exists within the old creek meander for Dawson Creek, which has a hydraulic conductivity of approximately $1x10^{-4}$ m/s indicating that this aquifer is a potential future drinking water source. • Groundwater impacts are observed on Site and surface water impacts are observed in Dawson Creek. • Groundwater and surface water concentration have recently exceeded BC CSR drinking water (DW), aquatic life (AW), livestock (LW), irrigation (IW), and/or wildlife (WW) standards **Based on the above, the human health (drinking water) exposure pathway is complete. Therefore, an unacceptable risk to human health exists.**
Exposure to Landfill Gas – Inhalation and/or Explosive Atmosphere	Human – Public, Trespasser, Site Worker	The exposure pathways for landfill gas migration may not be eliminated based on the following: • Significant potential landfill gas generation due to a total waste landfilled in exceedance of 100,000 tonnes. • The rate of landfill gas production is estimated to be 188.0 tonnes of methane per year in 2020. • Structures with concrete foundations are located north of the Site. Although, no preferential pathways leading from the landfill footprint to the off-Site structures (i.e. no utility trenches) have been identified, higher permeable soils may be present between the landfill and the neighboring property. **Based on the above, the human health and safety exposure pathway for landfill gas is potentially complete. A landfill gas perimeter probe monitoring program should be initiated to assess whether landfill gas is migrating in the soils adjacent to the Site.**
Environmental Exposure Scenarios		
Terrestrial Exposure to Contaminated Soil – Toxicity to Soil invertebrates and plants	Terrestrial	The exposure pathway for terrestrial exposure to contaminated soil and waste is possible due to: • The presence of exposed waste on the southwest side slope. Once the waste has been covered, exposure will be limited due to:

Pathway	Receptor	Risk Evaluation
		• The placement of final cover eliminates any contact between the waste and ground surface. • There have been no occurrences or indication of vectors or wildlife on-Site (e.g. burrows, digging marks). • Annual final cover monitoring will be completed by the PRRD during the post-closure period (see Section 11) to ensure the integrity of the final cover is maintained. **Based on the above, the terrestrial exposure pathway is present. Therefore, an unacceptable ecological risk exists until the litter and stockpile has been removed.**
	Invertebrates and plants	The exposure pathway for invertebrates and plants is possible due to: • Exposed waste on the southwest side slope. Once the exposed waste has been covered, the exposure pathway will be eliminated by: • Placement of final cover eliminates any contact between waste and ground surface and provides a barrier for the potential for invertebrates to come into contact with waste or waste beneath the geosynthetic where placed.. • Planting of specific non-deep rooting plants within the topsoil providing soil stability and limiting the potential for plants to break through the geosynthetic layer. • Annual final cover monitoring and erosion and settlement monitoring will be completed by the PRRD during the post-closure period (see Section 11) to ensure the integrity of the final cover is maintained. **Based on the above, the invertebrates and plants exposure pathway is complete. Therefore, an unacceptable ecological risk exists.**
Exposure of livestock to contaminated soil and groundwater – Livestock ingesting soil and fodder, and groundwater used for livestock watering.	Livestock	Livestock exposure is limited by the placement of final cover eliminating any contact between waste and ground surface and providing a barrier for the potential for livestock to come into contact with waste or waste beneath the geosynthetics where placed. An exposure pathway for livestock exists based on: • The groundwater quality and surface water quality within Dawson Creek shows landfill-related impacts.

Pathway	Receptor	Risk Evaluation
		• Surface water concentrations have recently exceeded BC CSR livestock (LW), irrigation (IW), and wildlife (WW) standards **Based on the above, the livestock exposure pathway to groundwater used for livestock watering is complete. Therefore, an unacceptable environmental risk exists.**
Exposure of aquatic biota to contaminated groundwater – Groundwater flow to surface water used by aquatic life	Aquatic Biota	Aquatic biota exposure exists from the following: • Dawson Creek is located in close proximity to the landfill to the south of the Site. • An old sand/gravel creek meander for Dawson Creek exists below the landfill, which acts as a preferential pathway for leachate migration to Dawson Creek. • Surface water quality within Dawson Creek shows landfill-related impacts with observation from multiple parameters exceeded BC CSR drinking water (DW), aquatic life (AW), livestock (LW), irrigation (IW), and/or wildlife (WW) standards. • Groundwater quality on Site shows landfill related impacts. • It is recommended that the current groundwater and surface water monitoring program continue. **Based on the above, the aquatic biota (surface water) exposure pathway is complete. Therefore, an unacceptable ecological risk exists.**

Based on the information presented in Table 8.1, all of the human and ecological exposure pathways exist. Therefore, the landfill poses unacceptable risk to human and environmental health in its current state. The Site can be classified as high risk.

9. Conclusions

Based on the Site physical setting, landfill closure design, and human and environmental risk evaluation, the following conclusions are made:

Site Setting

- Dawson Creek is located adjacent and south of the landfill.
- The Site is underlain primarily by glaciolacustrine clay and till. These soils act as a confining layer to overburden Aquifer 851, which is located beneath the Site. In addition, due to the physical characteristics of the soil, these surficial clays do not support a single-family domestic water supply well, and there are no drinking water wells located within a 500 m radius of the Site.

- An old creek meander for Dawson Creek exists below the landfill, consisting of sand and gravel. These soils act as a preferential pathway for leachate from the landfill to Dawson Creek.
- The groundwater flow rate is low at 0.06 m/yr in the glaciolacustrine clay and till. Groundwater flows in a southerly direction.

Landfill Closure

- The landfill was closed between 2000 and 2002. The Site currently operates as a transfer station.
- The 2020 Permit amendment was initiated by the ENV to update the format, make necessary adjustments to reflect the current state of the closed landfill, and add two new clauses including annual reporting and a landfill closure plan.

  Based on the existing conditions of the Site, the landfill cover appears to be discontinuous likely from differential settlement of the landfilled waste as indicated by the observed cracking and sloughing of soil.
- As presented in Table 1, Landfill Closure Plan Status, this report satisfies Permit Condition 4.5.

Risk Evaluation

- Leachate generation at the Site is estimated to be approximately 1,016 m^3 per year. This is a medium leachate generation rate relative to other closed landfills in BC.
- The potential for leachate migration is high within the sands and gravel of the old creek meander, which provides a preferential pathway for leachate transport to Dawson Creek. The potential for leachate migration vertically within the clay and till over the remainder of the Site is low largely due to the amount and considerable thickness of silts and clays underlying the landfill.
- Groundwater and surface water quality shows landfill-related impacts, with multiple parameters concentrations reported above the applicable CSR standards.
- The rate of landfill gas production is estimated to be 188.0 tonnes of methane per year in 2020, which is high relative to the other closed landfills in the PRRD. The potential for landfill gas migration in the soils around the landfill footprint exists and a soil gas monitoring program should be developed in order to evaluate the potential for soil gas migration.
- Based on the information presented in Table 8.1, all of the human and environmental exposure pathways exist. The Site can be classified as high risk.

10. Recommendations

Based on the conclusions in Section 9, the following recommendations are made:

- Remove the scattered litter and cover exposed waste on the landfill.
- Develop a cover rehabilitation program to ensure a continuous presence of final cover over the waste and a minimum grade of 5 percent. The final cover rehabilitation program should include

an assessment of whether the final cover requires armouring below the 1:200-year return period elevation of Dawson Creek.

- Complete a focused risk assessment on the impact of leachate migration from the landfill, through the creek meander to Dawson Creek.
- Establish a soil gas monitoring program at the north property boundary.
- Replace well BH-98-1 as recommended by Matrix.
- Continue to perform the current groundwater and surface water monitoring program, as recommended by Matrix.

11. Monitoring Plan and Design

As outlined in Table 11.1, the monitoring plan for the remaining post-closure period of 7 years includes erosion and settlement, groundwater, surface water, and landfill gas monitoring, and the development of a design concept and detailed design for final cover rehabilitation.

Table 11.1 2020–2027 Monitoring Plan

Component	Frequency	Description
Final cover	Ongoing	Development of a design concept and detailed design for final cover rehabilitation.
Erosion and settlement	Annually	Complete Site inspection for visual evidence of erosion, settlement, slope movement, and occurrence of leachate seeps with the potential for failure of the final cover. Visual observations may include tensions cracks, slumps, preferential settlement, vegetation stress, cover soil erosion, etc.
Groundwater/leachate	Triannually	Continue the current groundwater monitoring program as recommended in the 2019 Annual Operations and Monitoring Report.
Surface water	Triannually	Continue the current surface water sampling program as recommended in the 2019 Annual Operations and Monitoring Report.
Landfill gas	Triannually	Install and monitor two to three soil gas probes on the northern property line for the presence of methane.

12. References

BC Ministry of Environment. (2009). *Landfill Gas Generation Assessment Procedures Guidelines.* BC Ministry of Environment.

Edward A. McBean, F. A. (1995). *Solid Waste Landfill Engineering and Design.* Prentice Hall PTR.

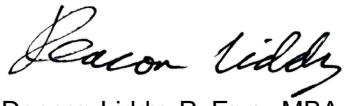
Environmental Protection Agency (EPA). (2005, August). Retrieved from Example Moisture Mass Balance Calculations for Bioreactor Landfills: https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=9101V4IJ.TXT

iMapBC. (2018, August). Retrieved from Government of British Columbia: https://www2.gov.bc.ca/gov/content/data/geographic-data-services/web-based-mapping/imapbc
Mareese Keane, P. (2003). *Landfill Surface Water Monitoring Program, Attention Mr. Larry Gardner, Environmental Protection Officer.*
Matrix Solutions Inc. (February 2020). *2019 Groundwater and Surface Water Monitoring and Sampling Program, Peace River Regional District Landfill Sites.*
Provincial Agricultural Land Commission (ALC). (2014). Retrieved from ALR & Maps: https://www.alc.gov.bc.ca/alc/content/alr-maps
SLR consultning (Canada). (2018). *2017 Groundwater and Surface Water Monitoring and Sampling Program, Peace River Regional District Landfill Sites.*
UMA Engineering Ltd. and EBA Engineering Consultants Ltd. (1997). *Landfill Closure Plan Ten Rural Sites.* Edmonton.

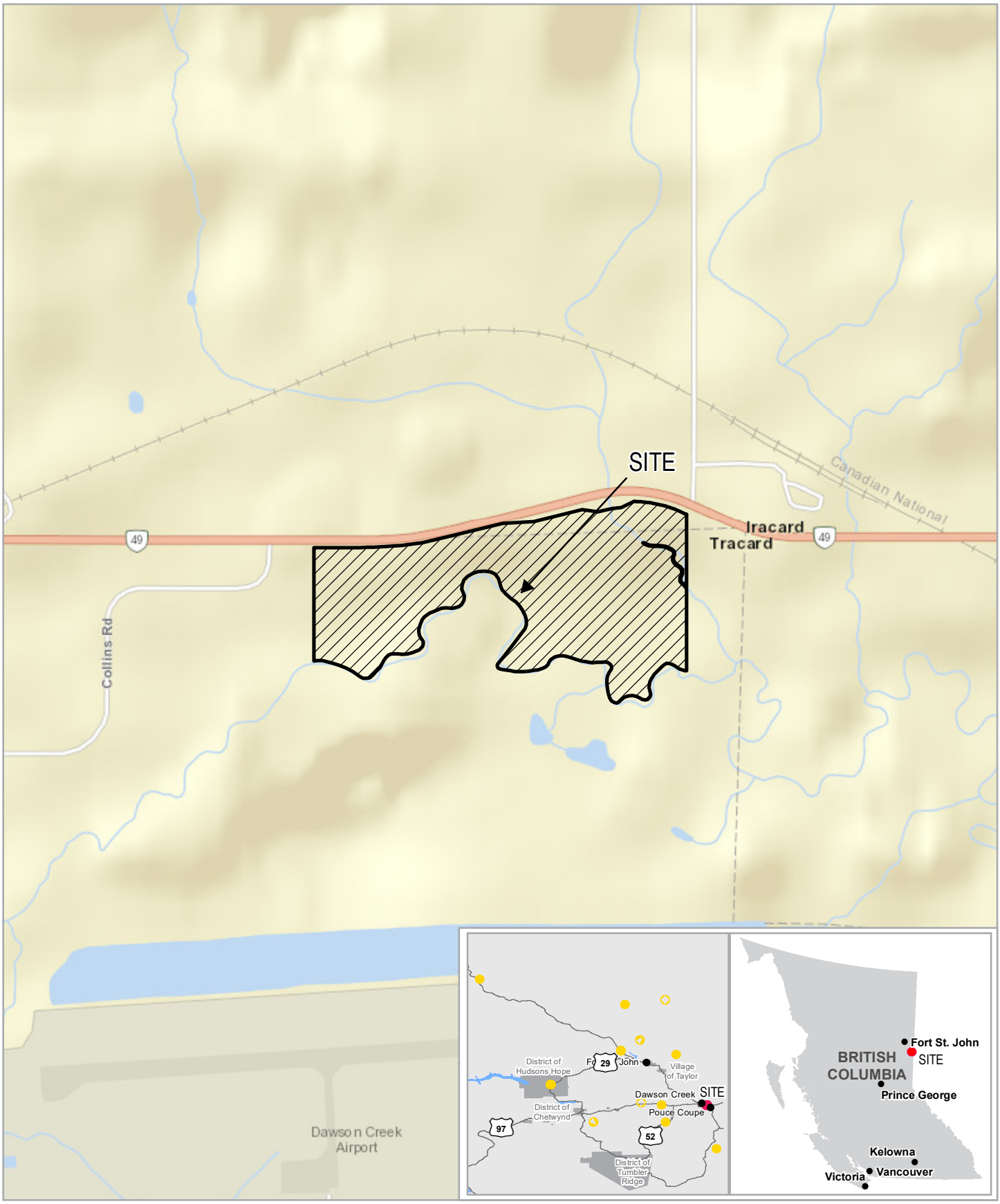
All of Which is Respectfully Submitted,

GHD

Rose Marie Rocca, P. Geo



Deacon Liddy, P. Eng., MBA



Paper Size ANSI A

0 130 260 390 520

Meters

Map Projection: Mercator Auxiliary Sphere
Horizontal Datum: WGS 1984
Grid: WGS 1984 Web Mercator Auxiliary Sphere

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GHD

DAWSON CREEK LANDFILL CLOSURE REPORT
DAWSON CREEK, BC
PEACE RIVER REGIONAL DISTRICT
DAWSON CREEK LANDFILL CLOSURE REPORT

Project No. 11213132
Revision No. -
Date Aug 21, 2020

SITE LOCATION MAP

FIGURE 1

Q:\GIS\PROJECTS\11213000s\11213132\Layouts\202008_RPT000\11213132_202008_RPT000_GIS001.mxd, Report 13

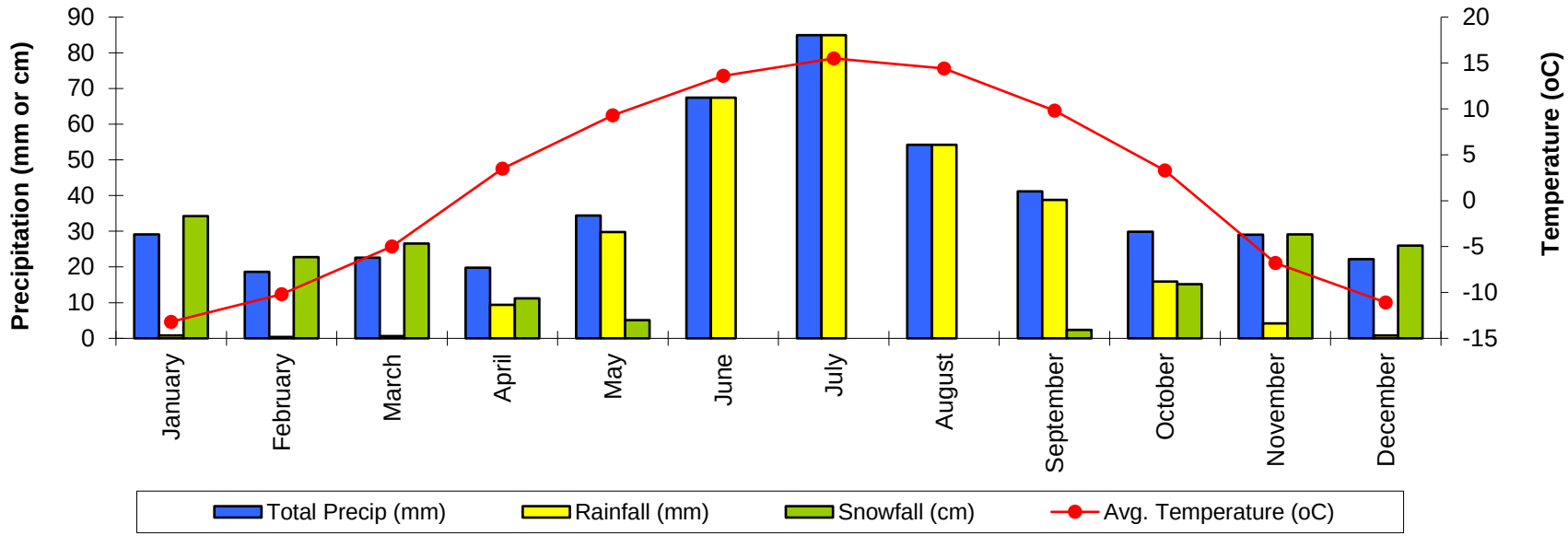
Data source: ESRI Topogrpahic basemapping, Accessed 2020

Source: Google Earth accessed October 2020

Site Boundary

Approximate Limit of Waste

FIGURE 2
SITE PLAN
DAWSON CREEK LANDFILL CLOSURE PLAN AND ASSESSMENT
DAWSON CREEK, BC
Peace River Regional District



Month	Daily Average Temperature (Celsius)[1]	Daily Maximum Temperature (Celsius)[1]	Daily Minimum Temperature (Celsius)[1]	Rainfall (mm)[1]	Snowfall (cm)[1][2]	Precipation (mm)[2]
January	-13.2	-7.2	-19	0.8	34.2	29.1
February	-10.2	-3.9	-16.5	0.4	22.8	18.6
March	-5	0.9	-10.9	0.6	26.6	22.6
April	3.5	10	-3.1	9.4	11.2	19.8
May	9.3	16.4	2.1	29.8	5.1	34.4
June	13.6	20.1	6.9	67.4	0	67.4
July	15.5	22.2	8.9	84.9	0	84.9
August	14.4	21.5	7.2	54.2	0	54.2
September	9.8	16.2	3.3	38.8	2.4	41.2
October	3.3	9	-2.4	15.9	15.2	29.9
November	-6.8	-1.5	-12.2	4.2	29.1	29
December	-11.1	-5.3	-16.8	0.8	26	22.2
Annual	**1.9**	**8.2**	**-4.4**	**307**	**173**	**453.2**

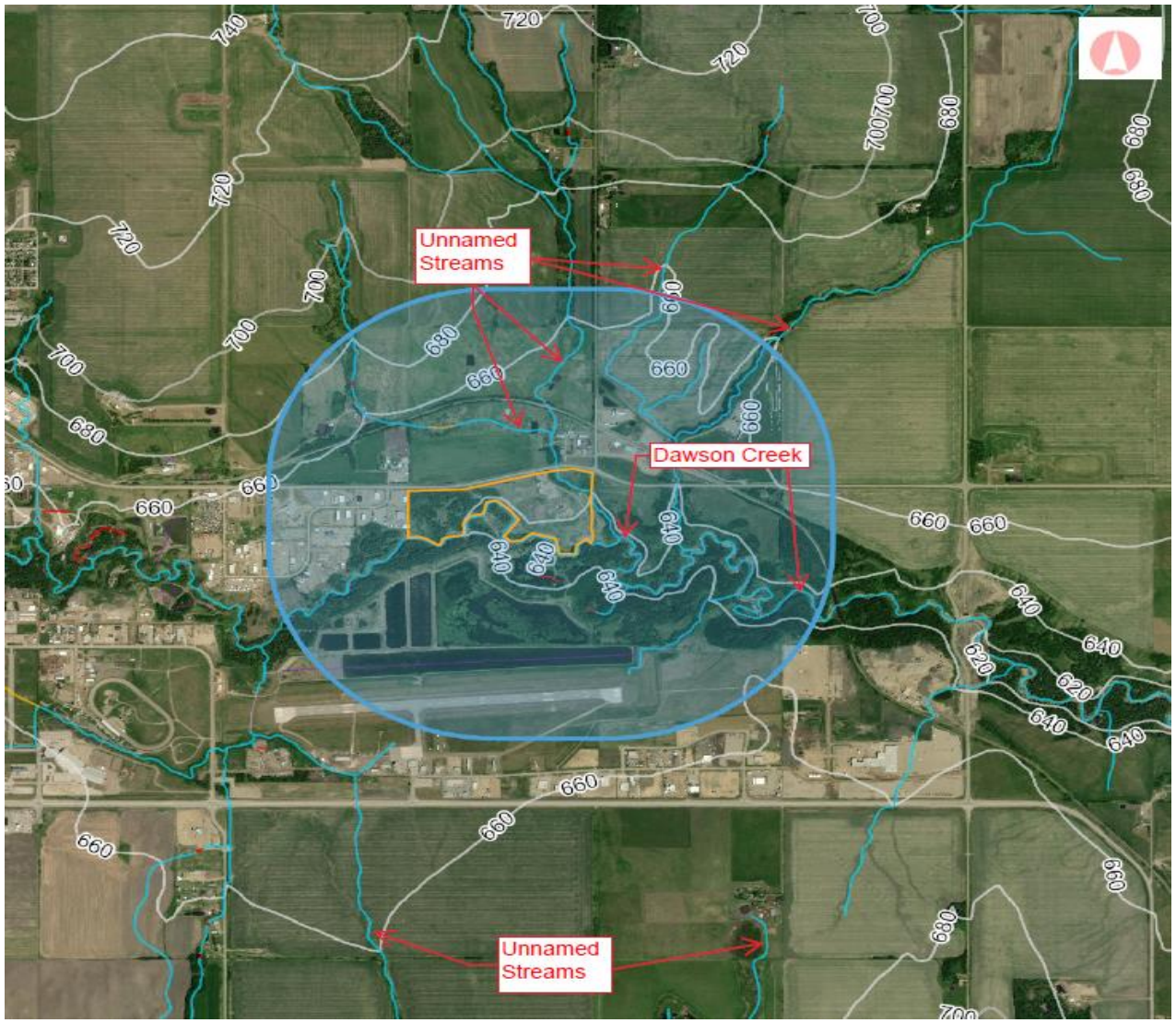
Notes:

(1) Source: Environment Canada: Climate Normals - Dawson Creek A (Station No. 1182285), 1981 - 2010

(2) 1 cm of snowfall corresponds to 1 mm of precipation

Approximate Dawson Creek Landfill Site Latitude 55°45'04"N

FIGURE 3
CLIMATE DATA
DAWSON CREEK LANDFILL CLOSURE PLAN AND ASSESSMENT
DAWSON CREEK, BC
Peace River Regional District



FWA - Stream Network - Lines

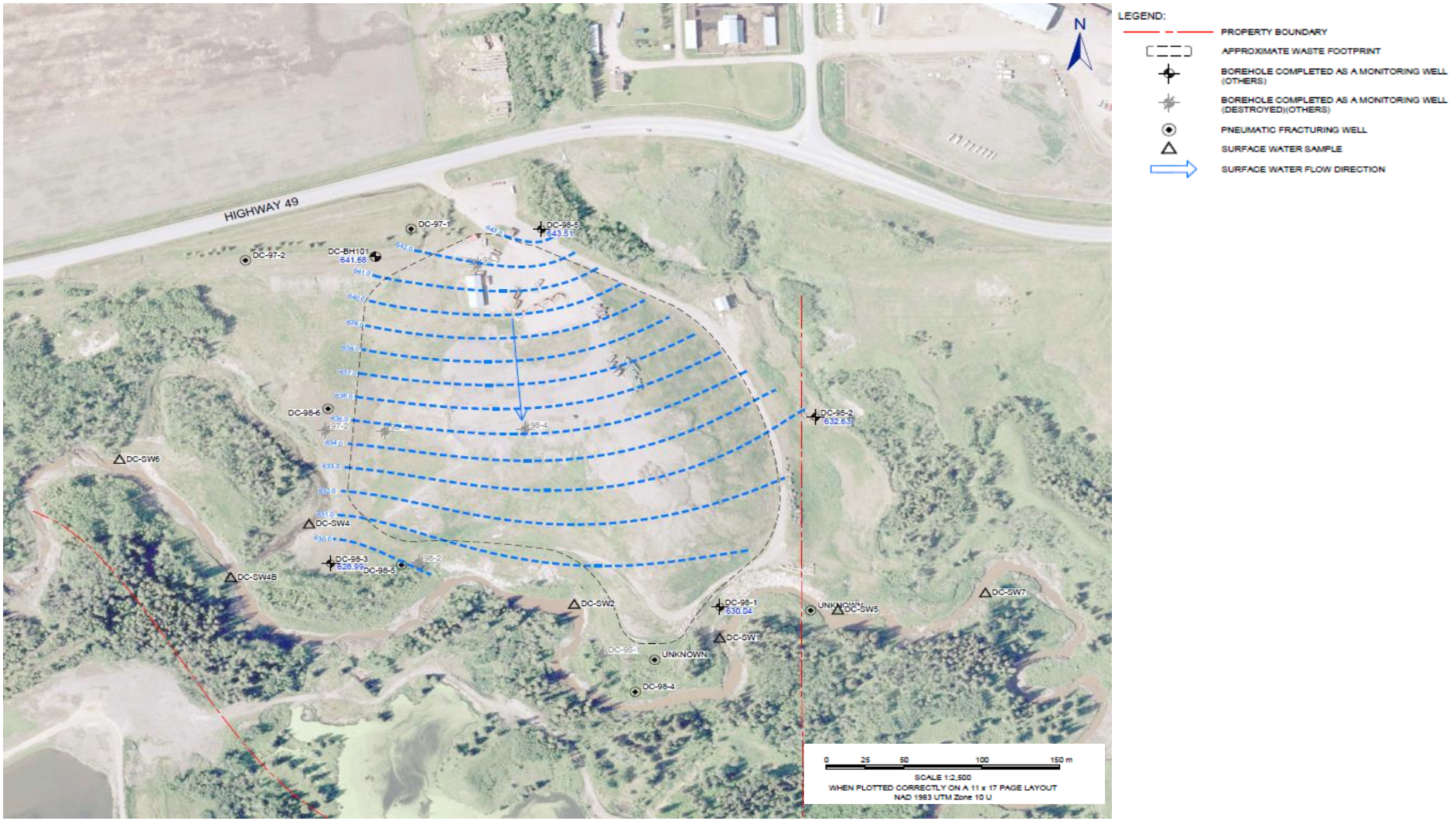
- Stream - Main Flow
- Stream - Secondary Flow
- Wetland - Main Flow
- Wetland - Secondary Flow
- Lake Skeleton - Main Flow
- Lake Skeleton - Secondary Flow
- Lake Arm Skeleton - Secondary Flow
- River Skeleton - Main Flow
- River Skeleton - Secondary Flow
- Flow Connector
- Isolated Waterbody Skeleton - Main flow
- Underground Connector - Main Flow
- 1km Radius
- Site Boundary

0 1.02 2.03 km

1: 50,000

Source: iMap B.C. accessed June 2020

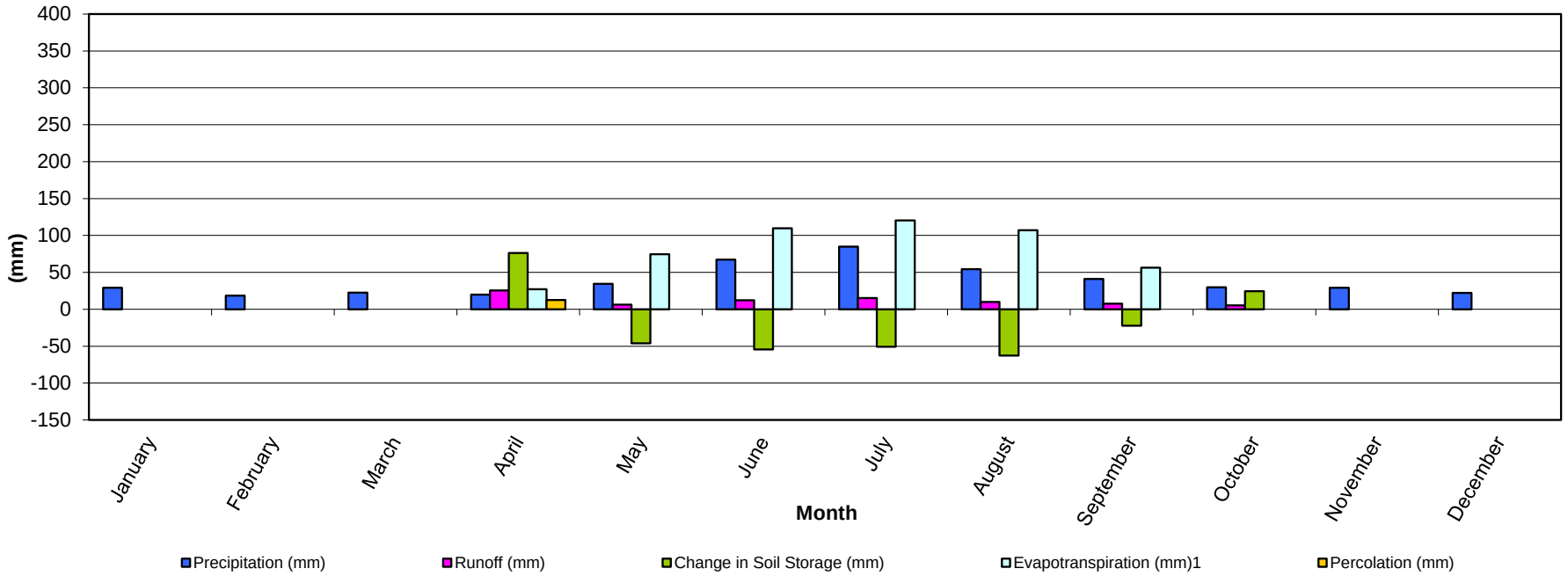
FIGURE 4
TOPOGRAPHY AND DRAINAGE WITHIN 1KM
DAWSON CREEK LANDFILL CLOSURE PLAN AND ASSESSMENT
DAWSON CREEK, BC
Peace River Regional District



Source: 2017 Groundwater and Surface Water Monitoring and Sampling Program, Peace River Regional District Landfill Sites, Peace River Regional District, Dawson Creek BC, submitted by SLR Consulting (Canada) Ltd, September 13, 2018

FIGURE 5
GROUNDWATER FLOW DIRECTION

DAWSON CREEK LANDFILL CLOSURE PLAN AND ASSESSMENT
DAWSON CREEK, BC
Peace River Regional District



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Precipitation (mm)	29.1	18.6	22.6	19.8	34.4	67.4	84.9	54.2	41.2	29.9	29.0	22.2	453.3
Runoff (mm)	0.0	0.0	0.0	25.4	6.2	12.1	15.3	9.8	7.4	5.4	0.0	0.0	81.6
Change in Soil Storage (mm)	0	0	0	76.2	-46.2265	-54.3913	-50.7	-62.7	-22.5	24.5	0.0	0	0
Evapotranspiration (mm)[1]	0.0	0.0	0.0	27.1	74.5	109.7	120.4	107.2	56.3	0.0	0.0	0.0	495.1
Percolation (mm)	0.0	0.0	0.0	12.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.7

Source: Environment Canada: Climate Normals - Dawson Creek A (Station No. 1182285), 1981 - 2010

(1) - Evapotranspiration was estimated using daylight calculations from: NOAA Global Monitoring Laboratory. *Solar Calculation Details.* Accessed July 22, 2020.

FIGURE 6

WATER BALANCE METHOD RESULTS

DAWSON CREEK LANDFILL CLOSURE PLAN AND ASSESSMENT

DAWSON CREEK, BC

Peace River Regional District

Landfill Closure Plan Status Form
Dawson Creek Landfill Closure Plan and Assessment
Dawson Creek, BC
PRRD

Condition Number	Condition Description	Compliant? (Yes/No/ND)	Action Taken
4.5	The Permittee must submit to the Director a Closure Plan Assessment prepared by an independent Qualified Professional by September 1st, 2021.	Yes	N/A - Closure Plan herein.
4.5 (a)	The Closure Plan Assessment must include the proposed end-use of the landfill after closure;	Yes	N/A - Refer to Section 4.5 of the Closure Plan report.
4.5 (b)	The Closure Plan Assessment must include the estimated and/or anticipated total volume and tonnes of waste received at the landfill during operations, and life of the landfill (i.e., closure date);	Yes	N/A - Refer to Section 4.3 of the Closure Plan report.
4.5 (c)	The Closure Plan Assessment must include the current final cover on site, including, the thickness and permeability of barrier layers and drainage layers, and information on topsoil, vegetative cover and erosion prevention controls;	Yes	N/A - Refer to Section 4.1 of the Closure Plan report.
4.5 (d)	The Closure Plan Assessment must include the current description of procedures for alternative waste disposal facilities;	Yes	N/A - The landfill stopped receiving waste between 2000 and 2002.
4.5 (e)	The Closure Plan Assessment must include the rodent and nuisance wildlife control procedures;	Yes	N/A - Refer to Section 4.2 of the Closure Plan report.
4.5 (f)	The Closure Plan Assessment must include a comprehensive monitoring plan, including groundwater monitoring, surface water monitoring, landfill gas monitoring, leachate monitoring, final cover monitoring, and erosion and settlement monitoring, for a minimum post-closure period of 25 years;	Yes	N/A - Refer to Section 11 of the Closure Plan report.
4.5 (g)	The Closure Plan Assessment must include a plan for operation of any required pollution abatement engineering works, such as leachate collection and treatment systems, for a minimum post-closure period of 25 years (if applicable)	Yes	N/A - The Site is a closed natural attenuation landfill.
4.5 (h)	The Closure Plan Assessment must include an estimated cost, updated annually, to carry out closure and post-closure activities for a minimum period of 25 years.	Yes	N/A - Refer to Section 11 of the Closure Plan report.

Appendices

Appendix A
Permit PR-2212

January 8, 2020

Tracking Number: 389445
Authorization Number: 2212

REGISTERED MAIL

PEACE RIVER REGIONAL DISTRICT
PO BOX 810
Dawson Creek, BC V1G 4H8

Dear Permittee:

Enclosed is Amended Permit 2212 issued under the provisions of the *Environmental Management Act*. Your attention is respectfully directed to the terms and conditions outlined in the permit. An annual fee will be determined according to the Permit Fees Regulation.

This permit does not authorize entry upon, crossing over, or use for any purpose of private or Crown lands or works, unless and except as authorized by the owner of such lands or works. The responsibility for obtaining such authority rests with the permittee. This permit is issued pursuant to the provisions of the *Environmental Management Act* to ensure compliance with Section 120(3) of that statute, which makes it an offence to discharge waste, from a prescribed industry or activity, without proper authorization. It is also the responsibility of the permittee to ensure that all activities conducted under this authorization are carried out with regard to the rights of third parties and comply with other applicable legislation that may be in force.

When a spill occurs, or there is an imminent risk of one occurring, the responsible person must ensure that it is reported in accordance with the Spill Reporting Regulation. Additional information on spill reporting requirements is available at gov.bc.ca/reportaspill

The Director may require the Permittee to repair, remove, or add to existing works, or to construct new works, and to submit plans and specifications for works specified in this authorization.

The Director may require the Permittee to conduct additional monitoring, and may specify procedures for monitoring, analysis, and procedures or requirements respecting the handling, treatment, transportation, discharge or storage of waste.

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

Ministry of Environment and Climate Change Strategy
Environmental Protection Division
Suite 325 - 1011 4th Avenue
Prince George BC V2L 3H9
Authorizations - North Region
Telephone: (250) 565-6135
Facsimile: (250) 565-6629

Administration of this permit will be carried out by staff from the Environmental Protection Division's Regional Operations Branch. Plans, data and reports pertinent to the operational certificate are to be submitted by email or electronic transfer to the Director, designated Officer, or as further instructed. To meet the reporting requirements in a form and manner acceptable to the Director, reports and notifications related to the administration of this operational certificate must be submitted electronically to the following ministry email addresses:

- EnvAuthorizationsReporting@gov.bc.ca for monitoring and annual reports

- EnvironmentalCompliance@gov.bc.ca for non-compliance reports.

For further information about how to submit data and reports, please refer to http://www2.gov.bc.ca/gov/content/environment/waste-management/waste-discharge-authorization/data-and-report-submissions.

For more information about how the Ministry will assesses compliance with your permit please refer to gov.bc.ca/environmentalcompliance.

For more information about how to make changes to your permit and to access waste discharge amendment forms and guidance, please refer to gov.bc.ca/wastedischarge-authorizations.

Yours truly,

Peter D. Lawrie
for Director, *Environmental Management Act*
Authorizations - North Region

MINISTRY OF ENVIRONMENT AND CLIMATE CHANGE STRATEGY

PERMIT

2212

Under the Provisions of the Environmental Management Act

Pursuant to the Approved Peace River Regional District Solid Waste Management Plan

PEACE RIVER REGIONAL DISTRICT
Dawson Creek, BC V1G 4H8

is authorized to discharge of municipal solid waste to ground at a landfill located at Dawson Creek, British Columbia, subject to the requirements listed below. Contravention of any of these requirements is a violation of the *Environmental Management Act* and may lead to prosecution.

This Authorization supersedes and replaces all previous versions of Permit 7319 issued under Section 14 of the *Environmental Management Act*.

GLOSSARY

"Facility" means: a landfill operation located at Dawson Creek, British Columbia.

"**Officer: means:** An Officer as defined by Section 1(1) of the *Environmental Management Act*.

"Qualified Professional " means: a person who:

(a) Is an engineer, scientist or technologist specializing in a particular applied science or technology;

(b) Is registered in British Columbia with a professional organization, is acting under that organization's code of ethics and is subject to disciplinary action by that organization;

(c) Through suitable education, experience, accreditation and knowledge respecting solid waste management and related engineering disciplines for the management of leachate, surface water, ground water, storm

Date issued: October 7, 1974
Date amended: January 8, 2020
(most recent)

Peter D. Lawrie
for Director, *Environmental Management Act*
Authorizations - North Region

water, and landfill gas and other specialist disciplines, may reasonably be relied upon to provide advice within his or her area of expertise and to carry out duties or functions in those areas; and

(d) Provides the completed Declaration of Competency and Conflict of Interest Disclosure Statements.

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

"Regulatory Document" means: any document that the Operational Certificate holder is required to provide to the Director or the Province pursuant to: (i) this Authorization; (ii) any regulation made under the *Environmental Management Act* that regulates the Facility described in this Authorization or the discharge of waste from that Facility; or (iii) any order issued under the *Environmental Management Act* directed against the Operational Certificate holder that is related to the Facility described in this Authorization or the discharge of waste from that Facility

1. AUTHORIZED DISCHARGES

1.1 Authorized Source

This section applies to the discharge of refuse to a landfill. The site reference number for this discharge is E210867.

1.1.1 The maximum rate of discharge is zero (0) cubic metres per day.

1.1.2 The characteristics of the waste which may be discharged are those of typical municipal solid waste.

1.1.3 The discharge is authorized from authorized works, which are a landfill, a carcass pit and related appurtenances approximately located as shown on the attached Site Plan.

1.1.4 The location of the facilities from which the discharge is authorized to originate is the northeast ¼ of Section 12, Township 78, Range 15, W6M, Peace River Land District approximately as shown on the Site Plan. (≈56.3946 N, -121.1383 W)

Date issued: October 7, 1974
Date amended: January 8, 2020
(most recent)

Peter D. Lawrie
for Director, *Environmental Management Act*
Authorizations - North Region

2. GENERAL REQUIREMENTS

2.1 Maintenance of Works and Emergency Procedures

All works must be complete and intact.

The Permittee must regularly inspect the Authorized Works and maintain them in good working order.

The Director may require the Permittee to reduce or suspend operations until the Authorized Works have been restored, and/or corrective steps have been taken to prevent unauthorized discharges.

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

2.2 Bypasses

The Permittee must not allow any discharge authorized by this authorization to bypass the Authorized Works, except with the prior written approval of the Director.

2.3 General Provisions

Where this Authorization provides that the Director may require an action to be carried out, the Permittee must carry out the action in accordance with the requirements of the Director.

3. OPERATIONAL REQUIREMENTS

3.1 Site Preparation and Restoration

3.1.1 The Permittee must ensure that the site is made inaccessible to the public to prevent unauthorized dumping.

Date issued: October 7, 1974
Date amended: January 8, 2020
(most recent)

Peter D. Lawrie
for Director, *Environmental Management Act*
Authorizations - North Region

3.1.2 The Permittee must provide surface water diversionary works, firebreaks and site restoration to the satisfaction of the Director.

3.1.3 The Permittee must inspect the landfill site a minimum of annually for any potential berm or slope failures or leachate. The inspection records must be included in the annual report.

3.2 Wildlife Nuisance

The Director may require the Permittee to construct or modify works, or follow specific operating instructions, if the Director is of the opinion that there is a possibility of nuisance or hazard being caused by bears or other animals that are attracted to the site.

3.3 Open Burning Prohibition

The Permittee must not allow the open burning of waste at the site caused by any means, including a deliberate or accidental action by the Permittee or others. The Permittee must immediately extinguish all fires of this nature and notify the Director within 24 hours.

3.4 Groundwater Impacts

3.4.1 The Permittee must not impact groundwater at the property boundary (or as otherwise specified by the Director) by leachate beyond levels specified by the Director.

3.4.2 The Permittee must continue to conduct a ground water and surface water monitoring program that is satisfactory to the Director.

3.5 Sampling Procedures

The Permittee must carry out sampling in accordance with the procedures described in the "British Columbia Field Sampling Manual for Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples, 2013 Edition (Permittee)" or most recent edition, or by alternative procedures as authorized by the Director.

A copy of the above manual is available on the Ministry web page at https://www2.gov.bc.ca/gov/content/environment/research-monitoring-

Date issued: October 7, 1974
Date amended: January 8, 2020
(most recent)

Peter D. Lawrie
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reporting/monitoring/laboratory-standards-quality-assurance/bc-field-sampling-manual

3.6 Analytical Procedures

The Permittee must carry out analyses in accordance with procedures described in the "British Columbia Laboratory Manual (2015 Permittee Edition)", or the most recent edition or by alternative procedures as authorized by the Director.

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

4. REPORTING REQUIREMENTS

The Permittee must maintain records of all monitoring data and must submit the results of water sampling analysis in an electronic format suitable for entry into the provincial database system known as EMS.

The Permittee must submit all data required to be submitted under this section by email to the Ministry's Routine Environmental Reporting Submission Mailbox (RERSM) at envauthorizationsreporting@gov.bc.ca or as otherwise instructed by the Director. For guidelines on how to properly name the files and email subject lines or for more information visit the Ministry website: https://www2.gov.bc.ca/gov/content/environment/waste-management/waste-discharge-authorization/data-and-report-submissions/routine-environmental-reporting-submission-mailbox

4.1 Annual Reporting

The Permittee must, by June 30th each year, submit to the Director an Annual Report for the previous calendar year. The report must contain at least the following information if applicable:

a) the type and tonnage of waste received, transferred, recycled and discharged for the proceeding such calendar year; "if no waste is received, this must be noted in the annual report"

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Date amended: January 8, 2020
(most recent)

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Authorizations - North Region

b) occurrences or observations of wildlife, including burrowing/scavenging (medium and large carnivores) at the facility;

c) the results of all monitoring programs as specified in this Authorization. The Permittee must ensure that data interpretation and trend analysis, as well as an evaluation of the impacts of the discharges on the receiving environment in the previous year, is included in such results and carried out by a Qualified Professional;

d) the methods and amounts of leachate collection, treatment and disposal, if applicable;

e) any unauthorized dumping; and

f) results from annually inspection for any potential berm or slope failures or leachate.

4.2 **Non-compliance Notification**

The Permittee must immediately notify the Director or designate by email at EnvironmentalCompliance@gov.bc.ca, or as otherwise instructed by the Director of any non-compliance with the requirements of this Authorization and take remedial action to remedy any effects of such non-compliance.

The Permittee must provide the Director with written confirmation of all such non-compliance events, including available test results within 24 hours of the original notification by email at EnvironmentalCompliance@gov.bc.ca, or as otherwise instructed by the Director.

4.3 **Non-compliance Reporting**

If the Permittee fails to comply with any of the requirements of this Authorization, the Permittee must, within 30 days of such non-compliance, submit to the director a written report that includes, but is not necessarily limited to, the following:

a) all relevant test results obtained by the Permittee related to the non-compliance,

b) an explanation of the most probable cause(s) of the non-compliance, and

c) a description of remedial action planned and/or taken by the Permittee to prevent similar non-compliance(s) in the future.

The Permittee must submit all non-compliance reporting required to be submitted under this section by email to the Ministry's Compliance Reporting Submission Mailbox (CRSM) at EnvironmentalCompliance@gov.bc.ca or as otherwise instructed by the Director. For guidelines on how to report a non-compliance or for more information visit the Ministry website: https://www2.gov.bc.ca/gov/content/environment/waste-management/waste-discharge-authorization/data-and-report-submissions/compliance-reporting-mailbox

4.4 Spill Reporting

The Permittee must immediately report all spills to the environment (as defined in the Spill Reporting Regulation) in accordance with the Spill Reporting Regulation, which among other things, requires notification to Emergency Management BC at 1-800-663-3456

4.5 Landfill Closure Plan

The Permittee must submit to the Director a Closure Plan Assessment prepared by an independent Qualified Professional by September 1st, 2021. The Closure Plan Assessment must, as a minimum, include the following:

a) proposed end-use of the landfill after closure;
b) estimated and/or anticipated total volume and tonnes of waste received at the landfill during operations, and life of the landfill (i.e. closure date);
c) current final cover on site, including, the thickness and permeability of barrier layers and drainage layers, and information on topsoil, vegetative cover and erosion prevention controls;
d) current description of procedures for alternative waste disposal facilities;
e) rodent and nuisance wildlife control procedures;
f) a comprehensive monitoring plan, including groundwater monitoring, surface water monitoring, landfill gas monitoring, leachate monitoring, final cover monitoring, and erosion and settlement monitoring, for a minimum post-closure period of 25 years;
g) if applicable, a plan for operation of any required pollution abatement engineering works, such as leachate collection and treatment systems, for a minimum post-closure period of 25 years; and

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Authorizations - North Region

h) an estimated cost, updated annually, to carry out closure and post-closure activities for a minimum period of 25 years.

4.6 **Site Decommissioning**

In accordance with Section 40 of the *Environmental Management Act* and Part 2 of the Contaminated Sites Regulation, the Permittee must submit a site profile to the manager at least 10 days prior to decommissioning the facilities authorized in Section 1.

5. **PUBLICATION OF DOCUMENTS**

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

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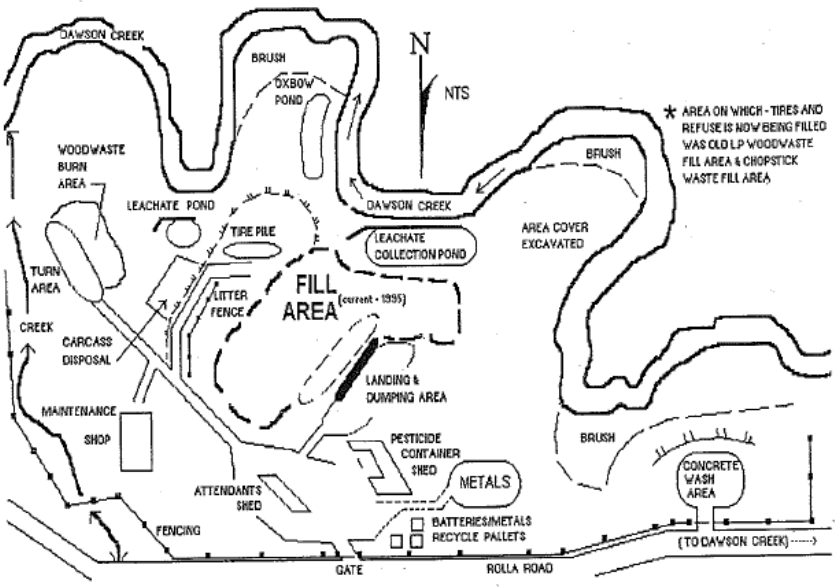
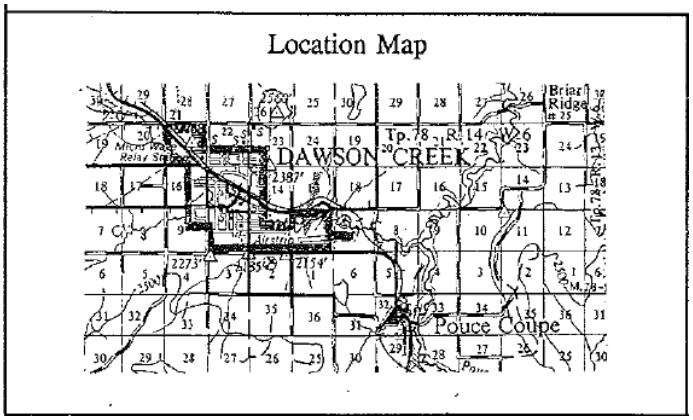
SITE PLAN A





Date issued: October 7, 1974
Date amended: January 8, 2020
(most recent)

Peter D. Lawrie
for Director, *Environmental Management Act*
Authorizations - North Region

Appendix B
Aerial Photographs

SOURCE: UBC GEOGRAPHICAL INFORMATION CENTER

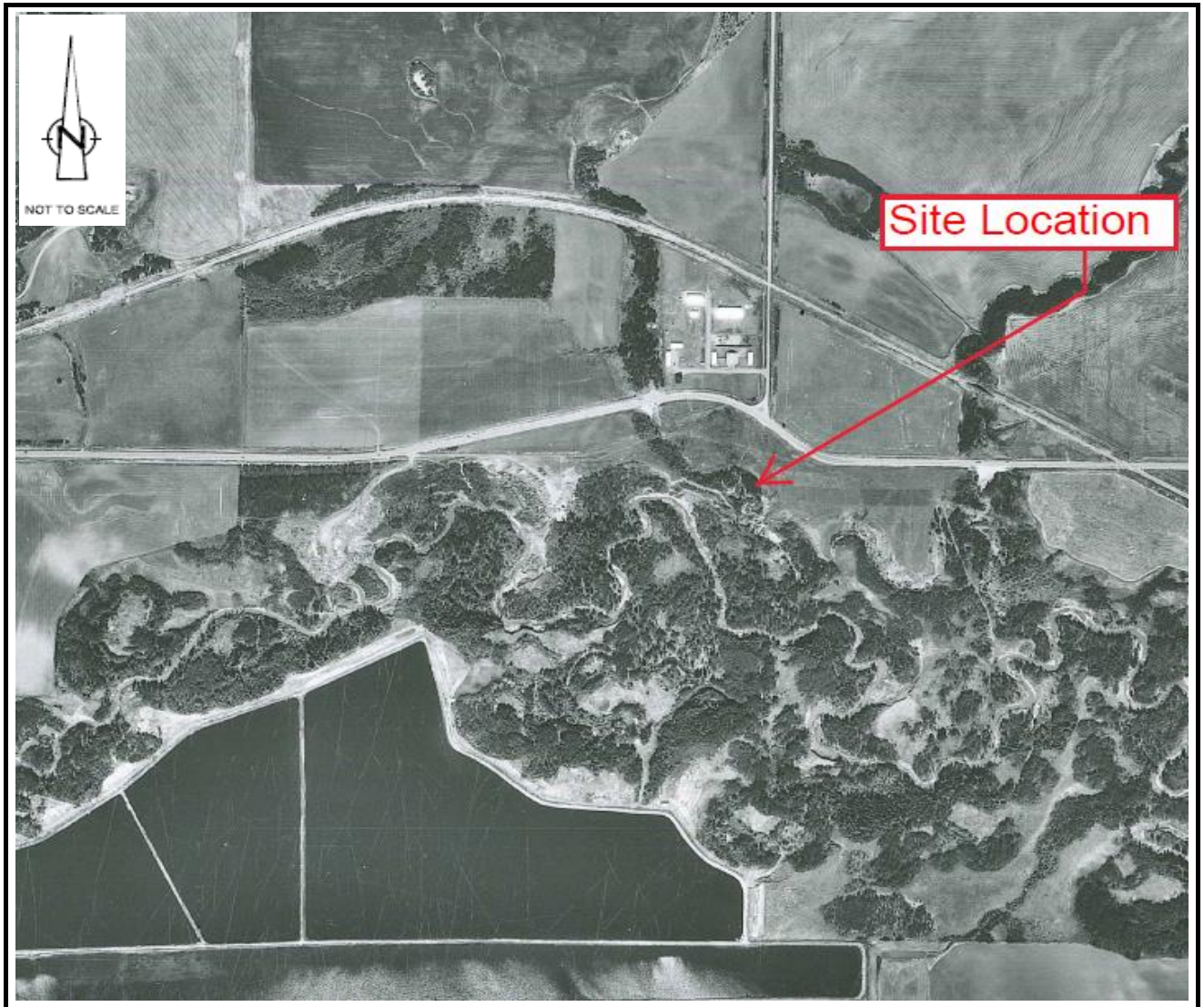
PHOTOLOG

1964 AERIAL PHOTOGRAPH
DAWSON CREEK LANDFILL CLOSURE PLAN AND ASSESSMENT
DAWSON CREEK, BC
Peace River Regional District

SOURCE: UBC GEOGRAPHICAL INFORMATION CENTER

PHOTOLOG

1966 AERIAL PHOTOGRAPH
DAWSON CREEK LANDFILL CLOSURE PLAN AND ASSESSMENT
DAWSON CREEK, BC
Peace River Regional District



SOURCE: UBC GEOGRAPHICAL INFORMATION CENTER

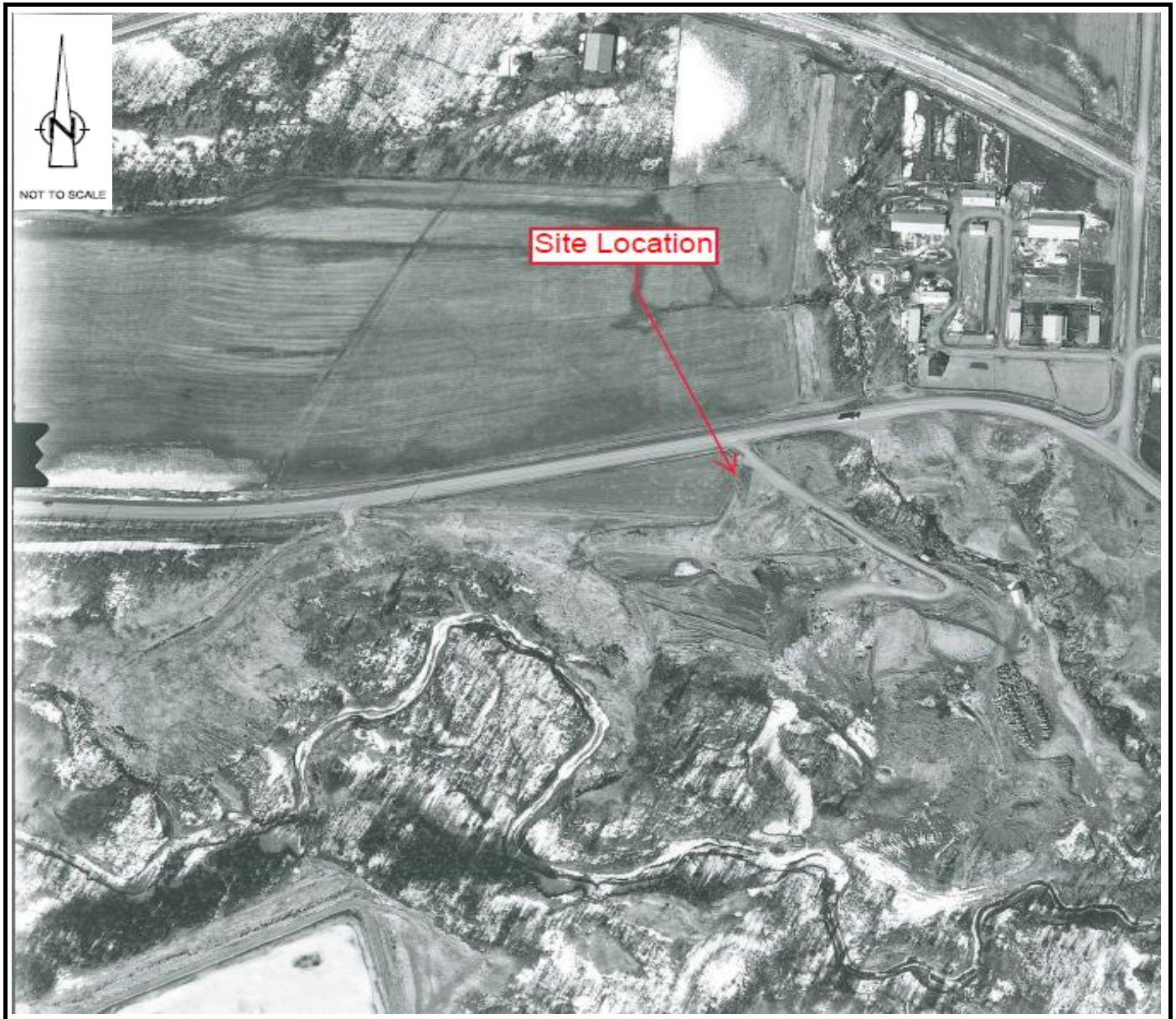
PHOTOLOG

1970 AERIAL PHOTOGRAPH
DAWSON CREEK LANDFILL CLOSURE PLAN AND ASSESSMENT
DAWSON CREEK, BC
Peace River Regional District

SOURCE: UBC GEOGRAPHICAL INFORMATION CENTER

PHOTOLOG

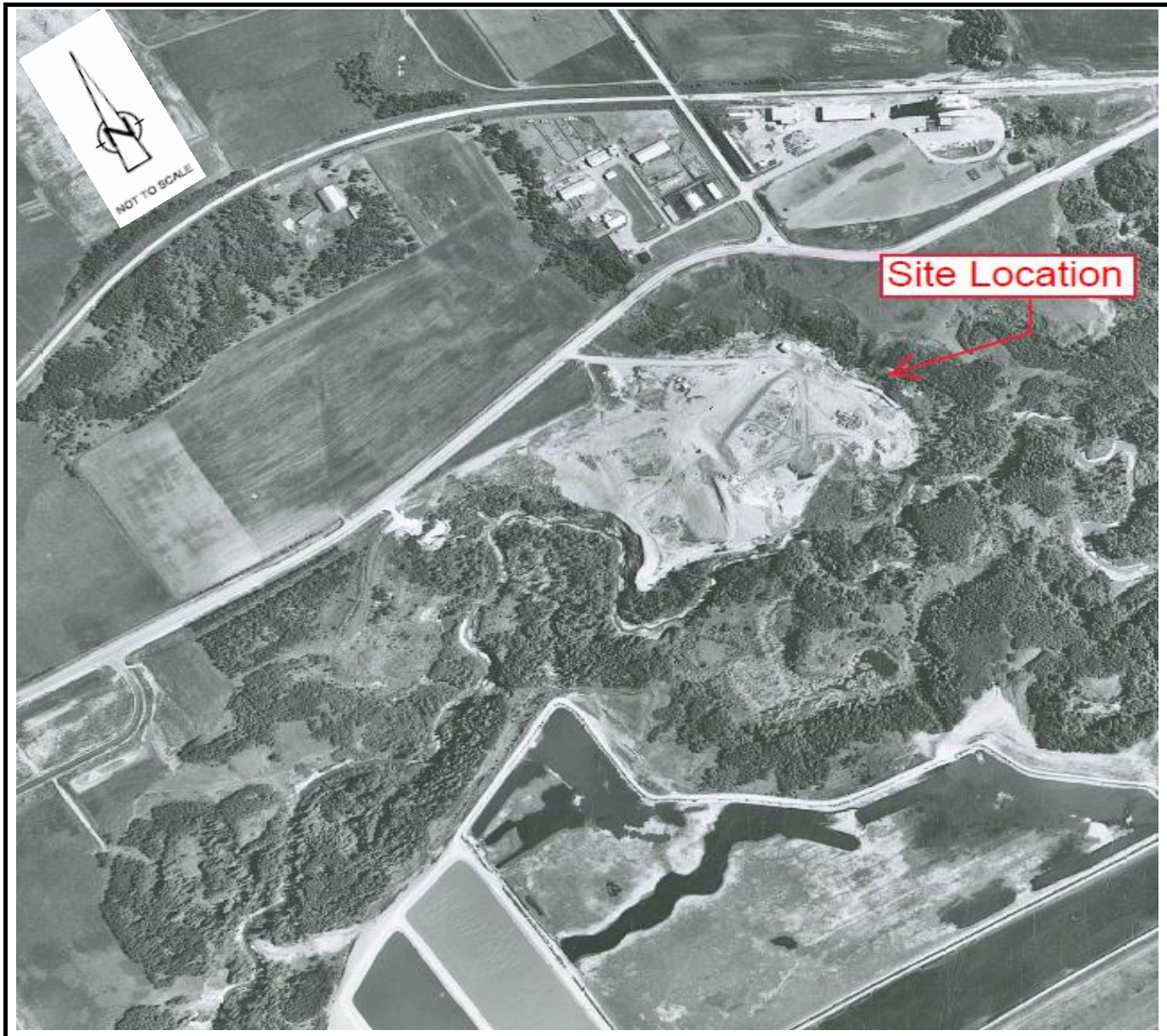
1977 AERIAL PHOTOGRAPH
DAWSON CREEK LANDFILL CLOSURE PLAN AND ASSESSMENT
DAWSON CREEK, BC
Peace River Regional District



SOURCE: UBC GEOGRAPHICAL INFORMATION CENTER

PHOTOLOG

1981 AERIAL PHOTOGRAPH
DAWSON CREEK LANDFILL CLOSURE PLAN AND ASSESSMENT
DAWSON CREEK, BC
Peace River Regional District



SOURCE: UBC GEOGRAPHICAL INFORMATION CENTER

PHOTOLOG

1984 AERIAL PHOTOGRAPH
DAWSON CREEK LANDFILL CLOSURE PLAN AND ASSESSMENT
DAWSON CREEK, BC
Peace River Regional District

SOURCE: UBC GEOGRAPHICAL INFORMATION CENTER

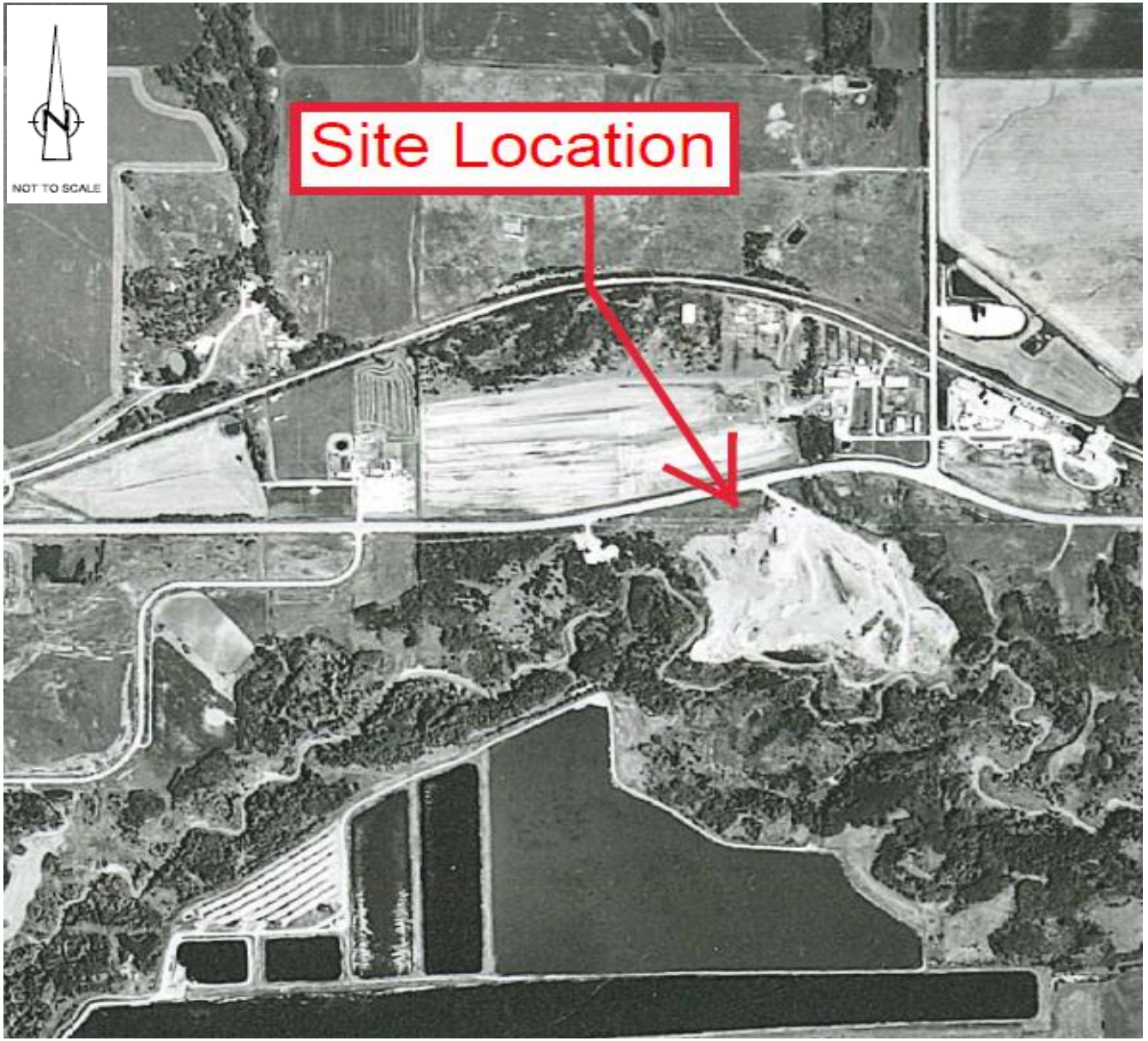
PHOTOLOG

1987 AERIAL PHOTOGRAPH
DAWSON CREEK LANDFILL CLOSURE PLAN AND ASSESSMENT
DAWSON CREEK, BC
Peace River Regional District

SOURCE: UBC GEOGRAPHICAL INFORMATION CENTER

PHOTOLOG

1990 AERIAL PHOTOGRAPH
DAWSON CREEK LANDFILL CLOSURE PLAN AND ASSESSMENT
DAWSON CREEK, BC
Peace River Regional District



SOURCE: UBC GEOGRAPHICAL INFORMATION CENTER

PHOTOLOG

1996 AERIAL PHOTOGRAPH
DAWSON CREEK LANDFILL CLOSURE PLAN AND ASSESSMENT
DAWSON CREEK, BC
Peace River Regional District

SOURCE: UBC GEOGRAPHICAL INFORMATION CENTER

PHOTOLOG

2007 AERIAL PHOTOGRAPH
DAWSON CREEK LANDFILL CLOSURE PLAN AND ASSESSMENT
DAWSON CREEK, BC
Peace River Regional District

Appendix C
Borehole Logs

CITY OF DAWSON CREEK	DAWSON CREEK LANDFILL	BOREHOLE NO: 97-1
	NE 1/2 SECTION 12 TWP 78 RGE 15 W6M	PROJECT NO: EG08201
MAYHEW 1000 TRUCK/ WET ROTARY		ELEVATION:

SAMPLE TYPE: Shelby Tube | No Recovery | SPT Test (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH(m)	STANDARD PEN (N) 20 40 60 80 / PLASTIC M.C. LIQUID 20 40 60 80	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT(N)	SLOPE INDICATOR	OTHER TESTS COMMENTS	DEPTH(m)
0.0			GRAVEL FILL, silty, sandy, brown loose to compact						0.0
1.0									1.0
2.0									2.0
3.0			CLAY, varved, silty, high plastic, stiff, grey to greyish brown, laminated with low to medium plastic pockets		U1			U1 Z = 3.1 5o 3.4 m varved clay, grey/brown, thin varves (1 to 4 mm)	3.0
4.0									4.0
5.0									5.0
6.0			dark grey, with brown-grey medium plastic laminations, random salt crystals		U2			U2 Z = 5.5 to 5.8 m varved clay, grey/brown some inclined of 20 degrees; 4" stone lamination	6.0
7.0									7.0
8.0									8.0
9.0			stiff to very stiff, gypsum crystals		U3			U3 Z = 8.5 to 8.8 m varved clay, siltier, gypsum crystals	9.0
10.0									10.0
11.0									11.0
12.0			CLAY, silty, some sand, very stiff, medium to high plastic, dark grey, fine gravel sizes, gypsum crystals		U4			U4 Z = 11.6 to 11.9 m some laminations 1/4" and 1" pockets	12.0
13.0									13.0
14.0									14.0
15.0			medium plastic, sandstone nodules		U5			U5 Z = 14.6 to 15.0 m lacustrine clay	15.0
16.0									16.0
17.0									17.0
18.0			medium-high plastic, grey, fine gravel sizes to random cobble Z = 18.6 - 18.9 m cobbles		U6			U6 Z = 17.7 to 18.1 m damaged, recovery, one 4" stone, some clay	18.0
19.0									19.0
20.0			CLAY, silty, some fine sand, stiff, medium plastic, grey, silt partings					Pneumatic piezometer #21678 installed at 20.2 m (see Note 1)	20.0
21.0					U7			U7 Z = 20.7 to 21.1 m lacustrine clay; very wet	21.0
22.0									22.0
23.0									23.0
24.0			stiff, medium-high plastic, grey		U8			U8 Z = 23.8 to 24.2 m lacustrine clay	24.0
25.0			CLAY TILL, silty, trace of sand, stiff to		C1			C1 Recovery = 83 %	25.0

AGRA Earth & Environmental Limited	LOGGED BY: CRA/AGK	COMPLETION DEPTH: 43.0 m
Edmonton, Alberta	REVIEWED BY: AGK	COMPLETE: 97/06/18
	Job No:	

98/06/23 11:02PM (25MW)

CITY OF DAWSON CREEK	DAWSON CREEK LANDFILL	BOREHOLE NO: 97-1
	NE 1/2 SECTION 12 TWP 78 RGE 15 W6M	PROJECT NO: EG08201
MAYHEW 1000 TRUCK/ WET ROTARY		ELEVATION:

SAMPLE TYPE: Shelby Tube | No Recovery | SPT Test (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH(m)	STANDARD PEN (N) 20 40 60 80 / PLASTIC M.C. LIQUID 20 40 60 80	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT(N)	SLOPE INDICATOR	OTHER TESTS COMMENTS	DEPTH(m)
25.0			very stiff, medium-high plastic, grey, slickensided, fine gravel sizes (friable shale, green/grey, some siltstone, poorly cemented grey sandstone, gypsum crystals); amount of gravel sizes increases with depth		C1				25.0
26.0					C2			C2 Recovery = 83 %	26.0
27.0									27.0
28.0					C3			C3 Recovery = 109 %	28.0
29.0			1" layer cobbles, fine sand						29.0
30.0			Various planar/non-planar slickensides						30.0
31.0			CLAY, silty, medium to high plastic, stiff to very stiff, grey, fine silt laminations or partings		C4			C4 Recovery = 46 % (Pump Water pressure build up due to hole squeezing, causing core to washed out)	31.0
32.0			very silty, some fine sand, low plastic,						32.0
33.0			silty, medium to high plastic, grey, random rust stains, laminations and slickensides, all @ 255 degrees to axis		C5			C5 Recovery = 70 %	33.0
34.0			intermixed/interbedded with low plastic silty clay or clayey sand beds or partings						34.0
35.0					C6			C6 Recovery = 59 %	35.0
36.0									36.0
37.0			partial slickensides, discontinuous, planar, some striation (20 to 55 degrees) in higher plastic clay; intermixed with fluvial sand/silt beds/partings,		C7			C7 Recovery = 67 %	37.0
38.0			indistinct bedding						38.0
39.0			Wet, gypsum crystals, thin fine/sand lamination, slickensided below sand		C8			C8 Recovery = 77 %	39.0
40.0			slickensides (20 to 35 degrees), planar, slightly striated						40.0
41.0			fine sand/silt partings		C9			C9 Recovery = 67 %	41.0
42.0			lamination rust stains and slickensides at subhorizontal		C10			Pneumatic piezometer #21674 installed at 41.2 m (See Note 1) C10 Recovery = 56 %	42.0
43.0			End of Hole at 43.0 m No water loss during drilling Note 1: Instalation: piezo tip in sand pack sock, strapped to SI casing and grouted in with tremie pipe						43.0
44.0									44.
45.0									45.0
46.0									46.
47.0									47.0
48.0									48.
49.0									49.0
50.0									50

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Edmonton, Alberta

LOGGED BY: CRA/AGK
REVIEWED BY: AGK

COMPLETION DEPTH: 43.0 m
COMPLETE: 97/06/18

CITY OF DAWSON CRREK	DAWSON CREEK LANDFILL	BOREHOLE NO: 97-2
	NE 1/2 SECTION 12 TWP 78 RGE 15 W6M	PROJECT NO: EG08201
MAYHEW 1000 TRUCK/ WET ROTARY		ELEVATION:

SAMPLE TYPE: Shelby Tube | No Recovery | SPT Test (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH(m)	STANDARD PEN (N) 20 40 60 80 / PLASTIC M.C. LIQUID 20 40 60 80	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT(N)	SLOPE INDICATOR	OTHER TESTS COMMENTS	DEPTH(m)
0.0			CLAY, silty, trace of sand, stiff, medium to high plastic, dark grey with brown mottles or laminations, laminated thin water-like, random gravel sizes						0.0
1.0									1.0
2.0									2.0
3.0			dark grey		U1			U1 Z = 3.1 to 3.5 m clay, well defined laminations, some high plastic laminations (1 to 3 mm), some fine gravel sizes	3.0
4.0									4.0
5.0									5.0
6.0			stiff, gypsum crystals, some laminations		U2			U2 Z = 5.5 to 5.8 m Clay, laminated, medium plastic, gypsum crystals, relatively dry	6.0
7.0									7.0
8.0									8.0
9.0			sizes		U3			U3 Z = 8.5 to 8.8 m clay, massive, silty, medium to low plastic, relatively dry	9.0
10.0			massive, medium to low plastic						10.0
11.0									11.0
12.0			medium plastic		U4			U4 Z = 11.6 to 11.9 clay, massive, dark grey, medium plastic, relatively dry	12.0
13.0			CLAY TILL, silty, trace of sand, medium to high plastic, stiff, dark grey, random gravel sizes, gypsum crystals						13.0
14.0								U5 Z = 11.6 to 11.9 m	14.0
15.0					U5			Pneumatic piezometer #21683 at 14.7 m (see Note 1)	15.0
16.0			medium plastic, sandy, stiff, grey, random high plastic clay zones, fine gravel sizes		C1			C1 Recovery = 100 %	16.0
17.0									17.0
18.0			slickensides 45 to 70 degrees medium-high plastic, some sand, stiff,		C2			C2 Recovery = 95 %	18.0
19.0			dark grey, random high plastic clay, fine gravel sizes						19.0
20.0					C3			C3 Recovery = 89 %	20.0
21.0			softer, high plastic, numerous slickensides						21.0
22.0					C4			C4 No Recovery	22.0
23.0									23.0
24.0			higher plastic, clay zones, slickensides		C5			C5 Recovery = 100 %	24.0
25.0					C6			C6 Recovery = 80 %	25.0

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LOGGED BY: CRA/AGK | COMPLETION DEPTH: 41.5 m
REVIEWED BY: AGK | COMPLETE: 97/06/21
Page 80 of 498 | Hole No: | Page 1 of 2

98/06/23 11:02PM (2sdw)

CITY OF DAWSON CRREK	DAWSON CREEK LANDFILL	BOREHOLE NO: 97-2
	NE 1/2 SECTION 12 TWP 78 RGE 15 W6M	PROJECT NO: EG08201
MAYHEW 1000 TRUCK/ WET ROTARY		ELEVATION:

SAMPLE TYPE: Shelby Tube | No Recovery | SPT Test (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH(m)	STANDARD PEN (N) 20 40 60 80 / PLASTIC M.C. LIQUID 20 40 60 80	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT(N)	SLOPE INDICATOR	OTHER TESTS COMMENTS	DEPTH(m)
25.0			silt partings, slickensides		C6				25.0
26.0			slickenside						26.0
27.0			shale nodules		C7			C7 Recovery = 41 %	27.0
28.0			high plastic, very stiff, grey, shale nodules, cobbles, gypsum crystals, brown, silt laminations, drier		C8			C8 Recovery = 83 %	28.0
29.0									29.0
30.0			CLAY SHALE, badly weathered, silty, low to medium plastic, hard, grey, with thin horizontal yellowish-grey to rust colored laminations?, very friable, fissile		C9			C9 Recovery = 94% Pneumatic piezometer #21675 at 31 m (see Note 1)	30.0
31.0									31.0
32.0					C10			C10 Recovery = 83 %	32.0
33.0									33.0
34.0			harder, well-cemented shale zones, but very friable, rust stained, breaks easily along various directions		C11			C11 Recovery = 83 %	34.0
35.0									35.0
36.0					C12			C12 Recovery = 90 %	36.0
37.0									37.0
38.0					C13			C13 Recovery = 89 %	38.0
39.0									39.0
40.0			medium plastic, harder shale, dark grey-brown, breaks easily along planes in all direction		C14			C14 Recovery = 95 %	40.0
41.0									41.0
42.0			End of Hole at 41.5 m No water loss during drilling						42.0
43.0									43.0
44.0									44.0
45.0			Note 1: Installation: piezo tip in sand pack sock, strapped to SI casing and grouted in with tremie pipe						45.0
46.0									46.0
47.0									47.0
48.0									48.0
49.0									49.0
50.0									50

AGRA Earth & Environmental Limited
Edmonton, Alberta

LOGGED BY: CRA/AGK
REVIEWED BY: AGK
Dwg. No:

COMPLETION DEPTH: 41.5 m
COMPLETE: 97/06/21

98/06/23 11:02PM (2AM)

CITY OF DAWSON CRREK	DAWSON CREEKK LANDFILL	BOREHOLE NO: 97-3
	NE 1/2 SECTION TWP 78 RGE 15 W6M	PROJECT NO: EG08201
MAYHEW 1000 TRUCK/ WET ROTARY		ELEVATION:

SAMPLE TYPE: Shelby Tube | No Recovery | SPT Test (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH(m) | ■ STANDARD PEN (N) ■ 20 40 60 80 | PLASTIC M.C. LIQUID 20 40 60 80 | SOIL SYMBOL

SOIL DESCRIPTION

GARBAGE, large pieces of concrete, metal, and ash, mixed with clay

last circulation; large pieces of concrete

ash mixed with gravel sizes, black to dark grey

CLAY, silty, very soft, squeezing, medium to high plastic, grey, silt/fine sand pockets (too soft to core)

CLAY TILL, silty, trace of sand, medium to high plastic, stiff, grey, fine gravel sizes (attempted to core but hole squeezing causing high pump pressures as well as material form upper hole keep falling in)

End of Hole at 19.6 m
Water level at 1.5 m at completion
Was losing water throughout the drilling of borehole

Note 1: Installation: piezo tip in sand pack sock, stapped to SI casing and grouted in with tremie pipe

SAMPLE TYPE | SAMPLE NO | SPT(N) | SLOPE INDICATOR

OTHER TESTS COMMENTS

U1 Z = 3.1 to 3.4 m

U2 Z = 5.5 to 5.8 m
medium to coarse sand, gravel, silty clay, very wet

U3 Z = 8.5 to 8.8 m
recovery approx. 8", sandy, silty clay, pebbles up to 3/4", very wet, 1/2" metal piece, maximum nail

U4 Z = 11.5 to 11.9 m
clay, sand, gravel very wet, soft, very soft at 11.7 m, drier and stiffer at 11.8 m, 1 large nail @ 11.7 m

U5 Z = 13.4 to 13.8 m
clay till, high plastic, stiff

U6 Z = 14.6 to 14.9 m
clay fill, high plastic stiff to very stiff

U7 Z = 16.2 to 16.6 m
clay fill, high plastic, stiff to very stiff, steel plate 1" x 2" at the bottom

Pneumatic piezometer #21679 at 18.5 m (see note 1)

U9 Z = 19.3 to 19.6 m

DEPTH(m)

AGRA Earth & Environmental Limited	LOGGED BY: CRA	COMPLETION DEPTH: 19.6 m
Edmonton, Alberta	REVIEWED BY: AGK	COMPLETE: 97/06/20
	Job No:	Page 1 of 1

PEACE RIVER REGIONAL DISTRICT	PHASE 2 – DAWSON CREEK LANDFILL	BOREHOLE NO: 98-4
	NE 1/4 12-78-15-W6M	PROJECT NO: EG08275
CANTERRA 310 TRACK/ WET ROTARY	DAWSON CREEK, BRITISH COLUMBIA	ELEVATION:

SAMPLE TYPE: Shelby Tube; No Recovery; SPT Test (N); Grab Sample; Split-Pen; Core

BACKFILL TYPE: BENTONITE; PEA GRAVEL; SLOUGH; GROUT; DRILL CUTTINGS; SAND

DEPTH(m) | STANDARD PEN (N) 20 40 60 80 | PLASTIC M.C. LIQUID 20 40 60 80 | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT(N) | PNEUMATIC PIEZOMETER | PNEUMATIC PIEZOMETER | OTHER TESTS COMMENTS | DEPTH(m)

DEPTH(m)	SOIL DESCRIPTION	SAMPLE NO	SPT(N)	OTHER TESTS COMMENTS
0.0	LANDFILL, clay, silty, low to medium plastic, mixed with wood, pieces of plastic, some metal			
3.0				Mixed heavy drilling mud, lossing some water in landfill material
4.0				Bit pluggged, pieces of plastic/wood retained in suspension plugged off bit ports
5.0				Bit plugged
5.0				Bit plugged
6.0				Bit plugged
7.0	gravel sizes, (maybe bottom of landfill)			
7.0	(TUBE), soft clay, with gravel sizes, pieces of plastic/glass	U1		Attempt to push Nilcon vane, no success
8.0	CLAY TILL, silty, trace of sand, high plastic, stiff, dark grey, shale nodules and pockets, random gravel sizes			
9.0	gravel sizes	U2		Pneumatic piezometer #22571 installed @ 8.6 m
9.0		D1	15	
10.0		U3		On rock
11.0	12/150	D2	12/150	
12.0		U4		
13.0		D3	20	
14.0		U5		Pneumatic piezometer #22569 Installed @ 13.9 m
14.0		D4	12	
15.0				

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REVIEWED BY: AGK
JOB No:

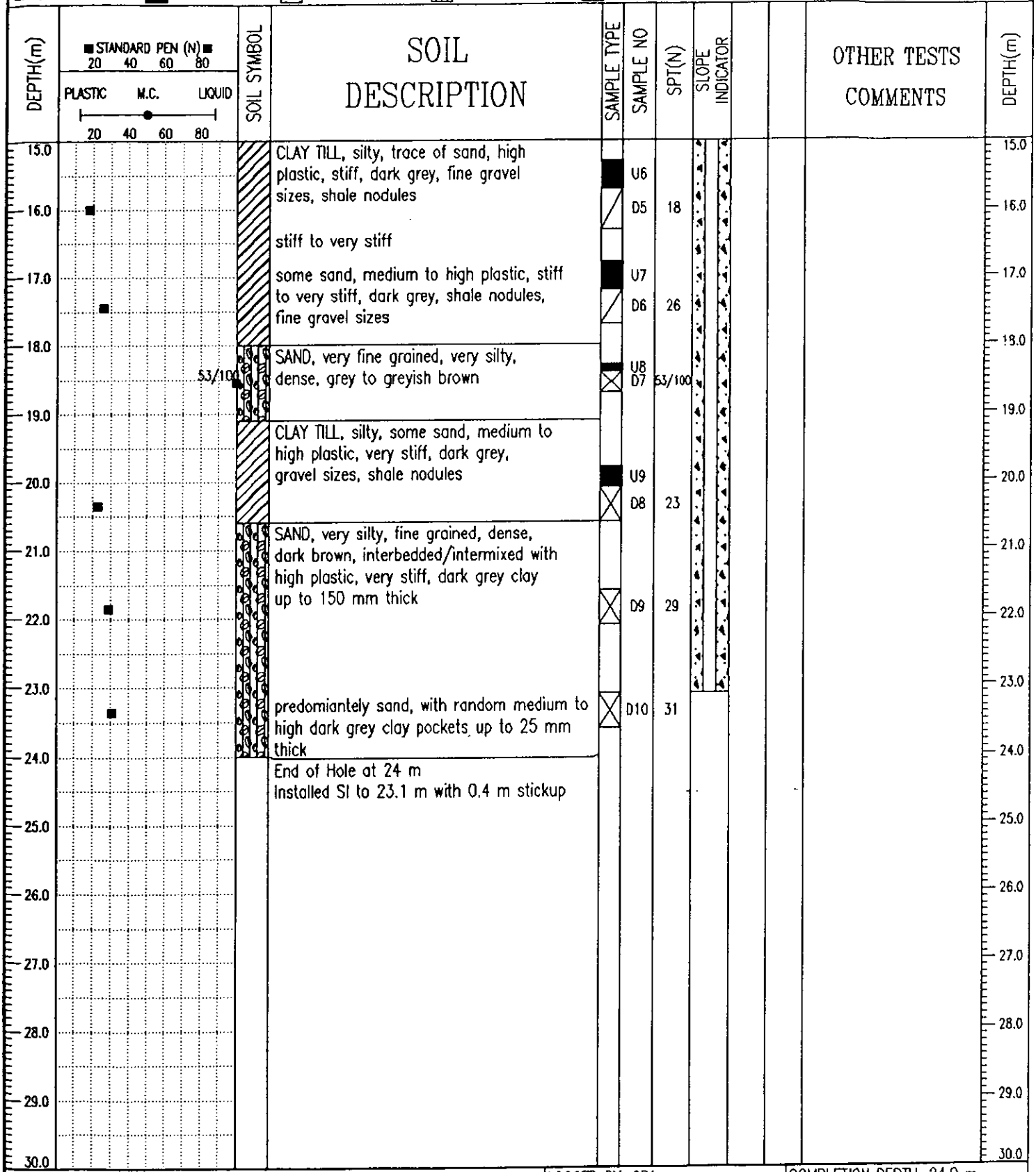
COMPLETION DEPTH: 24.0 m
COMPLETE: 98/04/14

98/06/23 11:21PM (15MM)

PEACE RIVER REGIONAL DISTRICT	PHASE 2 – DAWSON CREEK LANDFILL	BOREHOLE NO: 98-4
	NE 1/4 12-78-15-W6M	PROJECT NO: EG08275
CANTERRA 310 TRACK/ WET ROTARY	DAWSON CREEK, BRITISH COLUMBIA	ELEVATION:

SAMPLE TYPE: Shelby Tube; No Recovery; SPT Test (N); Grab Sample; Split-Pen; Core

BACKFILL TYPE: BENTONITE; PEA GRAVEL; SLOUGH; GROUT; DRILL CUTTINGS; SAND



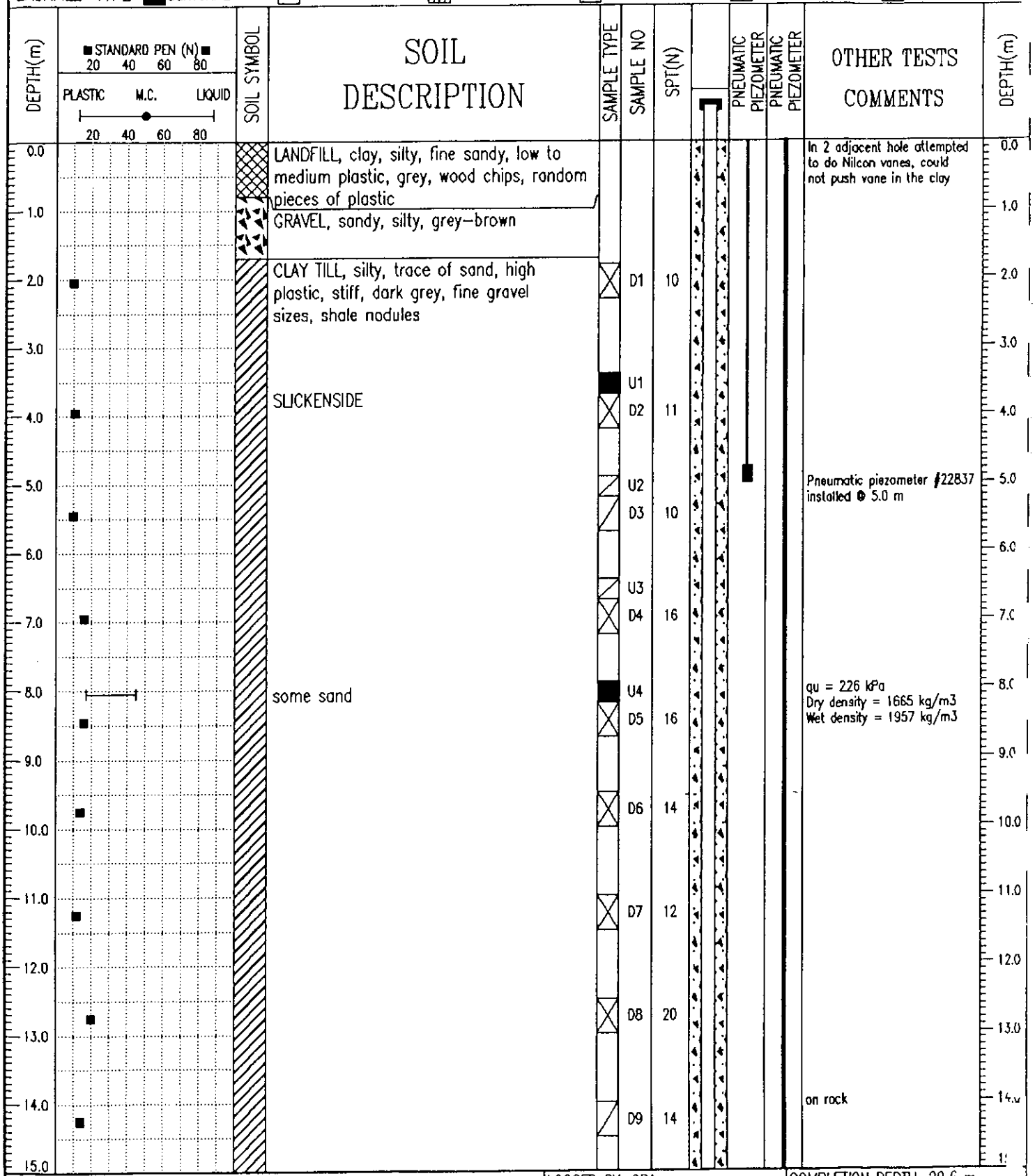
AGRA Earth & Environmental Limited	LOGGED BY: CRA	COMPLETION DEPTH: 24.0 m
Edmonton, Alberta	REVIEWED BY: AGK	COMPLETE: 98/04/14
	Fig. No:	Page 2 of 2

98/05/25 11:21PM (15MW)

PEACE RIVER REGIONAL DISTRICT	PHASE 2 – DAWSON CREEK LANDFILL	BOREHOLE NO: 98-5
	NE 1/4 12-78-15-W6M	PROJECT NO: EG08275
CANTERRA 310 TRACK/ WET ROTARY	DAWSON CREEK, BRITISH COLUMBIA	ELEVATION:

SAMPLE TYPE: Shelby Tube; No Recovery; SPT Test (N); Grab Sample; Split-Pen; Core

BACKFILL TYPE: BENTONITE; PEA GRAVEL; SLOUGH; GROUT; DRILL CUTTINGS; SAND



AGRA Earth & Environmental Limited	LOGGED BY: CRA	COMPLETION DEPTH: 20.6 m
Edmonton, Alberta	REVIEWED BY: AGK	COMPLETE: 98/04/16
	Eq. No:	Page 1 of

98/06/23 11:21PM (1Saw)

PEACE RIVER REGIONAL DISTRICT	PHASE 2 - DAWSON CREEK LANDFILL	BOREHOLE NO: 98-5
	NE 1/4 12-78-15-W6M	PROJECT NO: EG08275
CANTERRA 310 TRACK/ WET ROTARY	DAWSON CREEK, BRITISH COLUMBIA	ELEVATION:

SAMPLE TYPE: Shelby Tube | No Recovery | SPT Test (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH(m)	STANDARD PEN (N) 20 40 60 80 / PLASTIC M.C. LIQUID 20 40 60 80	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT(N)	SLOPE INDICATOR	PNEUMATIC PIEZOMETER	OTHER TESTS COMMENTS	DEPTH(m)
15.0	■		CLAY TILL, silty, some sand, high plastic, stiff, dark grey, fine gravel sizes, shale nodules,							15.0
16.0	■				D10	15				16.0
17.0	■				D11	16				17.0
18.0										18.0
19.0	■				D12	18				19.0
20.0	■				D13	18			Pneumatic piezometer #23161 installed @ 19.7 m	20.0
21.0			End of Hole at 20.6 m Installed SI to 19.8 m with 0.6 m stickup							21.0
22.0										22.0
23.0										23.0
24.0										24.0
25.0										25.0
26.0										26.0
27.0										27.0
28.0										28.0
29.0										29.0
30.0										30.0

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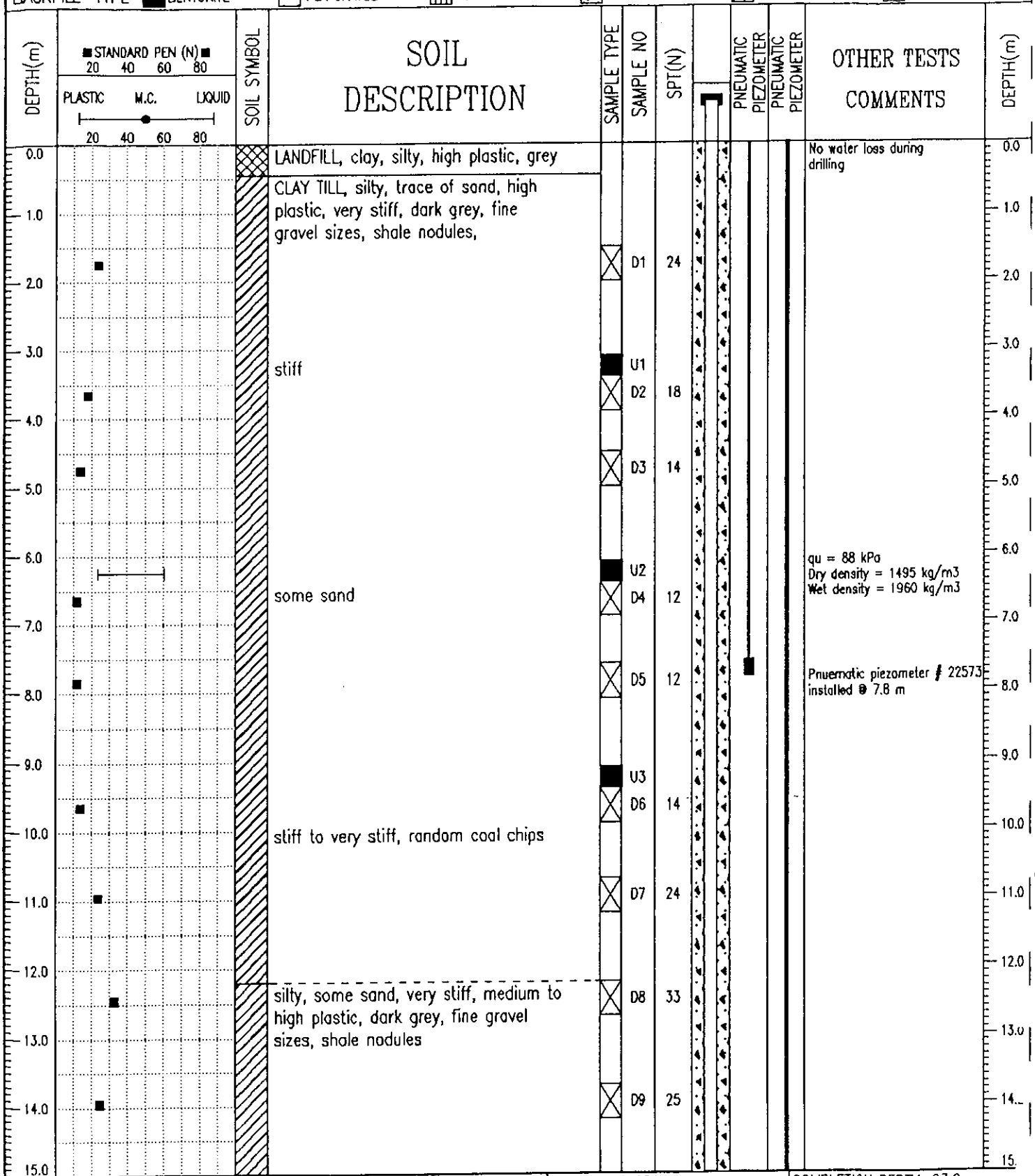
REVIEWED BY: AGK | COMPLETE: 98/04/16
Fax No: | Page 2 of 2

98/06/23 11:22PM (15MM)

PEACE RIVER REGIONAL DISTRICT	PHASE 2 - DAWSON CREEK LANDFILL	BOREHOLE NO: 98-6
	NE 1/4 12-78-15-W6M	PROJECT NO: EG08275
CANTERRA 310 TRACK/ WET ROTARY	DAWSON CREEK, BRITISH COLUMBIA	ELEVATION:

SAMPLE TYPE: Shelby Tube; No Recovery; SPT Test (N); Grab Sample; Split-Pen; Core

BACKFILL TYPE: BENTONITE; PEA GRAVEL; SLOUGH; GROUT; DRILL CUTTINGS; SAND



AGRA Earth & Environmental Limited	LOGGED BY: CRA	COMPLETION DEPTH: 23.0 m
Edmonton, Alberta	REVIEWED BY: AGK	COMPLETE: 98/04/17
	Fig. No:	Page 1 of 1

98/06/23 11:22PM (15MW)

PEACE RIVER REGIONAL DISTRICT	PHASE 2 - DAWSON CREEK LANDFILL	BOREHOLE NO: 98-6
	NE 1/4 12-78-15-W6M	PROJECT NO: EG08275
CANTERRA 310 TRACK/ WET ROTARY	DAWSON CREEK, BRITISH COLUMBIA	ELEVATION:

SAMPLE TYPE: Shelby Tube | No Recovery | SPT Test (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH(m) | ■STANDARD PEN (N)■ 20 40 60 80 | PLASTIC M.C. LIQUID 20 40 60 80 | SOIL SYMBOL

SOIL DESCRIPTION

SAMPLE TYPE	SAMPLE NO	SPT(N)	SLOPE INDICATOR	PNEUMATIC PIEZOMETER	OTHER TESTS COMMENTS
	D10	40			
	D11	42			
	D12	40			
	D13	31			
	D14	28			Pnuematic piezometer #23159 installed @ 21.5 m

15.0 CLAY TILL, silty, some sand very stiff to hard, medium to high plastic, dark grey, fine gravel sizes, shale nodules

16.0

17.0 very fine grained, dense, sand/silt pockets/partings, brown

18.0 SAND, very silty, clayey, non to low plastic, dense, brown, random dark grey high plastic clay partings

19.0 CLAY TILL, very sandy, silty, low plastic, hard, brown, fine gravel sizes, some rust staining, shale nodules

20.0 CLAY, silty, fine sandy, medium to high plastic, very stiff, dark grey, with horizonitally interbedding of light grey to brown, silt/fine sand laminations up to 5 mm thick
fine sand/silt laminations up to 25 mm thick

21.0

22.0

23.0 End of Hole at 23.0 m
Installed SI to 23 m with 0.7 m stickup

24.0

25.0

26.0

27.0

28.0

29.0

30.0

DEPTH(m) 15.0 16.0 17.0 18.0 19.0 20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0 29.0 30.0

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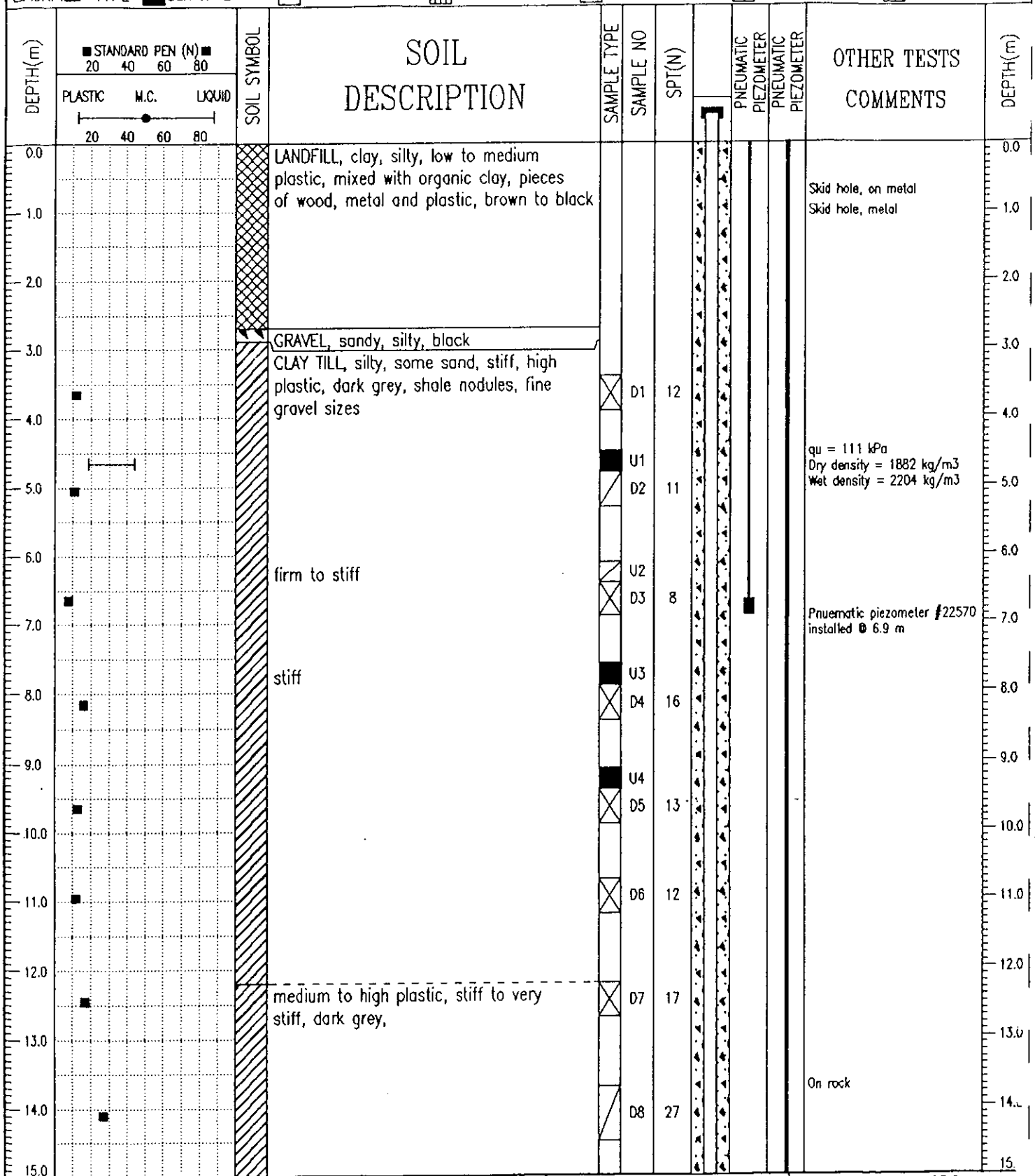
Edmonton, Alberta	REVIEWED BY: AGK	COMPLETE: 98/04/17
	Fig. No:	Page 2 of 2

98/06/23 11:29PM (15MW)

PEACE RIVER REGIONAL DISTRICT	PHASE 2 – DAWSON CREEK LANDFILL	BOREHOLE NO: 98-7
	NE 1/4 12-78-15-W6M	PROJECT NO: EG08275
CANTERRA 310 TRACK/ WET ROTARY	DAWSON CREEK, BRITISH COLUMBIA	ELEVATION:

SAMPLE TYPE: Shelby Tube | No Recovery | SPT Test (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND



AGRA Earth & Environmental Limited Edmonton, Alberta	LOGGED BY: CRA REVIEWED BY: AGK Fig. No:	COMPLETION DEPTH: 23.2 m COMPLETE: 98/04/18 Page 1 of 2

PEACE RIVER REGIONAL DISTRICT	PHASE 2 – DAWSON CREEK LANDFILL	BOREHOLE NO: 98-7
	NE 1/4 12-78-15-W6M	PROJECT NO: EG08275
CANTERRA 310 TRACK/ WET ROTARY	DAWSON CREEK, BRITISH COLUMBIA	ELEVATION:

SAMPLE TYPE: Shelby Tube; No Recovery; SPT Test (N); Grab Sample; Split-Pen; Core

BACKFILL TYPE: BENTONITE; PEA GRAVEL; SLOUGH; GROUT; DRILL CUTTINGS; SAND

DEPTH(m)	STANDARD PEN (N) 20 40 60 80 / PLASTIC M.C. LIQUID 20 40 60 80	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT(N)	SLOPE INDICATOR	PNEUMATIC PIEZOMETER	OTHER TESTS COMMENTS	DEPTH(m)
15.0			CLAY TILL, silty, some sand, medium to high plastic, stiff to very stiff, dark grey, fine gravel sizes, shale nodules		D9	19				15.0
16.0										16.0
17.0			very stiff		D10	22				17.0
18.0					D11	22				18.0
19.0			SAND, very fine grained, very silty, trace of clay, dense, brown, random high plastic dark grey clay layers/partings							19.0
20.0					D12	44				20.0
21.0			CLAY TILL, silty, very sandy, hard, low plastic, brown, fine gravel sizes							21.0
22.0			CLAY, silty, fine sandy, medium to high platic, dark grey, with thin light grey to brown fine sand/silt partings		D13	40			Pnuematic piezometer #23158 installed @ 22.2 m	22.0
23.0										23.0
24.0			End of Hole at 23.2 m Installed SI to 23.2 m with 0.5 m stickup							24.0
25.0										25.0
26.0										26.0
27.0										27.0
28.0										28.0
29.0										29.0
30.0										30.0

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Edmonton, Alberta

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REVIEWED BY: AGK
Log No:

COMPLETION DEPTH: 23.2 m
COMPLETE: 98/04/18

98/06/26 TIETBAM (TSAW)

Appendix D
Photolog

IMG_20200528_131429.jpg

Photo 1 - Main entrance to the landfill through the transfer station.

IMG_20200528_132226.jpg

Photo 2 - Loose soil and steep slopes along the top of slope of the landfill cover. Looking north at center of the site.

Site Photographs

IMG_20200528_132227.jpg

Photo 3 - Loose soil in foreground at the top of the landfill slope. General topography looking southwest from the center of the site.

IMG_20200528_132355.jpg

Photo 4 - General topography looking southwest. Pond shown to left center of photo. Photo taken from center of site.

Site Photographs

IMG_20200528_132526.jpg

Photo 5 - Exposed, loose soil at the top of the landfill's south slope. Looking east.

IMG_20200528_132722.jpg

Photo 6 Pond near toe of southwest landfill slope. Looking east.

Site Photographs

IMG_20200528_132655.jpg

Photo 7 - Exposed geosynthetics near pond on southwest slope.

IMG_20200528_132812.jpg

Photo 8 - Crack in soil observed at toe of slope along west side of landfill may be result of soil creep. Looking northeast.

Site Photographs

IMG_20200528_132816.jpg

Photo 9 - Crack in soil observed at toe of slope along west side of landfill. Looking south.

IMG_20200528_132909.jpg

Photo 10 - Construction debris at west side of landfill. Looking north.

Site Photographs

IMG_20200528_133000.jpg

Photo 11 - West perimeter of site at Dawson Creek.
Looking northwest. Rusted steel debris observed on bank.

IMG_20200528_133132.jpg

Photo 12 - General topography looking northeast at west side of landfill.

Site Photographs

IMG_20200528_133352.jpg

Photo 13 - General topography looking west/southwest away from west side of landfill.

IMG_20200528_133916.jpg

Photo 14 - South side of landfill slope with soil creep observed. Looking north. Monitoring location in foreground.

Site Photographs

IMG_20200528_133607.jpg

Photo 15 - General topography looking east at southeast landfill slopes. Concrete debris pile at mid-ground in center of photo.

IMG_20200528_133830.jpg

Photo 16 - Concrete debris piles at south side of landfill. Looking southwest.

IMG_20200528_134641.jpg

Photo 17 - Exposed waste on the landfill's southeast side slope. Looking west.

IMG_20200528_134700.jpg

Photo 18 - Concrete debris piles and monitoring location at southeast corner of site. Sparse vegetation around monitoring location was observed. Looking southeast.

Site Photographs

IMG_20200528_134734.jpg

Photo 19 - General topography of the east/southeast slope looking north.

IMG_20200528_134851.jpg

Photo 20 - Access road on southeast corner of site. Bins and materials staged to the right are used by transfer station operations. Looking east.

Site Photographs

IMG_20200528_135147.jpg

Photo 21 - General topography of the east landfill side slope.

IMG_20200528_135454.jpg

Photo 22 - Top of landfill area used as storage by transfer station operations. Looking south.

Appendix E
Landfill Gas Generation Potential Calculations

Landfill Gas Generation Potential Calculations
Dawson Creek Landfill Closure Plan and Assessment

	Relatively Inert	Moderately Decomposable	Decomposable	
Gas Production potential, Lo =	20	120	160	m^3 CH4/tonne
lag time before start of gas production, lag =	1 years			
Historical Data Used (years)	47			
1st Year of Historical Data Used	1974			
4 Years after Reporting Year	2024			
methane (by volume)	50%			
carbon dioxide (by volume)	50%			
methane (density) - 1atm, 25C	0.6557	kg/m^3	(25C,SP)	
carbon dioxide (density)	1.7988	kg/m^3	(25C,SP)	

Year	Year Number	Annual Tonnage (tonnes)	Cumulative Waste-in-place (tonnes)	Waste Tonnage			Methane Generation Rate, k			Annual Methane Production (tonnes/yr)
				Relatively Inert (tonnes)	Moderately Decomposable (tonnes)	Decomposable (tonnes)	Relatively Inert ($year^{-1}$)	Moderately Decomposable ($year^{-1}$)	Decomposable ($year^{-1}$)	
1974	1	9,636	9,636	3,212	3,212	3,212	0.01	0.02	0.05	0.00
1975	2	9,636	19,272	3,212	3,212	3,212	0.01	0.02	0.05	21.90
1976	3	9,636	28,908	3,212	3,212	3,212	0.01	0.02	0.05	42.90
1977	4	9,636	38,544	3,212	3,212	3,212	0.01	0.02	0.05	63.03
1978	5	9,636	48,180	3,212	3,212	3,212	0.01	0.02	0.05	82.34
1979	6	9,636	57,816	3,212	3,212	3,212	0.01	0.02	0.05	100.86
1980	7	9,636	67,452	3,212	3,212	3,212	0.01	0.02	0.05	118.62
1981	8	9,636	77,088	3,212	3,212	3,212	0.01	0.02	0.05	135.66
1982	9	9,636	86,724	3,212	3,212	3,212	0.01	0.02	0.05	152.02
1983	10	9,636	96,360	3,212	3,212	3,212	0.01	0.02	0.05	167.72
1984	11	9,636	105,996	3,212	3,212	3,212	0.01	0.02	0.05	182.79
1985	12	9,636	115,632	3,212	3,212	3,212	0.01	0.02	0.05	197.26
1986	13	9,636	125,268	3,212	3,212	3,212	0.01	0.02	0.05	211.17
1987	14	9,636	134,904	3,212	3,212	3,212	0.01	0.02	0.05	224.52
1988	15	9,636	144,540	3,212	3,212	3,212	0.01	0.02	0.05	237.35
1989	16	9,636	154,176	3,212	3,212	3,212	0.01	0.02	0.05	230.95
1990	17	9,636	163,812	3,212	3,212	3,212	0.01	0.02	0.05	242.29
1991	18	9,636	173,448	3,212	3,212	3,212	0.01	0.02	0.05	253.24
1992	19	9,636	183,084	3,212	3,212	3,212	0.01	0.02	0.05	263.80
1993	20	9,636	192,720	3,212	3,212	3,212	0.01	0.02	0.05	274.00
1994	21	9,636	202,356	3,212	3,212	3,212	0.01	0.02	0.05	283.84
1995	22	9,636	211,992	3,212	3,212	3,212	0.01	0.02	0.05	293.35
1996	23	9,636	221,628	3,212	3,212	3,212	0.01	0.02	0.05	302.53
1997	24	9,636	231,264	3,212	3,212	3,212	0.01	0.02	0.05	311.40
1998	25	9,636	240,900	3,212	3,212	3,212	0.01	0.02	0.05	319.97
1999	26	9,636	250,536	3,212	3,212	3,212	0.01	0.02	0.05	328.25
2000	27	9,636	260,172	3,212	3,212	3,212	0.01	0.02	0.05	336.25
2001	28	9,636	269,808	3,212	3,212	3,212	0.01	0.02	0.05	343.99
2002	29	0	269,808	0	0	0	0.01	0.02	0.05	351.47
2003	30	0	269,808	0	0	0	0.01	0.02	0.05	338.95
2004	31	0	269,808	0	0	0	0.01	0.02	0.05	326.94
2005	32	0	269,808	0	0	0	0.01	0.02	0.05	315.40
2006	33	0	269,808	0	0	0	0.01	0.02	0.05	304.32
2007	34	0	269,808	0	0	0	0.01	0.02	0.05	293.69
2008	35	0	269,808	0	0	0	0.01	0.02	0.05	283.48
2009	36	0	269,808	0	0	0	0.01	0.02	0.05	273.67
2010	37	0	269,808	0	0	0	0.01	0.02	0.05	264.24
2011	38	0	269,808	0	0	0	0.01	0.02	0.05	255.19
2012	39	0	269,808	0	0	0	0.01	0.02	0.05	246.49
2013	40	0	269,808	0	0	0	0.01	0.02	0.05	238.14
2014	41	0	269,808	0	0	0	0.01	0.02	0.05	230.10
2015	42	0	269,808	0	0	0	0.01	0.02	0.05	222.39
2016	43	0	269,808	0	0	0	0.01	0.02	0.05	214.97
2017	44	0	269,808	0	0	0	0.01	0.02	0.05	207.83
2018	45	0	269,808	0	0	0	0.01	0.02	0.05	200.98
2019	46	0	269,808	0	0	0	0.01	0.02	0.05	194.38
2020	47	0	269,808	0	0	0	0.01	0.02	0.05	188.04

about GHD

GHD is one of the world's leading professional services companies operating in the global markets of water, energy and resources, environment, property and buildings, and transportation. We provide engineering, environmental, and construction services to private and public sector clients.

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Technical Memorandum

29 June 2023

To	Gerritt Lacey	**Contact No.**	+1 604 248-3934 +1 604 248 3907
Copy to	Mark Parker	**Email**	lee.williams@ghd.com david.engstrom@ghd.com
From	Lee Williams; Dave Engstrom/ra/2	**Project No.**	11213132
Project Name	PRRD 2020 Closure Reports		
Subject	Dawson Creek Landfill Conceptual Regrading Plan		

1. Introduction

This technical memorandum (Memo) presents a conceptual regrading plan (Regrading Plan) for the Dawson Creek Landfill (Landfill, Site). The Regrading Plan is intended to provide a concept-level design with a budgetary cost estimate in preparation for detailed design and tender for construction in the future.

1.1 Scope and Limitations

This technical memorandum has been prepared by GHD for Peace River Regional District. It is not prepared as, and is not represented to be, a deliverable suitable for reliance by any person for any purpose. It is not intended for circulation or incorporation into other documents. The matters discussed in this memorandum are limited to those specifically detailed in the memorandum and are subject to any limitations or assumptions specially set out.

2. Background

The Landfill was constructed over a historical meander of Dawson Creek, which is approximately 20 metres thick and infilled with fluvial sand and gravel. Waste was placed from the pre-existing north bank of Dawson Creek near Highway 49 to the south towards the existing creek. In 1997, ownership of the Landfill was transferred to the PRRD.

The Landfill stopped receiving waste between 2000 and 2002. After closure, the Site continued to operate as a transfer station and waste was redirected to the Bessborough Landfill. The Site received clean fill material until January 1, 2020. The clean fill was placed at the crest of the Landfill and pushed down slope by hauling contractors.

In 2021, PRRD completed a Closure Plan and Assessment for the Landfill (Closure Plan). The Closure Plan included the following recommendations:

– Remove scattered litter and cover exposed waste on the Landfill.

– Develop a cover rehabilitation program.
– Establish final grades of not more than 3H:1V (horizontal to vertical) on side slopes and not less than 5 percent on the Landfill plateau.

3. Design Basis

This Regrading Plan has been prepared in accordance with the Landfill's Closure Plan (GHD, 2021) and the 2016 BC Landfill Criteria (Criteria). Recommended activities include reconstructing cover in areas with over-steepened and eroding slopes, repairing areas of sloughing that may cause future instability, and regrading to eliminate ponding and covering exposed waste. The Regrading Plan is intended to balance cut/fill volumes and minimize disturbance of disposed waste.

Applicable guidelines from BC Landfill Criteria (2016) were used as constraints for the Regrading Plan, including maximum slopes, minimum slopes, final cover thickness, final cover materials and vegetative requirements. GHD assumed that the existing cover system generally consisted of adequate cover material and thickness, unless otherwise noted in the Regrading Plan. The Criteria specifies a maximum hydraulic conductivity of $1x10^{-5}$ cm/sec for final cover material in "semi-arid" regions, and Dawson Creek falls under the Criteria definition of a "semi-arid" region, based on rainfall data.

3.1 Design Outputs

Regrading Plan drawings are provided in Attachment 1 along with cut/fill estimates. In general, regrading will consist of the following steps.

In Areas of Cut:

– Excavate to design elevation.
– Over-excavate 750 mm and prepare surface for final cover.
– Segregate excavated materials.
  - Stockpile excavated clean low permeability material for use as final cover.
  - Stockpile excavated clean aggregate material on Landfill plateau in areas designated by the PRRD.
  - Place waste in direct contact with underlying waste in areas requiring fill or on Landfill plateau, compact waste, and cover waste with final cover.
– Re-establish final cover, including 600 mm clay, 150 mm topsoil, seeding and coconut matting.
– Establish vegetation consistent with existing vegetation.

In Areas of Fill:

– Place and compact fill material to 750 mm below design elevation.
  - In areas with more than 750 mm fill, compacted waste is acceptable as fill material.
  - Waste used as fill material must be placed in direct contact with underlying waste and covered with final cover.
– Prepare surface for final cover.
– Re-establish final cover, including 600 mm clay, 150 mm topsoil, seeding and coconut matting.
– Establish vegetation consistent with existing vegetation.

Recommendations for specific areas are provided in the following subsections.

3.1.1 Northwest Crest

Slopes on the Northwest Crest are over-steepened and eroded. Soil stockpiles were observed on the plateau adjacent to the Northwest Crest during the Site visit and on aerial imagery. Grading of the Northwest Crest will generally require approximately 2 m to 5 m of cut to meet design grades.

3.1.2 West Crest

Slopes on the West Crest are over-steepened and eroded. Soil stockpiles were observed on the plateau adjacent to the West Crest during the Site visit and on aerial imagery. Grading of the West Crest will generally require approximately 1 m to 2 m of fill to meet design grades.

3.1.3 South Crest

Slopes on the South Crest are over-steepened and eroded. Grading of the South Crest will generally require approximately 1 m to 3 m cut to meet design grades.

3.1.4 Mid-Slope Slide

A portion of cover material on the southwest slope has slid down the slope. Although exposed waste was not observed in the area above the slide (north and east of the slide), the thickness of cover material is likely inadequate in the area above the slide. Filling will be required above the slide to meet design grades and re-establish final cover. The slide material will be cut to meet design grades.

3.1.5 Lower Slopes Cover Rehabilitation

Channelling, erosion, and sloughing were observed on the lower slopes of the Landfill, particularly on the west slope, contributing to pathways of unvegetated soils. The larger channels can be identified on the topographic survey.

Recommendations:

– Regrade areas of channelling/erosion/sloughing to meet design grades.
– Restore continuous, erosion-resistant cover system and establish vegetation.
– Cover exposed waste at the southeast toe and in other areas, if encountered.
– Remove scattered litter, if encountered.

3.1.6 Landfill Plateau Regrading

The Landfill plateau is generally flatter than 5% in any direction. Signs of ponding and desiccated clay were found in the plateau area, and portions of the plateau area were unvegetated.

Recommendations:

– Regrade area to 10% with final cover, per LF Criteria.
– Consider alternatives to reduce disturbance to the plateau, such as:
    - Pave plateau with asphalt for potential future use as transfer station.
    - Grade plateau to prevent ponding of water (<10%), establish vegetation, and monitor as required.

4. Cost Estimate

A capital cost estimate for the Regrading Plan is provided in Table 1 attached to this Memo. The estimated capital costs to execute the Regrading Plan is $780,000, including a 20% contingency and excluding applicable taxes.

This cost does not include Landfill plateau regrading, which should be added to the cost estimate after a preferred alternative is chosen.

5. Closure

Should you have any comments or require clarification on matters pertaining to the information in this Memo, please do not hesitate to contact the undersigned.

Regards,

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Environmental E.I.T.
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lee.williams@ghd.com

Dave Engstrom, P.Eng.
Landfill Engineer
+1 604 248 3907
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Table 1

Capital Cost Estimate
Conceptual Regrading Plan
Dawson Creek Landfill
Peace River Regional District

ITEM	SPEC. NO.	DESCRIPTION	EST. QTY.	UNIT	UNIT COST	TOTAL COST
1		Site Clearing - Clearing for surface re-grading and final cover	14,350	m^2	$ 0.90	$ 13,000.00
2		Excavation - Excavation to conform to landfill final contours	6,533	m^3	$ 6.80	$ 45,000.00
3		Fill - Fill to conform to landfill final contours	2,551	m^3	$ 13.50	$ 35,000.00
4		Re-installation of final cover (inlcuding native low-permeability soil, topsoil, seeding and coconut matting)	14,350	m^2	$ 39.70	$ 570,000.00
					Sub Total	**$ 650,000.00**
Totals					20% Contingency	$ 130,000.00
					Sub Total	$ 780,000.00
					G. S. T. (5%)	$ 39,000.00
					Total	**$ 819,000.00**

Notes:
1. Unit rates based on historical landfill projects in the PRRD with inflation adjustments based on Statistics Canada CPI inflation rates.
2. Estimated costs exclude engineering, contract administration and construciton quality assurance.
3. Estimated costs exclude grading of landfill plateau surface.
4. Costs are rounded up on $1000 basis, and contingency of 20% is included in cost estimate.

Attachment 1

Conceptual Regrading Plan Drawings (enclosed electronically)

CUT AREAS WITH STOCKPILED SOILS ALONG LANDFILL CREST

NORTHWEST CREST

A'

A

ADDRESS PONDING ON LANDFILL PLATEAU BY GRADING TO MINIMUM 10% WITH SOIL FINAL COVER PER LANDFILL CRITERIA OR ASPHALT PAVING.

WEST CREST

FILL AREA OF SLOUGHED COVER AND ERODED SIDE SLOPE AT LANDFILL CREST

LOWER SLOPE COVER REHABILITATION

CUT OVERSTEEP SIDE SLOPES ALONG LANDFILL CREST

B

SOUTH CREST

CUT OVERSTEEP SIDE SLOPES ALONG LANDFILL CREST

SOUTH CREST

REGRADE AREAS OF PONDING AND CHANNELLING

MID-SLOPE SLIDE

CUT AREAS OF SLOUGHING COVER SOILS

B'

COVER EXPOSED WASTE WITH 600mm LOW PERMEABILITY SOIL AND BLEND TO EXISTING GRADES

DRAFT

N

0 5 10 15

1:500

LEGEND:

SLOPES TO BE REMEDIATED TO RESTORE SLOPE STABILITY

AREAS TO BE REMEDIATED FOR POTENTIAL FUTURE INSTABILITY

EXPOSED WASTE TO BE COVERED

APPROXIMATE LIMITS OF WASTE

GHD Ltd.
138 East 7th Avenue, Suite 100
Vancouver British Columbia V5T 1M6 Canada
T 1 604 214 0510 **F** 1 604 214 0525

www.ghd.com

Bar is 25mm on original size sheet

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SURVEY INFORMATION - EXISTING CONDITIONS SURVEYED JULY-13-2022 BY McELHANNEY

No.	Issue	Checked	Approved	Date
NO. -	-		-	-
NO. -	-		-	-
NO. -	-		-	-
NO. -	-		-	-
NO. -	-		-	-
0	ISSUED FOR REVIEW	W.L.	D.E.	04/14/2023

Author	T. WAGSTAFF	Designer	L. WILLIAMS
Drafting Check	L. WILLIAMS	Design Check	D. ENGSTROM
Project Manager	R. ROCCA	Project Director	D. LIDDY

Client

PEACE RIVER REGIONAL DISTRICT

Project

DAWSON CREEK LANDFILL

Date	Scale
2023-04-14	1:500

Project No.
111213132

Title
CONCEPTUAL REGRADING PLAN

Size
ANSI D

Status Code

Sheet No.
CI-0101

Sheet of

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Elevations Table				
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2	−4.00	−3.00	147.28	
3	−3.00	−2.00	381.03	
4	−2.00	−1.00	1733.40	
5	−1.00	0.00	5881.60	
6	0.00	1.00	5210.11	
7	1.00	2.00	597.73	
8	2.00	2.20	1.76	

N

0 5 10 15

1:500

LEGEND:

EXPOSED WASTE TO BE COVERED

APPROXIMATE LIMITS OF WASTE

A'

A

B

B'

EXISTING vs REGRADING
CUT = 6,533.47 m³
FILL = 2,551.23 m³
NET(CUT) = 3,982.24 m³

COVER EXPOSED WASTE WITH 600mm LOW PERMEABILITY SOIL AND BLEND TO EXISTING GRADES

DRAFT

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Drafting Check	L. WILLIAMS	Design Check	D. ENGSTROM
Project Manager	R. ROCCA	Project Director	D. LIDDY

Client
PEACE RIVER REGIONAL DISTRICT

Project
DAWSON CREEK LANDFILL

Date	Scale
2023-04-14	1:500

Project No.
111213132

Title
CUT AND FILL BALANCE

Size
ANSI D

Status Code

Sheet No
CI-0102

Sheet
of

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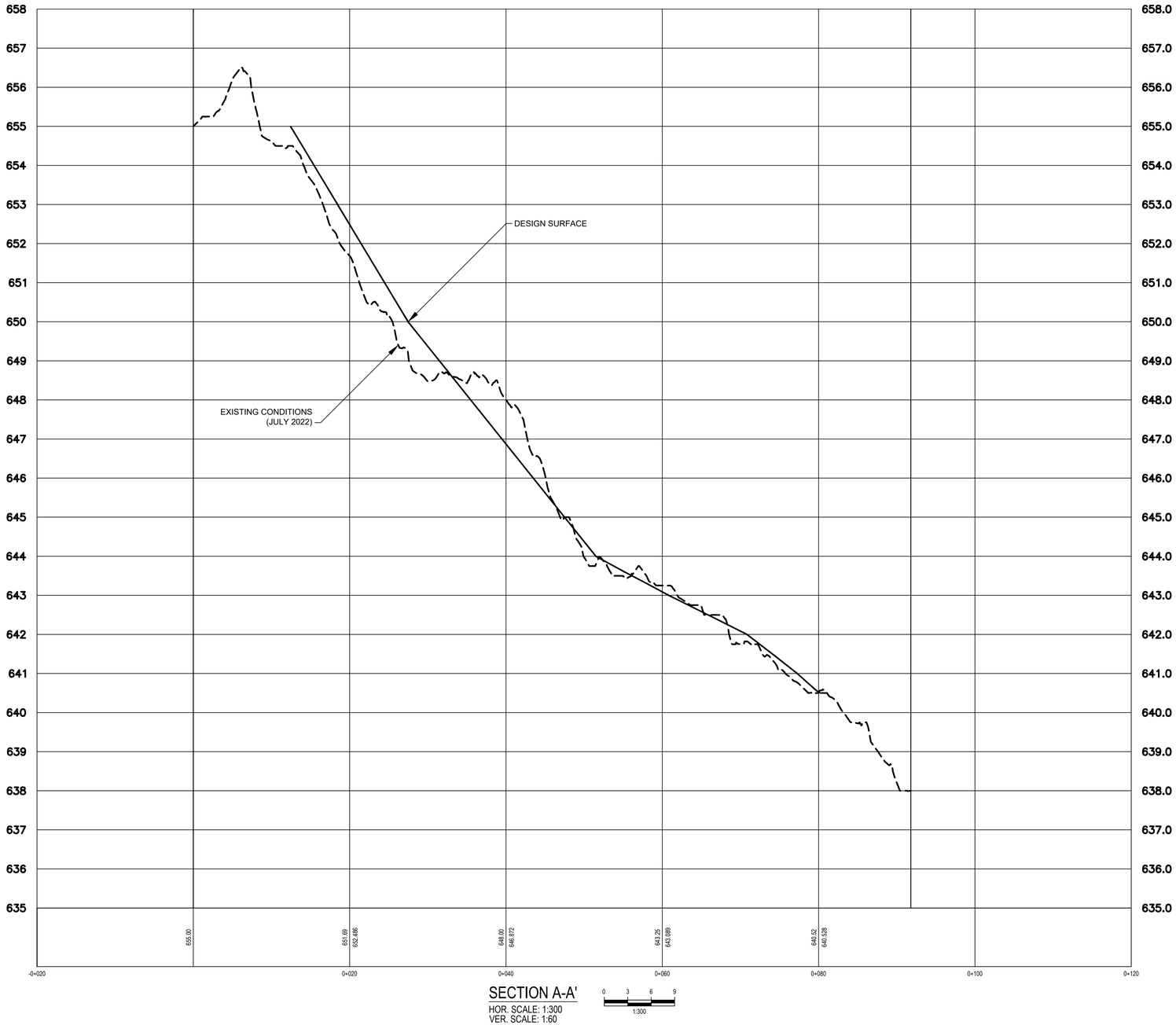

SECTION A-A'

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VER. SCALE: 1:60

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1:300

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Project Manager	R. ROCCA	Project Director	D. LIDDY

Client

PEACE RIVER REGIONAL DISTRICT

Project

DAWSON CREEK LANDFILL

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Title: SECTION A-A'	Size: ANSI D
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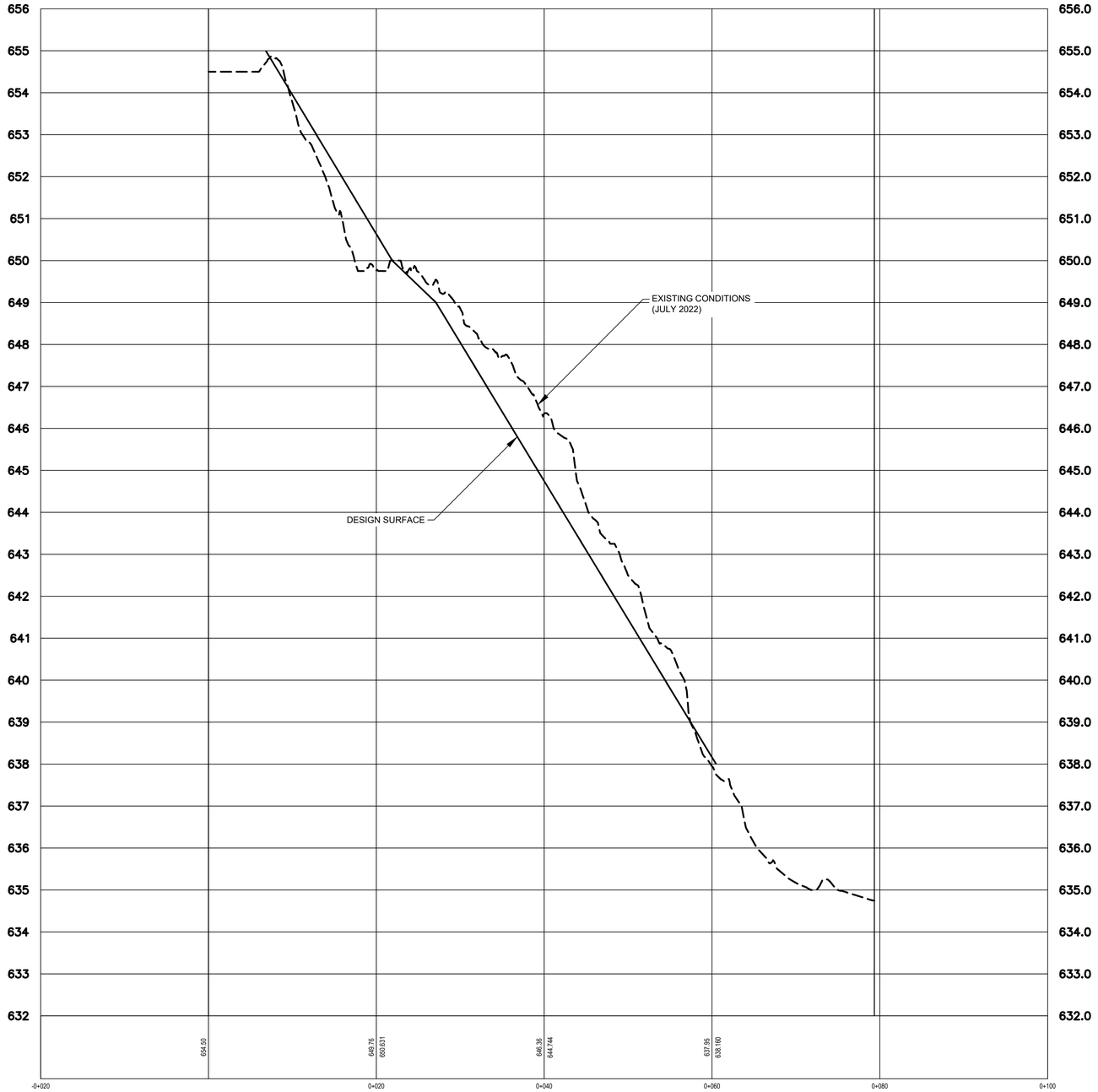

SECTION B-B'

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VER. SCALE: 1:60

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NO. -		-	-	-
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Author	T. WAGSTAFF	Designer	L. WILLIAMS
Drafting Check	L. WILLIAMS	Design Check	D. ENGSTROM
Project Manager	R. ROCCA	Project Director	D. LIDDY

Client
PEACE RIVER REGIONAL DISTRICT

Project
DAWSON CREEK LANDFILL

Date: 2023-04-14	Scale: AS SHOWN
Project No.: 111213132	
Title: SECTION B-B'	Size: ANSI D
Sheet No.: CI-0302	Status Code / Sheet of

Dawson Creek Groundwater and Surface Water Impact Assessment

Peace River Regional District

24 October 2023

Project name		PRRD 2020 Closure Reports #04-2020					
Document title		Dawson Creek Groundwater and Surface Water Impact Assessment |				
Project number		11213132					
File name		11213132-RPT-14-Dawson Creek Groundwater and Surface Water Assessment DRB.docx					
Status Code	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
S4		David R. Barton	Rose Marie Rocca,		Rose Marie Rocca,		Oct. 24, 2023
[Status code]							
[Status code]							

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[Compliance statement]

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1. Introduction

GHD has prepared the following Groundwater and Surface Water Assessment Report (Report) for the Peace River Regional District (PRRD) in support of the Dawson Creek Landfill (Site) closure. The location of the landfill is presented on Figure 1, a Site plan is presented on Figure 2.

1.1 Background

The Dawson Creek Landfill is located approximately 4 kilometres (km) east of the City of Dawson Creek. The landfill is located just south of Highway 49 and north of Dawson Creek.

Permit 2212 (permit) was first issued on October 7, 1974. The permit authorized the discharge of municipal solid waste to the landfill, animal refuse to a carcass pit, and the operation of controlled open burning for wood waste. The landfill was constructed over a historical meander of Dawson Creek, which is approximately 20 metres (m) thick and infilled with fluvial sand and gravel. Waste was placed from the pre-existing north bank of Dawson Creek near Highway 49 to the south towards the existing creek. In 1997, ownership of the landfill was transferred to the PRRD.

The landfill stopped receiving waste between 2000 and 2002. After closure, the Site continued to operate as a transfer station and waste was redirected to the Bessborough Landfill. Additionally, the Site received clean fill material until January 1, 2020. Historically, the clean fill was placed at the crest of the landfill and pushed down slope.

1.2 Assessment Approach

This assessment was undertaken to evaluate groundwater and surface water quality at the Site and assess any impacts related to landfill leachate migration to the receiving groundwater and surface water environments under existing conditions.

The purpose of the impact assessment is to support the conceptual design of the cover rehabilitation program, specifically to determine the level of design needed to reduce leachate generation and improve water quality within the receiving environments.

The following points describe the approach used to complete this assessment:

– The physical setting of the Site was investigated using historical stratigraphic logs. The physical setting is described in terms of subsurface geology and hydrogeology to define the presence and movement of groundwater through the subsurface.
– Groundwater and surface water quality outside the landfill footprint is characterized by samples collected from monitoring wells and surface water courses in the vicinity of the landfill. The sampling program includes the collection of groundwater and surface water samples from "background" locations.
– Leachate indicator parameters were selected based on historical Site groundwater and surface water quality data.
– The groundwater and surface water analytical results for the leachate indicator parameters were assessed and compared to background groundwater and upstream surface water quality to identify potential landfill-related water quality impacts.
– A conceptual Site model was developed to describe existing conditions, the Site physical setting, receptors, compliance locations, and how the Site interacts with the surrounding environment (i.e., pathways from contaminant source to receptor).
– A Hydrologic Evaluation Landfill Performance (HELP) model was created to estimate leachate generation rates and leachate impacted groundwater discharge to the receiving environment under existing conditions.
– Hydraulic monitoring data was used to prepare an annual water balance for the landfill. This water balance was prepared for the purposes of understanding the quantitative movement of groundwater through the Site.

– Assessment of risks to the receiving environment and potential engineered mitigation measures (e.g., low-permeable final cover).

1.3 Regulatory Setting

The appropriate groundwater standards to apply to the Site depend on the current and future groundwater and surface water uses and the potential for groundwater or surface water at the Site to flow to surface water bodies that support aquatic life.

The BC Ministry of Environment and Climate Change Strategy (ENV), formerly the BC MOE, document Protocol 21 for Contaminated Sites: Water Use Determination (Protocol 21) (ENV, 2020) provides the criteria for selecting the appropriate standards to apply to water quality results.

Based on GHD's experience and the guidance provided in Protocol 21, the BC Contaminated Sites Regulation (CSR) and Approved and Working Water Quality Guidelines (WQG) provide an appropriate benchmark for evaluating groundwater and surface water quality at the Site. The following describes the water quality standards that should be used to assess water quality at the Site moving forward and the rationale for using those standards.

Protocol 21 specifies that Aquatic Life (AW) standards apply to sites located within a 500 metre (m) radius of a surface water body. Dawson Creek is located approximately 50 m south of the Site. Therefore, CSR AW standards apply to groundwater at the Site.

To exclude the application of the Drinking Water (DW) standards from the Site, Protocol 21 indicates that there must be no groundwater wells used for drinking water purposes located with a 500 m radius from the Site, and there cannot be a viable aquifer on Site to protect future drinking water use. The Site is underlain primarily by glaciolacustrine clay and till which overly Aquifers 851 and 593. Aquifer 851 is a confined sand and gravel aquifer, and Aquifer 593 is a fractured sedimentary bedrock aquifer. Based on these observations, the CSR DW standards should conservatively apply to groundwater at the Site unless an additional hydrogeologic characterization demonstrates that the surficial soils act as an effective confining layer.

Analytical results for surface water samples are compared to the BC WQGs for the protection of drinking water (DW) and freshwater aquatic life (FWAL).

WQGs include both short term minimum/maximum (STM) (instantaneous) and long-term average (LTA) (30 day mean) guidelines and may apply to dissolved or total parameter concentrations. The long-term average (LTA) guidelines are generally more stringent than the short-term minimum/maximum (STM) guidelines. WQGs are also often dependent on background conditions, hardness, chloride, calcium pH, and/or temperature.

Based on the surface water sampling frequency and methodology conducted at the Site, STM WQGs for total concentrations apply.

2. Field Investigations

Field investigations to assess existing conditions at the landfill were completed by GHD in May 2020 and September 2022. During the Site visits, the following observations were made:

– Slope inclinometers are present on Site.
– Loose soil mounds were found at the landfill plateau.
– Uncompacted cover soil with no vegetation was found at the top of the west side slope of the landfill.
– Ponded surface water was found at the southwest toe of the landfill.
– Visual evidence of differential settlement was observed including a large crack at the toe of slope along the west side of the landfill and sloughing on the south landfill side slope.

– Scattered litter such as scrap metal and concrete were observed at the west side of the landfill.
– Exposed waste was observed at the southeast side slope of the landfill.
– Exposed geosynthetics observed on southwest slope.

3. Site Physical Setting

3.1 Climate

The climate of the Dawson Creek area is characterized by mild, wet summers and cold, dry winters. According to the data collected at the Dawson Creek Airport weather station (Climate ID 1182285), which is located approximately 1 km south of the Site and is in the same biogeoclimatic zone (Boreal White and Black Spruce) as the landfill, the area receives on average 453.2 millimetres (mm) of precipitation per year (307.2 mm is rainfall and 172.2 cm is snowfall). Precipitation is highly seasonal with 62% of total annual precipitation occurring from May to September. The daily average temperature is 1.9 degrees Celsius (°C) and ranges from -13.2 °C in January to 15.5 °C in July. The 1981 to 2010 Canadian Climate Normals data recorded at the Dawson Creek A climate station is presented on Figure 3.

3.2 Site Topography and Drainage

Topography and drainage features are shown on Figure 4. The Site slopes to the south from an elevation of approximately 650 metres above mean sea level (m AMSL) in the northern portion of Site to approximately 630 m AMSL in the southern portion of the Site. Regional topography near the Site slopes towards Dawson Creek.

Precipitation falling onto the landfill either infiltrates into the subsurface or flows as overland runoff. Runoff either flows down the landfill side slopes in a west-southwest direction toward Dawson Creek or is captured by the runoff collection ditches constructed around the perimeter of the landfill. The collection ditches discharge clean stormwater to the southeast corner of the Site.

3.3 Site Geology

Based on the results of previous drilling investigations, overburden geology underlying the Site can be described as glaciolacustrine deposits of laminated to massive clay associated with a former glacial lake and glacial till. Sand and gravel were encountered within a historical, cut off, meander of Dawson Creek. Historical photography shows that the cutoff meander, present in 1964, is in a horseshoe shape beneath the landfill footprint.

Bedrock was encountered in the northwest area of Site at a depth of approximately 29.5 metres below ground surface (mbgs). Bedrock is of the Kaskapau Formation of the Smokey Group and is Upper Cretaceous in age. The Kaskapau Formation is characterized by fine clastic sedimentary rock, including mudstones, siltstones, and shale. Available historical borehole logs are presented in Appendix A.

3.4 Hydrogeology

Two regional aquifers underly the Site as identified by iMapBC. Aquifer 851 is a confined overburden aquifer comprised of glacial sand and gravel deposits. This aquifer has moderate productivity and low vulnerability and is overlain by a confining layer of low porosity clay. Precipitation and infiltration from surface water bodies are the primary source of recharge for this aquifer. Aquifer 593 is a bedrock aquifer comprised primarily of shale with some sandstone of the Kaskapau Formation. Aquifer 593 has moderate vulnerability and productivity.

Five monitoring wells (MW) are installed within the overburden at the Site. Wells DC-98-5 and DC-BH101 are located upgradient to the north of the landfill and well DC-95-2 is located cross-gradient to the east. Wells DC-98-1 and DC-98-3 are located downgradient to the southeast and southwest, respectively. Well DC-98-1 was installed within sand

and gravel of the old creek meander of Dawson Creek. Other wells were installed within the glaciolacustrine clay and till deposits. Waste was placed on top of clay and clay till (AECOM, 2012).

Hydraulic conductivity testing was completed at Site monitoring wells by AGRA earth and Environmental (AGRA) in 1999, a summary of the hydraulic conductivity estimates is presented in Table 3.1, below. The hydraulic conductivities at the Site range between 3 x 10^{-9} m/sec in the high plasticity clay to 1 x 10^{-4} m/sec in the gravel of the old creek meander at DC-98-1. Based on the high hydraulic conductivity measured at DC-98-1, the cut off meander of Dawson Creek likely provides a preferential pathway for leachate migration directly to Dawson Creek.

Table 3.1 Site Hydraulic Conductivity Estimates

Location	Stratigraphy	Hydraulic Conductivity (m/sec)	Reference
DC-BH101	Clay	5 x 10^{-9}	(Matrix Solutions, 2018)
DC-95-1	Clay and Clay Till	1 x 10^{-7}	(AGRA Earth and Environmental, 1999)
DC-98-5	Clay Till	5 x 10^{-6}	
DC-98-2	Clay w sand	5 x 10^{-7}	
DC-98-1	Gravel Layer	1 x 10^{-4}	
MP99-1A	High Plastic Clay	3 x 10^{-8}	
MP99-1B	High Plastic Clay	3 x 10^{-9}	
MP99-2	High Plastic Clay	3 x 10^{-9}	

Based on the groundwater elevation data provided in annual reports for the Site, the depth of shallow groundwater ranges from approximately 10 to 14 mbgs (at wells DC-98-5 and DC-BH101 to the north) and 1 to 2 mbgs (at well DC-95-1 near Dawson Creek). Elevations of shallow groundwater ranges from approximately 643 m AMSL to the north, to approximately 630 m AMSL to the south. Groundwater elevations to the south are similar to elevations in Dawson Creek. Local groundwater flows to the south, following local topography and towards Dawson Creek.

For reference, the 2021 water level data (2021 Annual Monitoring Report, Matrix Solutions Inc.) are provided in Appendix C (Table 5a).

A horizontal groundwater flow velocity in the clay and clay till is estimated to range from 0.01 to 22 metres per year (m/yr). Based on a horizontal gradient of 0.05 m/m (average 2021 groundwater elevations at DC-BH101 and DC-98-3), a range of hydraulic conductivity values between of 5 x 10^{-6} m/sec (DC-98-5) and 3 x 10^{-9} (MP99-1B and MP99-2) and an estimated effective porosity of 0.35 representative of clay till (Spitz & Moreno, 1966). Using a geometric mean hydraulic conductivity of 6.4 x 10^{-8} m/sec, a horizontal groundwater flow velocity of 0.29 m/year is estimated.

Groundwater monitoring wells and flow direction are presented on Figure 5.

3.5 Estimated Leachate Generation Rate

Leachate generation at the landfill was estimated using the HELP model. To estimate an overall leachate generation rate for the landfill, leachate generation was modeled for both the landfill plateau and side slopes. Leachate generation was assumed to be the rate at which leachate percolated through the clay till underlying the landfill.

Leachate generation was modeled for two scenarios: the first model assumed a low permeability cover (1.0 x 10^{-9} m/sec), representing properly moisture-conditioned and compacted cover material with minimal deterioration; and the second model assumed a medium permeability cover (1.0 x 10^{-7} m/sec), representing a conservative estimate for the effective permeability of the existing cover at the Landfill. Both scenarios potentially conform to the landfill cover material requirements set out in the 2016 BC Landfill Criteria for Municipal Solid Waste (Criteria).

The HELP model inputs are summarized below, and leachate generation rates calculated from the HELP models are presented in Table 3.2, below. The estimated leachate generation rates reported in the 2012 Dawson Creek Landfill

Hydrogeologic Assessment (AECOM, 2012) are presented in Table 3.2 for comparison. As summarized below, the results of the medium permeability cover are generally comparable to previous estimates made by AECOM. It is recommended that test pitting and soil sampling be completed to accurately determine hydraulic conductivity and thickness of landfill cover.

Leachate generation rates estimated by GHD and HELP model inputs and results are presented in Appendix B.

HELP Model Assumptions/Inputs:

Slopes: 27% side slopes; 1% plateau

Topsoil Thickness: 15 cm

Cover thickness: 60 cm

Cover hydraulic conductivity: 1.0 x 10^{-9} m/sec (Low permeability)

Cover hydraulic conductivity: 1.0 x 10^{-7} m/sec (Medium permeability)

Landfill Plateau area: 3.125 Hectares (Ha)

Landfill Side Slopes Area: 3.125 Ha

Total Landfill Area: 6.25 Ha

Table 3.2 HELP Model Leachate Generation Rates

HELP Model Simulation	Precipitation (m^3/year)	Leachate Generation Rate (m^3/year)	Runoff (m^3/year)	Evapotranspiration (m^3/year)
AECOM, 2012 (Low Rate)	28,892	3,285	-	-
AECOM, 2012 (High Rate)	28,892	6,242	-	-
GHD, 2023 (Low Permeability)	28,892	631	6,368	21,902
GHD, 2023 (Medium Permeability)	28,892	5,197	5,107	18,597

4. Water Quality Monitoring

4.1 Environmental Monitoring Program

The purpose of the water quality monitoring program is to characterize groundwater and surface water quality at the Site and assess water quality impacts resulting from landfill leachate migration. Groundwater quality is assessed at four monitoring locations located upgradient, cross-gradient, and downgradient of the landfill waste footprint. The following groundwater monitoring wells are included in the current environmental monitoring program:

– DC-BH101 (Upgradient)
– DC-95-2 (Cross-Gradient)
– DC-19-1 (Downgradient)
– DC-98-1 (Downgradient)

Surface water quality is assessed at four monitoring locations located upstream, midstream, and downstream of the landfill. The following surface water monitoring locations are included in the current environmental monitoring program:

– DC-SW6 (Upstream)
– DC-SW4 (Midstream)

– DC-SW2 (Midstream)
– DC-SW7 (Downstream)

The locations of the groundwater monitoring wells and surface water monitoring locations are illustrated on Figure 5. Appendix C, Table 5a (2021 Annual Monitoring Report, Matrix Solutions Inc.) includes a summary of the well completion details where available.

Surface water monitoring location DC-SW4 is located on an oxbow adjacent to the main channel of Dawson Creek. Based on historical satellite imagery of the Site, the oxbow does not appear to have a perennial hydraulic connection to the main channel of Dawson Creek. Because this monitoring location does not represent surface water quality in Dawson Creek, it was not considered in this assessment.

The groundwater and surface water monitoring and sampling program were completed by SLR Consulting Ltd. Between 2015-2017, and by Matrix Solutions Inc. from 2018 to 2022.

As part of the monitoring program, groundwater, and surface water samples are collected and analyzed for a comprehensive list of field parameters, general chemistry, nutrients, metals, hydrogen sulfide, hydrocarbons and extractable petroleum hydrocarbons (EPH). The analytical results from the 2021 Annual Monitoring Report prepared by Matrix Solutions Inc. along with the selected comparative criteria are presented in Appendix C (Tables 5b – 5j). The groundwater samples have been compared to the CSR DW and AW criteria and the Surface Water samples have been compared to the WQG DW and FAW criteria. Historical concentrations of leachate indicator parameters and concentration trend analysis from the 2021 Annual Monitoring Report prepared by Matrix Solutions Inc. are presented in Appendix D.

4.2 Groundwater Quality

4.2.1 Background Groundwater Quality

Monitoring wells DC-BH101 is located immediately upgradient of the Landfill approximately 10 m northwest of the waste footprint. DC-BH101 is screened within till/clay unit. Based on the location of this well and historical water quality, it is considered to be representative of background groundwater quality that has not been affected by landfill related impacts. Elevated concentrations of groundwater analytical parameters observed at DC-BH101 are interpreted to be representative of natural conditions and/or impacts from off-Site related activities occurring upgradient of the Site.

4.2.2 Leachate Quality and Quantity

Matrix Solutions Inc. determined that data documenting leachate concentrations beneath the Site is not available. Leachate indicator parameters for the landfill are assumed to be sodium, chloride, sulphate, boron, iron, and manganese based on leachate water quality from other landfills in the Peace River Regional District.

4.2.3 Groundwater Quality Impact Assessment

Impacts to groundwater from landfill leachate are clearly apparent at the downgradient monitoring wells, where concentrations of leachate indicator parameters chloride and boron (Appendix C) are observed at significantly higher levels than in upgradient and cross-gradient groundwater. Concentrations of ammonia, arsenic, cobalt, iron, and manganese are also observed at significantly higher levels in downgradient groundwater than in upgradient and cross-gradient groundwater.

A summary of the analytical parameters reported at concentrations in excess of their applicable groundwater quality standards between 2018 and 2021 are presented in Table 4.1, below. Please note that the exceeding parameters listed below are summarized from the historical reports prepared by others.

Table 4.1 2018-2021 Groundwater Quality – Analytes Exceeding Applicable Water Quality Standards.

Year	DC-BH101 (Upgradient)	DC-95-2 (Cross-Gradient)	DC-19-1 (Downgradient)	DC-98-1 (Downgradient)
2018	Na, SO_4, Li, Sr, U,	Na, SO_4, S^{2-} as H_2S, Co, Li, Sr	--	Na, Cl, SO_4, NH_3-N, As, Co, Fe, Li, Mn, Sr
2019	Na, SO_4, Li, Sr, U,	Na, SO_4, Co, Li, Mn, Sr	Na, Cl, Co, Li, Mn, Sr, U	Na, Cl, NH3-N, As, Co, Fe, Li, Mn, Sr
2020	Na, SO_4, Li, Sr, U	Na, SO_4, Co, Li, Mn, Sr	Na, Cl, SO_4, Co, Li, Mn, Sr, U	Na, Cl, SO_4, NH_3-N, S^{2-} as H_2S, As, Co, Fe, Mn
2021	Na, SO_4, Li, Sr, U	Na, SO_4, Co, Li, Mn, Sr	Na, SO_4, Co, Li, Mn, Sr, U	Na, Cl, NH3-N, As, Co, Fe, Li, Mn, Sr

Notes:
-- - data not collected
** - no analytes in sample exceeded both applicable standards and background concentrations.
Criteria applied: BC CSR: AW and DW; BC WQG: AW, DW, WW, IW, and LW

It should be noted that the concentrations of sodium, sulphate, lithium, and strontium at the background well are frequently higher than concentrations reported at the cross-gradient DC-95-2 and downgradient well DC-19-1. Concentrations of lithium and strontium are occasionally higher in background when compared to DC-98-1. As shown above the number of parameters in excess of their applicable standards is greater at the downgradient most monitoring well. DC-98-1 is screened within the cut off meander of Dawson Creek and provides worst-case landfill impacts.

Based on the historical data, concentrations of leachate indicator parameters in downgradient groundwater appear to have been stable for several years. These observations indicate that while impacts to groundwater from landfill leachate are present, and resulting in exceedances of applicable groundwater quality standards, they do not appear to be worsening.

While groundwater quality concentrations have stabilized, it is recommended that monitoring and reporting continue to ensure that groundwater quality remains at current concentrations or decrease over time.

4.3 Surface Water Quality

4.3.1 Background Surface Water Quality

Surface water monitoring location DC-SW6 is located in the main channel of Dawson Creek approximately 200 m upstream of the landfill waste footprint. Based on the location of this monitoring location and historical water quality results, it is considered to be representative of upstream surface water quality that has not been affected by landfill related impacts. Background surface water quality in Dawson Creek is known to be impacted by the wastewater treatment plant, which is located upstream from the landfill and contributes a large proportion of surface water flow to the creek (AECOM, 2012). Elevated concentrations of surface water analytical parameters observed at DC-SW6 are interpreted to be representative of natural conditions and/or impacts from the wastewater treatment plant.

4.4 Surface Water Quality Impact Assessment

Based on the historical surface water quality data (Appendix C), impacts to surface water quality in Dawson Creek from landfill leachate appear to be present but limited. Concentrations of chloride, sulphate, chromium, iron, and manganese have generally been similar, or higher in concentration at the upstream monitoring location (DC-SW6) compared to the mid- and downstream locations (DC-SW2 and DC-SW7). Concentrations of these parameters exceed BC WQGs at the upstream monitoring location. This indicates that the elevated concentrations of these parameters in surface water are related to activities upstream of the landfill.

Concentrations of sodium and boron show seasonal variations, with elevated concentrations observed at the mid- and downstream locations relative to background surface water, indicating that leachate impacted groundwater is likely discharging to Dawson Creek during the summer and fall. Based on the historical data and trend analyses completed by Matrix (Matrix, 2022) (Appendices C and D), concentrations of boron and sodium in Dawson Creek are well below the BC WQGs and show no overall increasing trend.

The midstream (SW2) and downstream (SW7) surface water monitoring points are located downstream of the confluence of the former meander and Dawson Creek. Water quality at these points are good representatives of worst-case leachate impacted groundwater discharging to Dawson Creek. As described above, the landfill is having some influence on surface water quality but is not significant in comparison to upstream impacts. Thus, worst-case groundwater discharge is not having a significant influence on surface water quality.

SLR reported that the landfill contributes less than 0.1% to stream flow in Dawson Creek and accounts for 0.08% to 0.54% mass loading to the stream (SLR, 2018). Reported exceedances of the applicable surface water quality standards between 2017 and 2021 are presented in Table 4.2.

Table 4.2 2017-2021 Surface Water Quality – Analytes Exceeding Applicable Water Quality Standards

Year	DC-SW6 (Upstream)	DC-SW2 (Midstream)	DC-SW7 (Downstream)
2017	Conductivity, total dissolved solids, sulphide, faecal coliforms, aluminum, chromium, iron, manganese,	Conductivity, total dissolved solids, sulphide, faecal coliforms, aluminum, beryllium, chromium, iron, manganese	Conductivity, total dissolved solids, faecal coliforms, chromium, manganese
2018	Temperature, field pH, field dissolved oxygen, chloride, total phosphorous, iron, e.coli	Field pH, field dissolved oxygen, lab pH, e.coli	Field pH, field dissolved oxygen, lab pH, chloride, ammonia-nitrogen, total phosphorous,
2019	Temperature, chloride, ammonia-nitrogen, total phosphorous, iron, faecal coliforms	Temperature, chloride, nitrite-nitrogen, total phosphorous, faecal coliforms	Temperature, field dissolved oxygen, chloride, nitrite-nitrogen, total phosphorous, faecal coliforms
2020	Temperature, field dissolved oxygen, ammonia-nitrogen, total phosphorous, iron, faecal coliforms	Chloride, ammonia-nitrogen, total phosphorous, iron	Temperature, ammonia-nitrogen, total phosphorous
2021	Temperature, chloride, sulphide, total phosphorus, cobalt, iron, manganese, faecal coliforms	Temperature, field dissolved oxygen, chloride, ammonia-nitrogen, total phosphorus, arsenic, cobalt, iron, manganese	Chloride, ammonia-nitrogen, total phosphorus, cobalt, iron, manganese

5. Conceptual Site Model

Based on the available regional and Site-specific information, the following Conceptual Site model has been developed:

– The Site is located south of highway 49 and immediately north of Dawson Creek. The Site slopes to the south towards Dawson Creek.
– The landfill received municipal solid waste and animal waste between 1974-2002 and received clean fill until 2020. The Site now operates as a transfer station.
– Groundwater elevations measured at monitoring wells across the Site indicate that groundwater flow is to the south toward Dawson Creek.
– The surficial geology underlying the Site consists of glaciolacustrine deposits of laminated to massive clay and glacial till which act as a barrier to groundwater migration.

    - There is a historical cut off meander of Dawson Creek beneath the landfill footprint. The meander is characterized by sand and gravel and notably higher permeability and hydraulic conductivity than the surrounding glaciolacustrine deposits. The meander is interpreted to be preferential pathway for leachate migration. Leachate generated in the landfill would preferentially flow through the more permeable sand and gravel and discharge into Dawson Creek.
- Leachate generation for the landfill under the existing conditions of the final cover is estimated to be between 631 to 5,197 m^3 per year.
- Background groundwater quality at the Site (DC-BH101) is characterized by elevated concentrations of sodium, sulphate, lithium, strontium, and uranium which have been consistently observed at concentrations exceeding the applicable groundwater quality standards at the Site. The elevated concentrations of these parameters are interpreted to be representative of natural conditions and/or impacts resulting from off-Site activities upgradient of the landfill.
- Downgradient groundwater quality at the Site (DC-19-1 and DC-98-1 is characterized by elevated concentrations (i.e., elevated above background groundwater quality) of chloride, ammonia, H_2S, arsenic, boron, cobalt, iron, and manganese, which are interpreted to represent impacts from landfill leachate.
    - Monitoring well DC-98-1, is located within the Dawson Creek meander. Thus, water quality result represent worse-case migration of leachate impacts through the preferential pathway.
    - Concentration versus time plots show that groundwater impacts have been stable for a number of years.
- Surface water quality in Dawson Creek is affected by wastewater effluent from the wastewater treatment plant located upstream from the Site.
    - The midstream (SW2) and downstream (SW7) surface water monitoring points are located downstream of the confluence of the former meander and Dawson Creek. Water quality at these points are good representatives of worst-case leachate impacts discharging to Dawson Creek.
- A comparison between upstream, midstream, and downstream water quality shows that landfill is having some influence on water quality in Dawson Creek; however, concentrations of landfill derived analytes are not greater than BC WQG (sodium and boron). It is reported that the landfill contributes less than 0.1% to stream flow in Dawson Creek and accounts for 0.08% to 0.54% mass loading to the stream (SLR, 2018).

6. Water Balance Model

GHD developed a generalized water balance model to quantitatively estimate the movement of groundwater and leachate through the Site. In order to develop the water balance model, the Site was divided into three areas: upgradient of the landfill, the landfill footprint, and downgradient of the landfill. The following describes the water inputs and outputs considered for each of the three areas.

Area 1 – Upgradient of the Landfill

Area 1 represents the area directly north or upgradient of the landfill. Water input into Area 1 consists of the infiltration of precipitation and groundwater flow from further upgradient. Water output from Area 1 consists of groundwater flux through the glaciolacustrine deposits and beneath the landfill footprint.

Area 2 – Landfill Footprint

Area 2 represents the landfill footprint. The water inputs to Area 2 include groundwater flux from upgradient and infiltration of precipitation over the landfill footprint (i.e., leachate generation). The amount of infiltration into the landfill is based on existing conditions including landfill cover soil, vegetative coverage, evaporative zone depth, slope, and waste thickness. The rate of leachate generation was estimated using the HELP model as described in Section 3.5.

Water output from Area 2 consists of leachate impacted groundwater flux to Area 3 as well as evapotranspiration of precipitation falling onto the landfill mound. It is likely that much of the leachate flux from Area 2 would flow through the former Dawson Creek meander.

Area 3 – Downgradient

Area 3 represents the area downgradient of the landfill footprint. The water inputs to Area 3 include infiltration of precipitation, and flux from Area 2. Water output from Area 3 consists of discharge to Dawson Creek, runoff of precipitation into Dawson Creek, and evapotranspiration.

Dawson Creek Meander

Sand and gravel were encountered within the cut off meander of Dawson Creek. The hydraulic conductivities in the sand and gravel is estimated to be on the order of 1 x 10^{-4} m/sec (measured at DC-98-1). Based on the hydraulic conductivity, the old creek meander of Dawson Creek likely provides a preferential pathway for leachate migration directly to Dawson Creek. It is likely that leachate impacted groundwater from Area 2, discharges into the meander which is hydraulically connected to Dawson Creek; however, the horizontal groundwater velocity within the clay and clayey till material would limit discharge into the meander. Some infiltration of precipitation would occur into the meander which would further dilute impacts originating from Area 2. Because the receptor of groundwater discharge within the meander is still Dawson Creek, this area has not been considered separately from Area 3.

6.1 Calculation Methodology and Key Inputs

The following sections provide descriptions of the key methodologies and inputs used in creating the water balance model. Appendix E provides the detailed step-by-step calculations used in the model as well as the data used to complete those calculations. Simplified calculations are presented in each subsection.

6.1.1 Area 1 – Upgradient of Landfill

The groundwater flux flowing across the boundary of Area 1 can be calculated using Darcy's Law and is expressed by the following equation:

$$Q_1 = K \times A \times i$$

Where:

Q_1= flux or flow across the width of the landfill footprint within Area 1 (m^3/year)

K = hydraulic conductivity (m/sec)

A = Cross-sectional area through which groundwater is flowing (m^2)

i = hydraulic gradient or change in hydraulic head over a distance (between DC-BH101 and DC-98-3) (m/m)

Where the cross-sectional area is calculated by the following:

$$A = L \times D$$

Where:

L = length of the landfill footprint which is perpendicular to groundwater flow (m)

D = the saturated thickness of the underlying aquifer (m)

Groundwater influx from Area 1 was estimated based on the following:

– An average horizontal gradient of 0.05 m/m. This value was calculated based on the May 19, July 14, and October 6, 2021, groundwater elevations measured at DC-BH101 and DC-98-3.
– The upgradient length of the landfill footprint which is perpendicular to groundwater flow is estimated to be approximately 256 m.
– The assumed saturated thickness of the aquifer underlying the landfill is estimated to be approximately 12 m based on the average 2021 observed groundwater elevation at DC-BH101 relative to the elevation of Dawson Creek.
– A geometric mean hydraulic conductivity of 6.4×10^{-8} m/sec based on the hydraulic conductivity estimates from MW95-1, MW98-5, MW98-2, MW99-1A/B, and MW99-2.

The groundwater flux from Area 1 (Q_1) entering Area 2 was calculated to be 300 m^3 per year.

Calculations:

$$\begin{aligned} Q_1 &= K \times A \times i \\ &= 6.3 \times 10^{-8}\, m/s \times (256 \times 12.0)\, m^2 \times 0.05\, m/m \times 31536000\, s/yr \\ &= 300\, m^3/yr \end{aligned}$$

Detailed step-by-step calculations of the entire water balance, including the flux from Area 1, are included in Appendix E.

6.1.2 Area 2 – Landfill Footprint

A portion of the precipitation that falls onto the landfill infiltrates and generates leachate, which then mixes with groundwater and follows the natural groundwater flow direction. Leachate generation from the landfill footprint (Q_2) was estimated using the HELP Model described in Section 3.5.

Leachate generation under existing conditions was estimated to be between 631 and 5,197 m^3 per year ($Q_{2\ Low\ Permeability}$ and $Q_{2\ Medium\ Permeability}$).

Outflow from Area 2 into Area 3 ($Q_3 = Q_1 + Q_2$) is estimated to be between 931 and 5,497 m^3 per year.

Calculations:

$$\begin{aligned} Q_{3\ Low\ Permeability} &= Q_1 + Q_{2\ Low} \\ &= 300\, m^3/yr + 631\, m^3/yr \\ &= 931\, m^3/yr \\ Q_{3\ Medium\ Permeability} &= Q_1 + Q_{2\ Med} \\ &= 300\, m^3/yr + 5197\, m^3/yr \\ &= 5497\, m^3/yr \end{aligned}$$

6.1.3 Area 3 – Downgradient

A portion of the precipitation falling onto the area downgradient of the landfill will infiltrate through the subsurface and mix with the groundwater flow from Area 2. Groundwater recharge flux from downgradient precipitation was estimated by multiplying the precipitation infiltration rate by area downgradient of the landfill. The infiltration rate for Dawson Creek area was obtained from Protocol 2 for Contaminates Sites (2017)[1]. The area downgradient of the landfill was estimated to be approximately 15,000 m^2. Based on the Dawson Creek infiltration rate of 80 mm/yr, the flux of precipitation infiltration downgradient of the landfill is estimated to be 1200 m^3/yr (Q_4).

The groundwater flux leaving Area 3 ($Q_5 = Q_3 + Q_4$) was calculated to be between 2,131 and 6,697 m^3 per year. This value is representative of the upgradient groundwater flux that mixes with leachate and downgradient precipitation that

[1] Protocol 2 for Contaminated Sites, 2017. Ministry of Environment and Climate Change Strategy

discharges into Dawson Creek. The clean stormwater runoff from Area 3 would also enter Dawson Creek but would not adversely influence groundwater quality.

This is estimate is shows that leachate is between 30 and 78% of the volume discharging into the creek (based on a low or medium permeable cover material). Given the contrast in permeability between the clayey soils and sand and gravel, it is likely that much of this discharge is occurring within the former Dawson Creek meander.

Calculations:

$$Q_{5\,Low} = Q_{3\,Low} + Q_4$$
$$= 931\ m^3/yr + 1200\ m^3/yr$$
$$= 2131\ m^3/yr$$

$$Q_{5\,High} = Q_{3\,Med} + Q_4$$
$$= 5497\ m^3/yr + 1200\ m^3/yr$$
$$= 6697\ m^3/yr$$

7. Conclusions

Site Physical Setting

– The Site is located south of Highway 49 and north of Dawson Creek

– Based on Site inspections, the following observations have been made:

- Loose soil mounds were found at the landfill plateau.
- Uncompacted cover soil with no vegetation was found at the top of the west side slope of the landfill.
- Ponded surface water was found at the southwest toe of the landfill.
- Visual evidence of differential settlement was observed including a large crack at the toe of slope along the west side of the landfill and sloughing on the south landfill side slope.
- Scattered litter such as scrap metal and concrete were observed at the west side of the landfill.
- Exposed waste was observed at the southeast side slope of the landfill.
- Exposed geosynthetics observed on southwest slope

Site Hydrogeology

– Groundwater levels and quality is monitored at wells DC-98-5, DC-BH101, DC-95-2, DC-98-1, and DC-98-3, installed upgradient, cross-gradient, and downgradient of the landfill within the overburden

– Groundwater elevations at the Site range from approximately 643 m AMSL to the north, to approximately 630 m AMSL to the south.

– Groundwater at the Site flows to the south, following local topography and towards Dawson Creek.

– Hydraulic conductivity in the overburden has been estimated to range from 3 x 10^{-9} to 1 x 10^{-6} m/sec in the clay till and 1 x 10^{-4} m/sec in the sand and gravel in the old creek meander of Dawson Creek

– The contrast in hydraulic conductivity between the clay till and creek meander will result in a preferential pathway for groundwater and leachate to flow to Dawson Creek

Groundwater Quality

– At the downgradient monitoring wells DC-19-1 and DC-98-1, concentrations of chloride, boron, ammonia, H_2S, arsenic, cobalt, iron, and manganese are elevated compared to upgradient and cross-gradient groundwater and exceed CSR DW and/or FWAL water quality standards.

– Based on the historical data, concentrations of leachate indicator parameters in downgradient groundwater appear to be stable indicating that the presence of leachate is not worsening over time.

Surface Water Quality

– Background surface water quality in Dawson Creek is known to be impacted by the wastewater treatment plant, which is located upstream from the landfill and contributes a large proportion of surface water flow to the creek
– Elevated concentrations of surface water analytical parameters observed in Dawson Creek are interpreted to be representative of natural conditions and/or impacts from the wastewater treatment plant
– Concentrations of leachate indicator parameters in surface water within Dawson Creek are generally similar or higher at monitoring locations upstream of the landfill compared to mid-stream and down-stream locations
– Groundwater impacted by leachate discharges into Dawson Creek in the summer and fall as indicated by elevated concentrations of sodium and boron at downstream surface water monitoring locations.
– Boron and sodium concentrations in Dawson Creek are well below the applicable water quality standards and show no increasing trends, indicating that groundwater recharge is not adversely affecting freshwater aquatic life in Dawson Creek.
– The landfill is not adversely impacting freshwater aquatic life in Dawson Creek.

Leachate Generation Rate

– Leachate generation at the landfill was estimated using the HELP model for two scenarios
  - The first model assumed a low permeability cover (1.0×10^{-9} m/sec), representing properly moisture-conditioned and compacted cover material with minimal deterioration
  - The second model assumed a medium permeability cover (1.0×10^{-7} m/sec), representing a conservative estimate for the effective permeability of the existing cover at the Landfill
– Based on the two scenarios, the leachate generation for the landfill was estimated to be between 631 and 5,197 m^3 per year

Water Balance Model

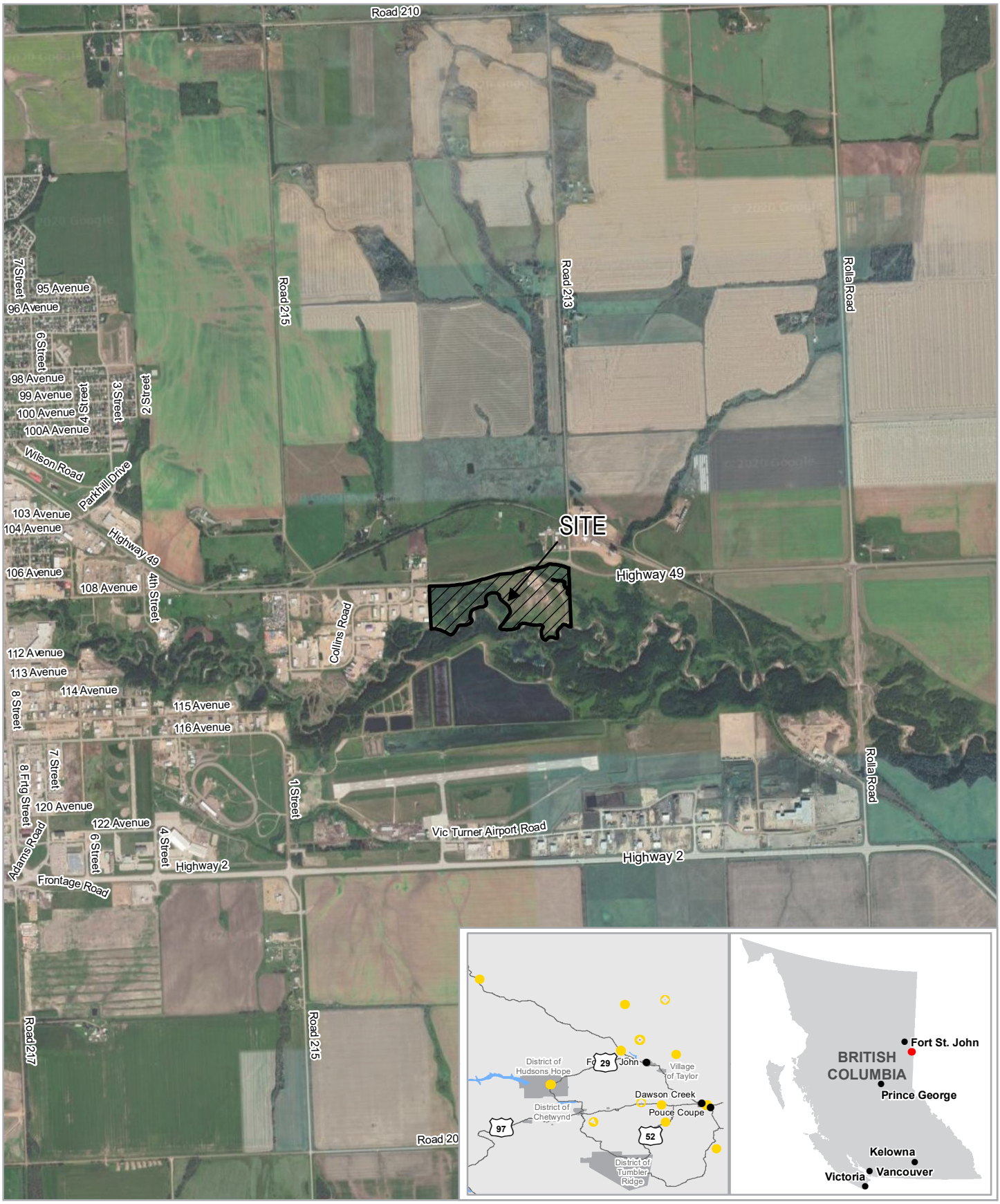
– A water balance model for the Site to quantitatively estimate the movement of groundwater and leachate through the Site was completed
– The model considered groundwater flow from upgradient of the landfill, leachate generated within the landfill footprint using a HELP model, and precipitation falling downgradient of the landfill footprint
– The groundwater discharge into Dawson Creek is estimated to be between 2,131 and 6,697 m^3 per year

8. Recommendations

Based on the findings of this Report, the following recommendations are made:

– Test pitting needed to determine hydraulic conductivity and thickness of landfill cover. This can be used to confirm the results of the HELP model and confirm leachate generation rates
– Continue monitoring groundwater and surface water quality at the Site
– Implement cover rehabilitation measures described in the Cover Rehabilitation report (GHD, 2023)

Figures



Paper Size ANSI A

0 200 400 600 800

Meters

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 10N

N

GHD

DAWSON CREEK LANDFILL CLOSURE PLAN AND ASSESSMENT
DAWSON CREEK, BC
PEACE RIVER REGIONAL DISTRICT

Project No. **11213132**
Revision No. **-**
Date **Oct 20, 2020**

SITE LOCATION PLAN

FIGURE 1

Q:\GIS\PROJECTS\11213000s\11213132\Layouts\202008_RPT\11213132_202007_RPT013_GIS001.MXD

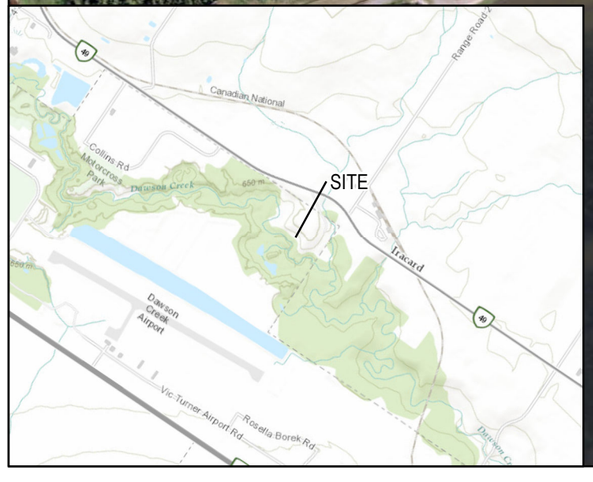
Data source: gOOGLE eARTH iMAGERY, VARIOUS DATES - Accessed 2020

SITE BOUNDARY

APPROXIMATE LIMIT OF WASTE

APPROXIMATE LOCATION OF OLD CREEK MEANDER

SITE



Paper Size ANSI B

0 50 100

Meters

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 10N

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GHD

DAWSON CREEK
BRITISH COLUMBIA
GROUNDWATER AND SURFACE WATER IMPACT ASSESSMENT

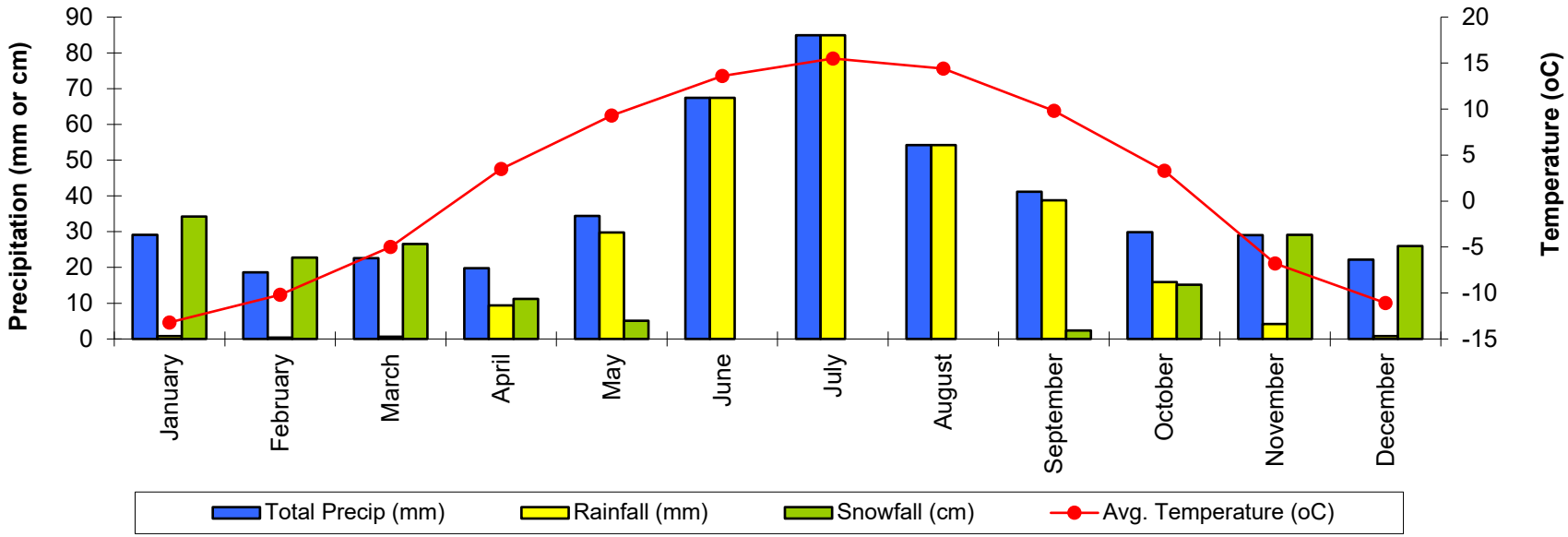
SITE PLAN

Project No. **11213132**
Revision No. **-**
Date **Sep 1, 2023**

FIGURE 2

Q:\GIS\PROJECTS\11213000s\1121312\Layouts\202208_RPT001\11213132_202208_RPT001_GIS005.mxd
Print date: 01 Sep 2023 - 15:33

Data source: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, Maxar, Earthstar Geographics, IGN, and the GIS User Community.



Month	Daily Average Temperature (Celsius)[1]	Daily Maximum Temperature (Celsius)[1]	Daily Minimum Temperature (Celsius)[1]	Rainfall (mm)[1]	Snowfall (cm)[1][2]	Precipation (mm)[2]
January	-13.2	-7.2	-19	0.8	34.2	29.1
February	-10.2	-3.9	-16.5	0.4	22.8	18.6
March	-5	0.9	-10.9	0.6	26.6	22.6
April	3.5	10	-3.1	9.4	11.2	19.8
May	9.3	16.4	2.1	29.8	5.1	34.4
June	13.6	20.1	6.9	67.4	0	67.4
July	15.5	22.2	8.9	84.9	0	84.9
August	14.4	21.5	7.2	54.2	0	54.2
September	9.8	16.2	3.3	38.8	2.4	41.2
October	3.3	9	-2.4	15.9	15.2	29.9
November	-6.8	-1.5	-12.2	4.2	29.1	29
December	-11.1	-5.3	-16.8	0.8	26	22.2
Annual	**1.9**	**8.2**	**-4.4**	**307**	**173**	**453.2**

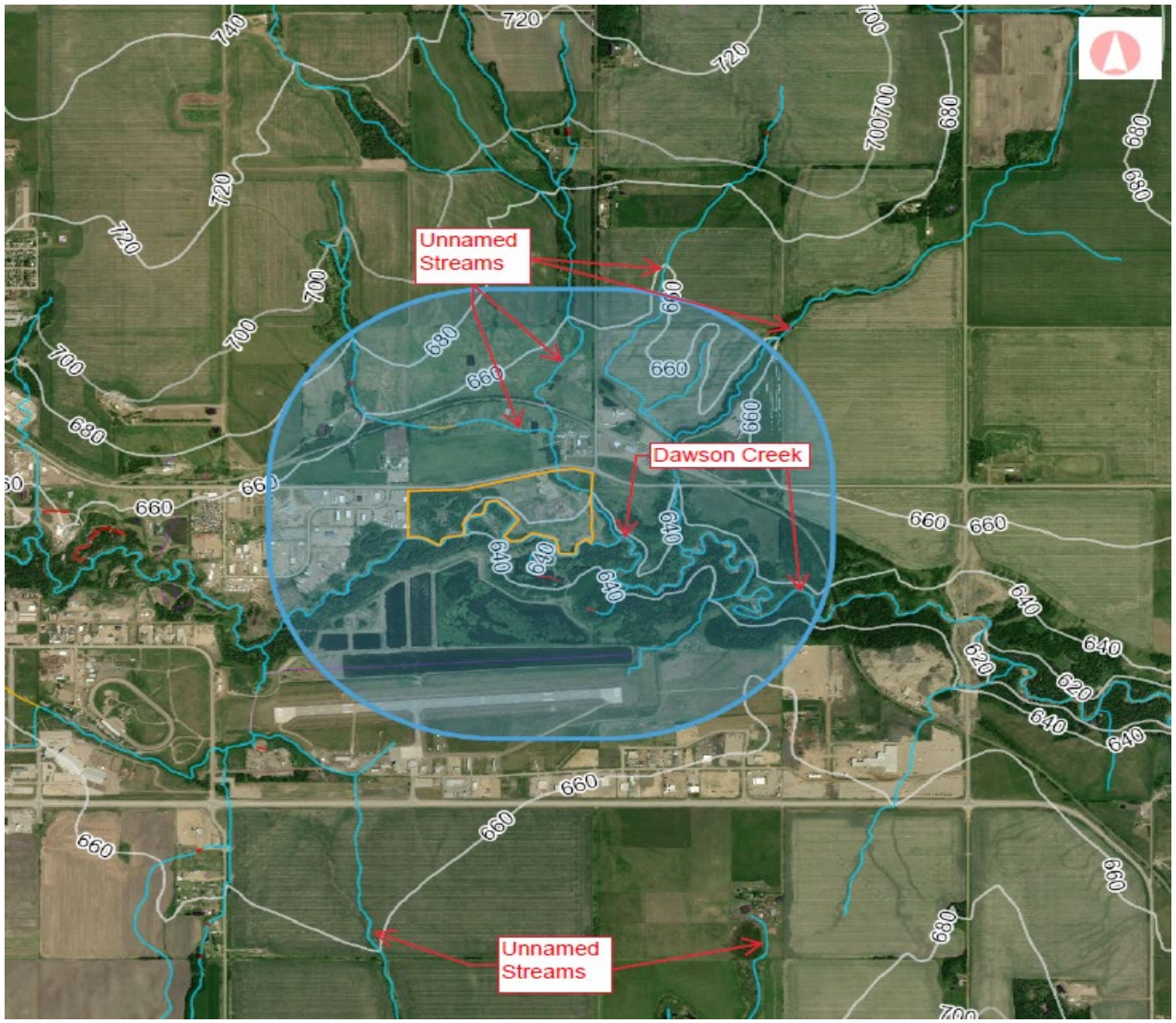
Notes:

(1) Source: Environment Canada: Climate Normals - Dawson Creek A (Station No. 1182285), 1981 - 2010

(2) 1 cm of snowfall corresponds to 1 mm of precipation

Approximate Dawson Creek Landfill Site Latitude 55°45'04"N

FIGURE 3
CLIMATE DATA
GROUNDWATER AND SURFACEWATER IMPACT ASSESSMENT
DAWSON CREEK, BC
Peace River Regional District



FWA - Stream Network - Lines

- Stream - Main Flow
- Stream - Secondary Flow
- Wetland - Main Flow
- Wetland - Secondary Flow
- Lake Skeleton - Main Flow
- Lake Skeleton - Secondary Flow
- Lake Arm Skeleton - Secondary Flow
- River Skeleton - Main Flow
- River Skeleton - Secondary Flow
- Flow Connector
- Isolated Waterbody Skeleton - Main flow
- Underground Connector - Main Flow

- 1km Radius
- Site Boundary

0 1.02 2.03 km

1: 50,000

Source: iMap B.C. accessed June 2020

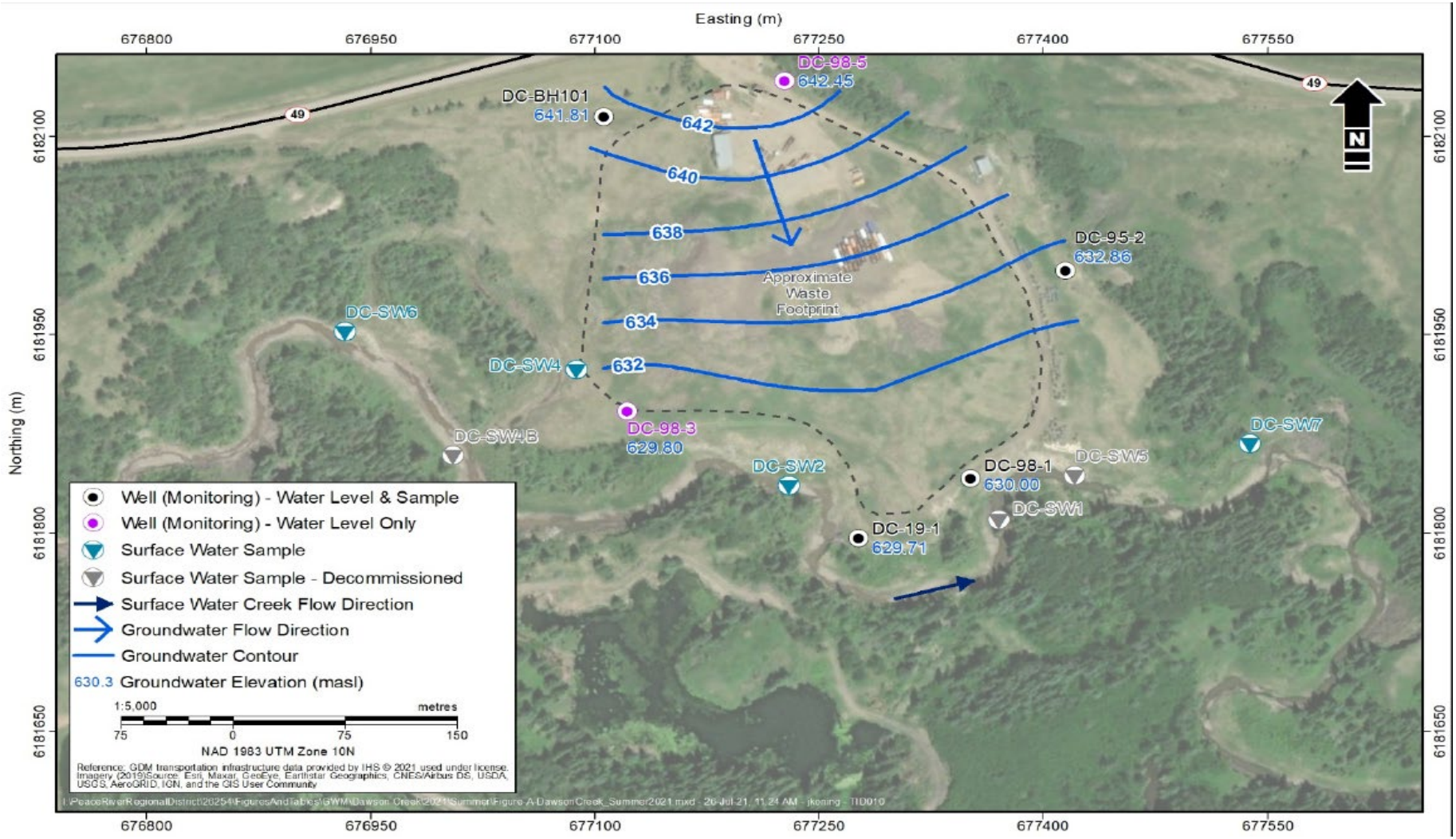
FIGURE 4

TOPOGRAPHY AND DRAINAGE WITHIN 1KM

GROUNDWATER AND SURFACEWATER IMPACT ASSESSMENT

DAWSON CREEK, BC

Peace River Regional District



Source: 2021 Groundwater and Surface Water Monitoring and Sampling Program, Peace River Regional District Landfill Sites, Peace River Regional District, Dawson Creek BC. By Matrix Solutions Inc, March, 2022.

FIGURE 5
GROUNDWATER FLOW DIRECTION
GROUNDWATER AND SURFACEWATER IMPACT ASSESSMENT
DAWSON CREEK, BC
Peace River Regional District

Appendices

Appendix A

Borehole Logs

CITY OF DAWSON CREEK	DAWSON CREEK LANDFILL	BOREHOLE NO: 97-1
	NE 1/2 SECTION 12 TWP 78 RGE 15 W6M	PROJECT NO: EG08201
MAYHEW 1000 TRUCK/ WET ROTARY		ELEVATION:

SAMPLE TYPE: Shelby Tube | No Recovery | SPT Test (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH(m)	STANDARD PEN (N) 20 40 60 80 / PLASTIC M.C. LIQUID 20 40 60 80	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT(N)	SLOPE INDICATOR	OTHER TESTS COMMENTS	DEPTH(m)
0.0			GRAVEL FILL, silty, sandy, brown loose to compact						0.0
1.0									1.0
2.0									2.0
3.0			CLAY, varved, silty, high plastic, stiff, grey to greyish brown, laminated with low to medium plastic pockets		U1			U1 Z = 3.1 5o 3.4 m varved clay, grey/brown, thin varves (1 to 4 mm)	3.0
4.0									4.0
5.0									5.0
6.0			dark grey, with brown-grey medium plastic laminations, random salt crystals		U2			U2 Z = 5.5 to 5.8 m varved clay, grey/brown some inclined of 20 degrees; 4" stone lamination	6.0
7.0									7.0
8.0									8.0
9.0			stiff to very stiff, gypsum crystals		U3			U3 Z = 8.5 to 8.8 m varved clay, siltier, gypsum crystals	9.0
10.0									10.0
11.0									11.0
12.0			CLAY, silty, some sand, very stiff, medium to high plastic, dark grey, fine gravel sizes, gypsum crystals		U4			U4 Z = 11.6 to 11.9 m some laminations 1/4" and 1" pockets	12.0
13.0									13.0
14.0									14.0
15.0			medium plastic, sandstone nodules		U5			U5 Z = 14.6 to 15.0 m lacustrine clay	15.0
16.0									16.0
17.0									17.0
18.0			medium-high plastic, grey, fine gravel sizes to random cobble Z = 18.6 - 18.9 m cobbles		U6			U6 Z = 17.7 to 18.1 m damaged, recovery, one 4" stone, some clay	18.0
19.0									19.0
20.0			CLAY, silty, some fine sand, stiff, medium plastic, grey, silt partings					Pneumatic piezometer #21678 installed at 20.2 m (see Note 1)	20.0
21.0					U7			U7 Z = 20.7 to 21.1 m lacustrine clay; very wet	21.0
22.0									22.0
23.0									23.0
24.0			stiff, medium-high plastic, grey		U8			U8 Z = 23.8 to 24.2 m lacustrine clay	24.0
25.0			CLAY TILL, silty, trace of sand, stiff to		C1			C1 Recovery = 83 %	25.0

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98/06/23 11:02PM (25MW)

CITY OF DAWSON CREEK	DAWSON CREEK LANDFILL	BOREHOLE NO: 97-1
	NE 1/2 SECTION 12 TWP 78 RGE 15 W6M	PROJECT NO: EG08201
MAYHEW 1000 TRUCK/ WET ROTARY		ELEVATION:

SAMPLE TYPE: Shelby Tube | No Recovery | SPT Test (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH(m)	STANDARD PEN (N) 20 40 60 80 / PLASTIC M.C. LIQUID 20 40 60 80	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT(N)	SLOPE INDICATOR	OTHER TESTS COMMENTS	DEPTH(m)
25.0			very stiff, medium-high plastic, grey, slickensided, fine gravel sizes (friable shale, green/grey, some siltstone, poorly cemented grey sandstone, gypsum crystals); amount of gravel sizes increases with depth		C1				25.0
26.0					C2			C2 Recovery = 83 %	26.0
27.0									27.0
28.0					C3			C3 Recovery = 109 %	28.0
29.0			1" layer cobbles, fine sand						29.0
30.0			Various planar/non-planar slickensides						30.0
31.0			CLAY, silty, medium to high plastic, stiff to very stiff, grey, fine silt laminations or partings		C4			C4 Recovery = 46 % (Pump Water pressure build up due to hole squeezing, causing core to washed out)	31.0
32.0			very silty, some fine sand, low plastic,						32.0
33.0			silty, medium to high plastic, grey, random rust stains, laminations and slickensides, all @ 255 degrees to axis		C5			C5 Recovery = 70 %	33.0
34.0			intermixed/interbedded with low plastic silty clay or clayey sand beds or partings						34.0
35.0					C6			C6 Recovery = 59 %	35.0
36.0									36.0
37.0			partial slickensides, discontinuous, planar, some striation (20 to 55 degrees) in higher plastic clay; intermixed with fluvial sand/silt beds/partings, indistinct bedding		C7			C7 Recovery = 67 %	37.0
38.0									38.0
39.0			Wet, gypsum crystals, thin fine/sand lamination, slickensided below sand slickensides (20 to 35 degrees), planar, slightly striated		C8			C8 Recovery = 77 %	39.0
40.0									40.0
41.0			fine sand/silt partings lamination rust stains and slickensides at subhorizontal		C9			C9 Recovery = 67 %	41.0
42.0					C10			Pneumatic piezometer #21674 installed at 41.2 m (See Note 1) C10 Recovery = 56 %	42.0
43.0			End of Hole at 43.0 m No water loss during drilling						43.0
44.0									44.0
45.0			Note 1: Instalation: piezo tip in sand pack sock, strapped to SI casing and grouted in with tremie pipe						45.0
46.0									46.0
47.0									47.0
48.0									48.0
49.0									49.0
50.0									50.0

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FORM No:

COMPLETION DEPTH: 43.0 m
COMPLETE: 97/06/18

98/06/23 11:02PM (2.0W)

CITY OF DAWSON CRREK	DAWSON CREEK LANDFILL	BOREHOLE NO: 97-2
	NE 1/2 SECTION 12 TWP 78 RGE 15 W6M	PROJECT NO: EG08201
MAYHEW 1000 TRUCK/ WET ROTARY		ELEVATION:

SAMPLE TYPE: Shelby Tube | No Recovery | SPT Test (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH(m)	STANDARD PEN (N) 20 40 60 80 / PLASTIC M.C. LIQUID 20 40 60 80	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT(N)	SLOPE INDICATOR	OTHER TESTS COMMENTS	DEPTH(m)
0.0			CLAY, silty, trace of sand, stiff, medium to high plastic, dark grey with brown mottles or laminations, laminated thin water-like, random gravel sizes						0.0
1.0									1.0
2.0									2.0
3.0			dark grey		U1			U1 Z = 3.1 to 3.5 m clay, well defined laminations, some high plastic laminations (1 to 3 mm), some fine gravel sizes	3.0
4.0									4.0
5.0									5.0
6.0			stiff, gypsum crystals, some laminations		U2			U2 Z = 5.5 to 5.8 m Clay, laminated, medium plastic, gypsum crystals, relatively dry	6.0
7.0									7.0
8.0									8.0
9.0			sizes		U3			U3 Z = 8.5 to 8.8 m clay, massive, silty, medium to low plastic, relatively dry	9.0
10.0			massive, medium to low plastic						10.0
11.0									11.0
12.0			medium plastic		U4			U4 Z = 11.6 to 11.9 clay, massive, dark grey, medium plastic, relatively dry	12.0
13.0			CLAY TILL, silty, trace of sand, medium to high plastic, stiff, dark grey, random gravel sizes, gypsum crystals						13.0
14.0								U5 Z = 11.6 to 11.9 m	14.0
15.0					U5			Pneumatic piezometer #21683 at 14.7 m (see Note 1)	15.0
16.0			medium plastic, sandy, stiff, grey, random high plastic clay zones, fine gravel sizes		C1			C1 Recovery = 100 %	16.0
17.0									17.0
18.0			slickensides 45 to 70 degrees medium-high plastic, some sand, stiff,		C2			C2 Recovery = 95 %	18.0
19.0			dark grey, random high plastic clay, fine gravel sizes						19.0
20.0					C3			C3 Recovery = 89 %	20.0
21.0			softer, high plastic, numerous slickensides						21.0
22.0					C4			C4 No Recovery	22.0
23.0									23.0
24.0			higher plastic, clay zones, slickensides		C5			C5 Recovery = 100 %	24.0
25.0					C6			C6 Recovery = 80 %	25.0

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Rig No: | Page 1 of 2

98/06/23 11:02PM (2sdw)

CITY OF DAWSON CRREK	DAWSON CREEK LANDFILL	BOREHOLE NO: 97-2
	NE 1/2 SECTION 12 TWP 78 RGE 15 W6M	PROJECT NO: EG08201
MAYHEW 1000 TRUCK/ WET ROTARY		ELEVATION:

SAMPLE TYPE: Shelby Tube | No Recovery | SPT Test (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH(m)	STANDARD PEN (N) 20 40 60 80 / PLASTIC M.C. LIQUID 20 40 60 80	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT(N)	SLOPE INDICATOR	OTHER TESTS COMMENTS	DEPTH(m)
25.0			silt partings, slickensides		C6				25.0
26.0			slickenside						26.0
27.0			shale nodules		C7			C7 Recovery = 41 %	27.0
28.0			high plastic, very stiff, grey, shale nodules, cobbles, gypsum crystals, brown, silt laminations, drier		C8			C8 Recovery = 83 %	28.0
29.0									29.0
30.0			CLAY SHALE, badly weathered, silty, low to medium plastic, hard, grey, with thin horizontal yellowish-grey to rust colored laminations?, very friable, fissile		C9			C9 Recovery = 94% Pneumatic piezometer #21675 at 31 m (see Note 1)	30.0
31.0									31.0
32.0					C10			C10 Recovery = 83 %	32.0
33.0									33.0
34.0			harder, well-cemented shale zones, but very friable, rust stained, breaks easily along various directions		C11			C11 Recovery = 83 %	34.0
35.0									35.0
36.0					C12			C12 Recovery = 90 %	36.0
37.0									37.0
38.0					C13			C13 Recovery = 89 %	38.0
39.0									39.0
40.0			medium plastic, harder shale, dark grey-brown, breaks easily along planes in all direction		C14			C14 Recovery = 95 %	40.0
41.0									41.0
42.0			End of Hole at 41.5 m No water loss during drilling						42.0
43.0									43.0
44.0									44.0
45.0			Note 1: Installation: piezo tip in sand pack sock, strapped to SI casing and grouted in with tremie pipe						45.0
46.0									46.0
47.0									47.0
48.0									48.0
49.0									49.0
50.0									50

CITY OF DAWSON CRREK	DAWSON CREEKK LANDFILL	BOREHOLE NO: 97-3
	NE 1/2 SECTION TWP 78 RGE 15 W6M	PROJECT NO: EG08201
MAYHEW 1000 TRUCK/ WET ROTARY		ELEVATION:

SAMPLE TYPE: Shelby Tube | No Recovery | SPT Test (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH(m) | ■ STANDARD PEN (N) ■ 20 40 60 80 | PLASTIC M.C. LIQUID 20 40 60 80 | SOIL SYMBOL

SOIL DESCRIPTION

GARBAGE, large pieces of concrete, metal, and ash, mixed with clay

last circulation; large pieces of concrete

ash mixed with gravel sizes, black to dark grey

CLAY, silty, very soft, squeezing, medium to high plastic, grey, silt/fine sand pockets (too soft to core)

CLAY TILL, silty, trace of sand, medium to high plastic, stiff, grey, fine gravel sizes (attempted to core but hole squeezing causing high pump pressures as well as material form upper hole keep falling in)

End of Hole at 19.6 m
Water level at 1.5 m at completion
Was losing water throughout the drilling of borehole

Note 1: Installation: piezo tip in sand pack sock, stapped to SI casing and grouted in with tremie pipe

SAMPLE TYPE | SAMPLE NO | SPT(N) | SLOPE INDICATOR

OTHER TESTS COMMENTS

U1 Z = 3.1 to 3.4 m

U2 Z = 5.5 to 5.8 m
medium to coarse sand, gravel, silty clay, very wet

U3 Z = 8.5 to 8.8 m
recovery approx. 8", sandy, silty clay, pebbles up to 3/4", very wet, 1/2" metal piece, maximum nail

U4 Z = 11.5 to 11.9 m
clay, sand, gravel very wet, soft, very soft at 11.7 m, drier and stiffer at 11.8 m, 1 large nail @ 11.7 m

U5 Z = 13.4 to 13.8 m
clay till, high plastic, stiff

U6 Z = 14.6 to 14.9 m
clay fill, high plastic
stiff to very stiff

U7 Z = 16.2 to 16.6 m
clay fill, high plastic, stiff to very stiff, steel plate 1" x 2" at the bottom

Pneumatic piezometer #21679 at 18.5 m (see note 1)

U9 Z = 19.3 to 19.6 m

DEPTH(m)

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Edmonton, Alberta	REVIEWED BY: AGK	COMPLETE: 97/06/20
	Job No:	Page 1 of 1

98/06/23 11:03PM (25MB)

PEACE RIVER REGIONAL DISTRICT	PHASE 2 – DAWSON CREEK LANDFILL	BOREHOLE NO: 98-4
	NE 1/4 12-78-15-W6M	PROJECT NO: EG08275
CANTERRA 310 TRACK/ WET ROTARY	DAWSON CREEK, BRITISH COLUMBIA	ELEVATION:

SAMPLE TYPE: Shelby Tube; No Recovery; SPT Test (N); Grab Sample; Split-Pen; Core

BACKFILL TYPE: BENTONITE; PEA GRAVEL; SLOUGH; GROUT; DRILL CUTTINGS; SAND

DEPTH(m) | STANDARD PEN (N) 20 40 60 80 | PLASTIC M.C. LIQUID 20 40 60 80 | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT(N) | PNEUMATIC PIEZOMETER | PNEUMATIC PIEZOMETER | OTHER TESTS COMMENTS | DEPTH(m)

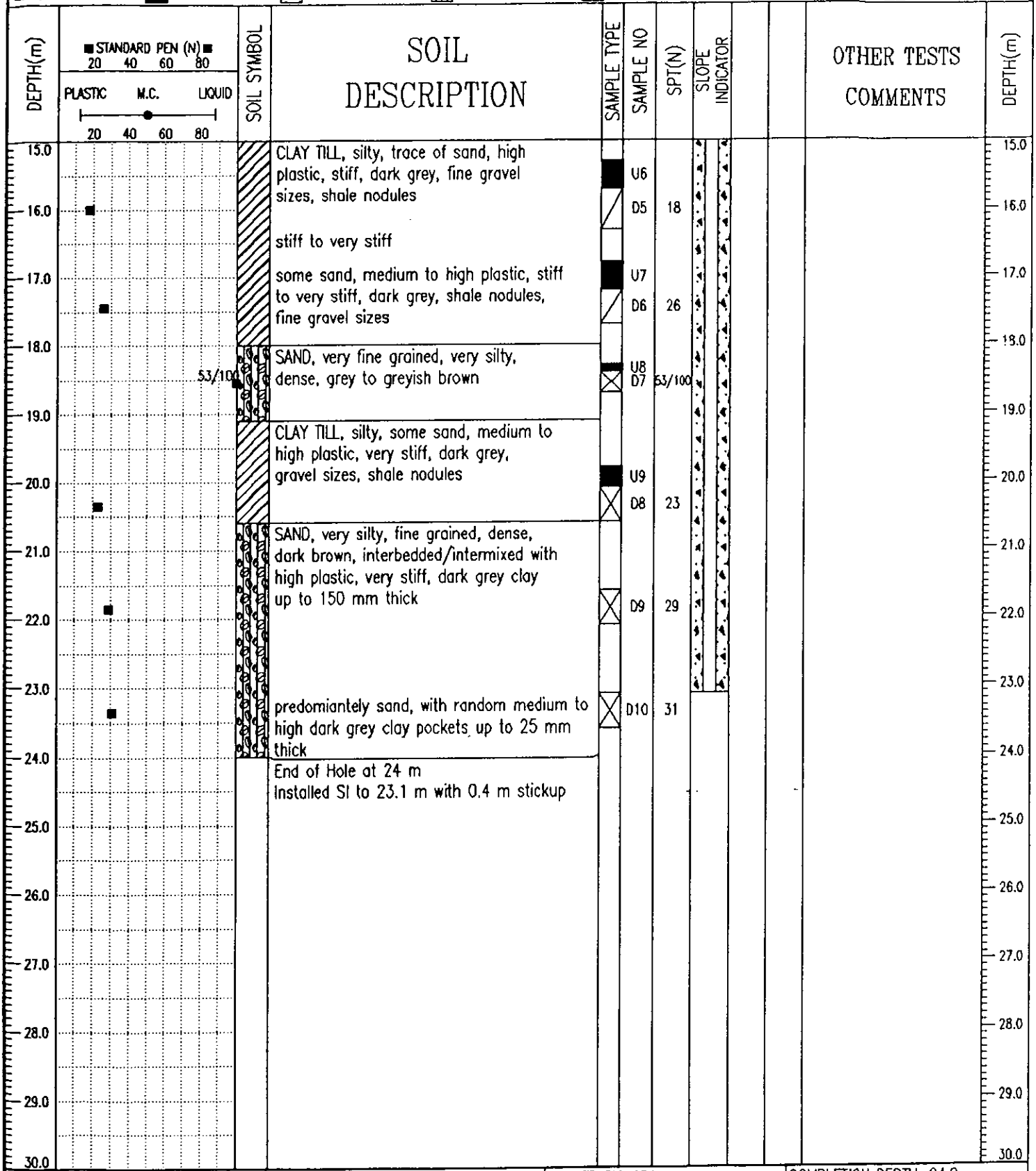
DEPTH(m)	SOIL DESCRIPTION	SAMPLE NO	SPT(N)	OTHER TESTS COMMENTS
0.0	LANDFILL, clay, silty, low to medium plastic, mixed with wood, pieces of plastic, some metal			
7.0	gravel sizes, (maybe bottom of landfill)			
	(TUBE), soft clay, with gravel sizes, pieces of plastic/glass	U1		Attempt to push Nilcon vane, no success
8.0	CLAY TILL, silty, trace of sand, high plastic, stiff, dark grey, shale nodules and pockets, random gravel sizes			
9.0	gravel sizes	U2		Pneumatic piezometer #22571 installed @ 8.6 m
		D1	15	
10.0		U3		On rock
11.0	12/150	D2	12/150	
12.0		U4		
13.0		D3	20	
14.0		U5		Pneumatic piezometer #22569 Installed @ 13.9 m
		D4	12	
15.0				

Mixed heavy drilling mud, lossing some water in landfill material
Bit pluggged, pieces of plastic/wood retained in suspension plugged off bit ports
Bit plugged
Bit plugged
Bit plugged

PEACE RIVER REGIONAL DISTRICT	PHASE 2 – DAWSON CREEK LANDFILL	BOREHOLE NO: 98-4
	NE 1/4 12-78-15-W6M	PROJECT NO: EG08275
CANTERRA 310 TRACK/ WET ROTARY	DAWSON CREEK, BRITISH COLUMBIA	ELEVATION:

SAMPLE TYPE: Shelby Tube; No Recovery; SPT Test (N); Grab Sample; Split-Pen; Core

BACKFILL TYPE: BENTONITE; PEA GRAVEL; SLOUGH; GROUT; DRILL CUTTINGS; SAND



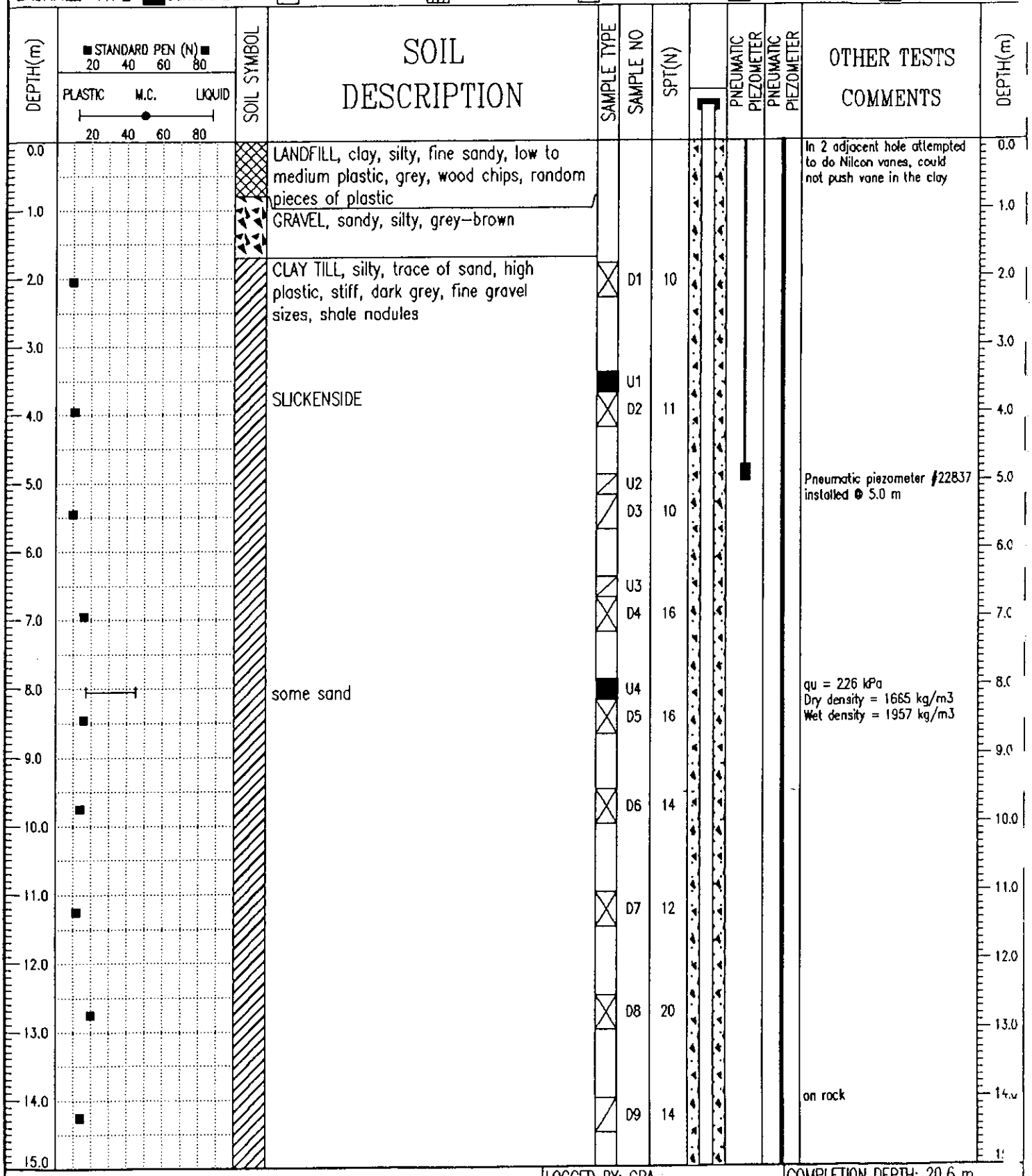
AGRA Earth & Environmental Limited	LOGGED BY: CRA	COMPLETION DEPTH: 24.0 m
Edmonton, Alberta	REVIEWED BY: AGK	COMPLETE: 98/04/14
	Fig No:	Page 2 of 2

98/05/25 11:21PM (15MW)

PEACE RIVER REGIONAL DISTRICT	PHASE 2 – DAWSON CREEK LANDFILL	BOREHOLE NO: 98-5
	NE 1/4 12-78-15-W6M	PROJECT NO: EG08275
CANTERRA 310 TRACK/ WET ROTARY	DAWSON CREEK, BRITISH COLUMBIA	ELEVATION:

SAMPLE TYPE: Shelby Tube; No Recovery; SPT Test (N); Grab Sample; Split-Pen; Core

BACKFILL TYPE: BENTONITE; PEA GRAVEL; SLOUGH; GROUT; DRILL CUTTINGS; SAND



AGRA Earth & Environmental Limited	LOGGED BY: CRA	COMPLETION DEPTH: 20.6 m
Edmonton, Alberta	REVIEWED BY: AGK	COMPLETE: 98/04/16
	File No:	Page 1 of

98/06/23 11:21PM (1Saw)

PEACE RIVER REGIONAL DISTRICT	PHASE 2 - DAWSON CREEK LANDFILL	BOREHOLE NO: 98-5
	NE 1/4 12-78-15-W6M	PROJECT NO: EG08275
CANTERRA 310 TRACK/ WET ROTARY	DAWSON CREEK, BRITISH COLUMBIA	ELEVATION:

SAMPLE TYPE: Shelby Tube | No Recovery | SPT Test (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH(m) | ■STANDARD PEN (N)■ 20 40 60 80 | PLASTIC M.C. LIQUID 20 40 60 80 | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT(N) | SLOPE INDICATOR | PNEUMATIC PIEZOMETER | OTHER TESTS COMMENTS | DEPTH(m)

CLAY TILL, silty, some sand, high plastic, stiff, dark grey, fine gravel sizes, shale nodules,

SAMPLE NO	SPT(N)
D10	15
D11	16
D12	18
D13	18

Pneumatic piezometer #23161 installed @ 19.7 m

End of Hole at 20.6 m
Installed SI to 19.8 m with 0.6 m stickup

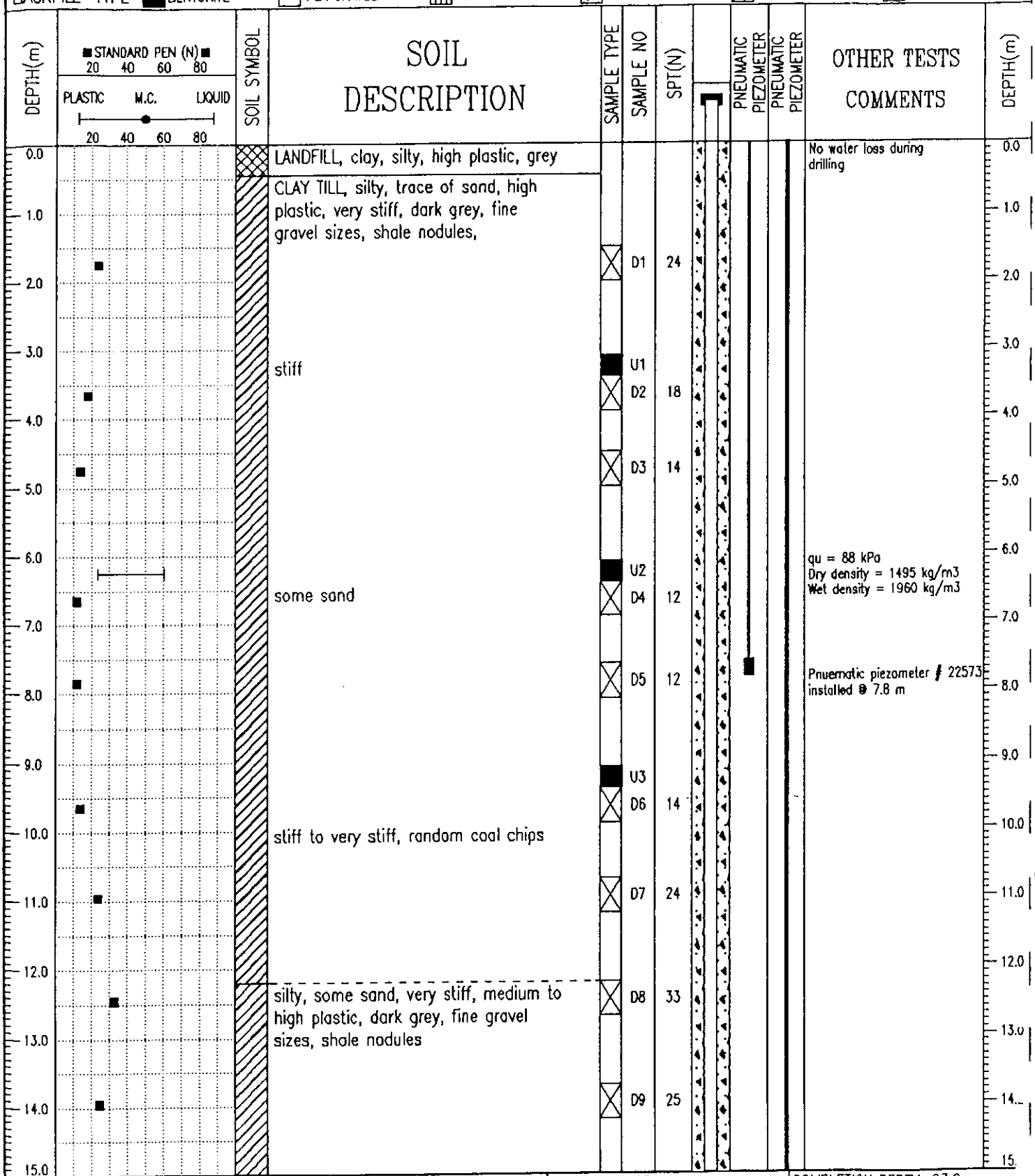
AGRA Earth & Environmental Limited Edmonton, Alberta	LOGGED BY: CRA REVIEWED BY: AGK Log No:
	COMPLETION DEPTH: 20.6 m COMPLETE: 98/04/16

98/06/23 11:22PM (15MM)

PEACE RIVER REGIONAL DISTRICT	PHASE 2 - DAWSON CREEK LANDFILL	BOREHOLE NO: 98-6
	NE 1/4 12-78-15-W6M	PROJECT NO: EG08275
CANTERRA 310 TRACK/ WET ROTARY	DAWSON CREEK, BRITISH COLUMBIA	ELEVATION:

SAMPLE TYPE: Shelby Tube; No Recovery; SPT Test (N); Grab Sample; Split-Pen; Core

BACKFILL TYPE: BENTONITE; PEA GRAVEL; SLOUGH; GROUT; DRILL CUTTINGS; SAND



AGRA Earth & Environmental Limited	LOGGED BY: CRA	COMPLETION DEPTH: 23.0 m
Edmonton, Alberta	REVIEWED BY: AGK	COMPLETE: 98/04/17
	Fig No:	Page 1 of 1

98/06/23 11:22PM (15MM)

PEACE RIVER REGIONAL DISTRICT	PHASE 2 - DAWSON CREEK LANDFILL	BOREHOLE NO: 98-6
	NE 1/4 12-78-15-W6M	PROJECT NO: EG08275
CANTERRA 310 TRACK/ WET ROTARY	DAWSON CREEK, BRITISH COLUMBIA	ELEVATION:

SAMPLE TYPE: Shelby Tube | No Recovery | SPT Test (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND

DEPTH(m) | ■STANDARD PEN (N)■ 20 40 60 80 | PLASTIC M.C. LIQUID 20 40 60 80 | SOIL SYMBOL

SOIL DESCRIPTION

SAMPLE TYPE	SAMPLE NO	SPT(N)	SLOPE INDICATOR	PNEUMATIC PIEZOMETER	OTHER TESTS COMMENTS	DEPTH(m)
						15.0
						16.0
						17.0
						18.0
						19.0
						20.0
						21.0
						22.0
						23.0
						24.0
						25.0
						26.0
						27.0
						28.0
						29.0
						30.0

CLAY TILL, silty, some sand very stiff to hard, medium to high plastic, dark grey, fine gravel sizes, shale nodules

X	D10	40

very fine grained, dense, sand/silt pockets/partings, brown

X	D11	42

SAND, very silty, clayey, non to low plastic, dense, brown, random dark grey high plastic clay partings

X	D12	40

CLAY TILL, very sandy, silty, low plastic, hard, brown, fine gravel sizes, some rust staining, shale nodules

X	D13	31

CLAY, silty, fine sandy, medium to high plastic, very stiff, dark grey, with horizonitally interbedding of light grey to brown, silt/fine sand laminations up to 5 mm thick
fine sand/silt laminations up to 25 mm thick

X	D14	28

Pneumatic piezometer #23159 installed @ 21.5 m

End of Hole at 23.0 m
Installed SI to 23 m with 0.7 m stickup

LOGGED BY: CRA	COMPLETION DEPTH: 23.0 m
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Fig. No:	Page 2 of 2

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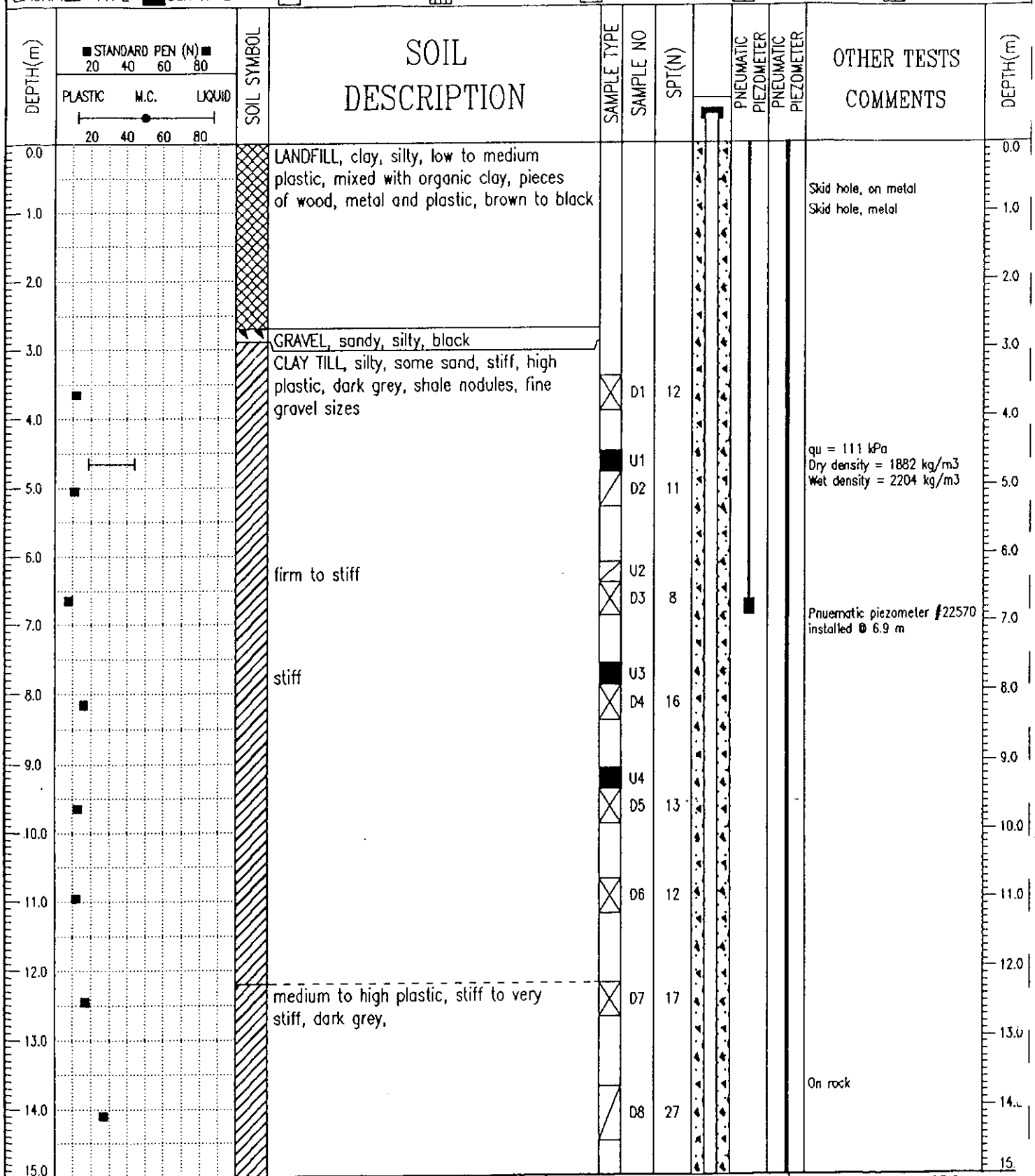
98/06/23 11:29PM (15MW)

PEACE RIVER REGIONAL DISTRICT	PHASE 2 – DAWSON CREEK LANDFILL	BOREHOLE NO: 98-7
	NE 1/4 12-78-15-W6M	PROJECT NO: EG08275
CANTERRA 310 TRACK/ WET ROTARY	DAWSON CREEK, BRITISH COLUMBIA	ELEVATION:

SAMPLE TYPE: Shelby Tube | No Recovery | SPT Test (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: BENTONITE | PEA GRAVEL | SLOUGH | GROUT | DRILL CUTTINGS | SAND



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PEACE RIVER REGIONAL DISTRICT	PHASE 2 – DAWSON CREEK LANDFILL	BOREHOLE NO: 98-7
	NE 1/4 12-78-15-W6M	PROJECT NO: EG08275
CANTERRA 310 TRACK/ WET ROTARY	DAWSON CREEK, BRITISH COLUMBIA	ELEVATION:

SAMPLE TYPE: Shelby Tube; No Recovery; SPT Test (N); Grab Sample; Split-Pen; Core

BACKFILL TYPE: BENTONITE; PEA GRAVEL; SLOUGH; GROUT; DRILL CUTTINGS; SAND

DEPTH(m)	STANDARD PEN (N) 20 40 60 80 / PLASTIC M.C. LIQUID 20 40 60 80	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT(N)	SLOPE INDICATOR	PNEUMATIC PIEZOMETER	OTHER TESTS COMMENTS	DEPTH(m)
15.0	■		CLAY TILL, silty, some sand, medium to high plastic, stiff to very stiff, dark grey, fine gravel sizes, shale nodules		D9	19				15.0
16.0										16.0
17.0	■		very stiff		D10	22				17.0
18.0										18.0
19.0	■				D11	22				19.0
20.0	■		SAND, very fine grained, very silty, trace of clay, dense, brown, random high plastic dark grey clay layers/partings		D12	44				20.0
21.0			CLAY TILL, silty, very sandy, hard, low plastic, brown, fine gravel sizes							21.0
22.0	■		CLAY, silty, fine sandy, medium to high platic, dark grey, with thin light grey to brown fine sand/silt partings		D13	40			Pnuematic piezometer #23158 installed @ 22.2 m	22.0
23.0			End of Hole at 23.2 m Installed SI to 23.2 m with 0.5 m stickup							23.0
24.0										24.0
25.0										25.0
26.0										26.0
27.0										27.0
28.0										28.0
29.0										29.0
30.0										30.0

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Edmonton, Alberta

LOGGED BY: CRA
REVIEWED BY: AGK
Fig No:

COMPLETION DEPTH: 23.2 m
COMPLETE: 98/04/18

98/06/26 TIETBAM (TSAW)

Appendix B

HELP Model Inputs and Results

APPENDIX B - TABLE 1
SUMMARY OF HELP MODEL INPUTS AND RESULTS
Dawson Creek Landfill

	Low Permeability		***Medium Permeability***	
	Side Slopes	***Plateau***	***Unlined***	***Lined***
Layer 1				
Layer Type	Vert. Perc.	Vert. Perc.	Vert. Perc.	Vert. Perc.
Material Description	Topsoil (Silty CLAY with Gravel)	Topsoil (Silty CLAY with Gravel)	Topsoil (Silty CLAY with Gravel)	Topsoil (Silty CLAY with Gravel)
Material Texture Number	12	12	12	12
Effective Saturated Hydraulic Conductivity (cm/s)	4.2×10^{-5}	4.2×10^{-5}	4.2×10^{-5}	4.2×10^{-5}
Thickness (centimetres)	15	15	15	15
Layer 2				
Layer Type	Barrier Soil	Barrier Soil	Barrier Soil	Barrier Soil
Material Description	Compacted Clay	Compacted Clay	Compacted Clay	Compacted Clay
Material Texture Number	16	16	0	0
Effective Saturated Hydraulic Conductivity (cm/s)	1.0×10^{-7}	1.0×10^{-7}	1.0×10^{-5}	1.0×10^{-5}
Thickness (centimetres)	60	60	60	60
Layer 3				
Layer Type	Vert. Perc.	Vert. Perc.	Vert. Perc.	Vert. Perc.
Material Description	MSW	MSW	MSW	MSW
Material Texture Number	18	18	18	18
Effective Saturated Hydraulic Conductivity (cm/s)	1.0×10^{-3}	1.0×10^{-3}	1.0×10^{-3}	1.0×10^{-3}
Thickness (centimetres)	1000	1000	1000	1000
Layer 4				
Layer Type	Barrier Soil	Barrier Soil	Barrier Soil	Barrier Soil
Material Description	Clay Till	Clay Till	Clay Till	Clay Till
Material Texture Number	0	0	0	0
Effective Saturated Hydraulic Conductivity (cm/s)	4.6×10^{-7}	4.6×10^{-7}	4.6×10^{-7}	4.6×10^{-7}
Thickness (centimetres)	680	680	680	680
Slope	26.8%	0.6%	26.8%	0.6%
SCS Curve Number	85	95.2	85	95.2
Evaporative Depth Zone (centimetres)	15	15	15	15
Annual Averages (millimetres)				
Precipitation	462.27	462.27	462.27	462.27
Runoff	98.80	105.00	82.25	81.17
Evapotranspiration	355.53	345.35	304.54	290.59
Percolation/Leakage Through Barrier Layer	8.13	12.06	75.65	90.64
Average Head on Top of Barrier Layer	0.01	0.01	25.65	33.01
Change in Water Storage	-0.19	-0.15	-0.17	-0.14

Notes:

A material texture number of zero indicates that the design parameters are user specified, rather than default HELP3 Model data.

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**               HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                  **
**                 HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY                      **
**                     USAE WATERWAYS EXPERIMENT STATION                        **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                 **
**                                                                              **
**                                                                              **
**********************************************************************************
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PRECIPITATION DATA FILE:    C:\DC\DC1PP.D4
TEMPERATURE DATA FILE:      C:\DC\DC1TM.D7
SOLAR RADIATION DATA FILE:  C:\DC\DC1SLRD.D13
EVAPOTRANSPIRATION DATA:    C:\DC\DC1ET.D11
SOIL AND DESIGN DATA FILE:  C:\DC\DC1SOIL.D10
OUTPUT DATA FILE:           C:\DC\DC1OUT.OUT


TIME:   8:27     DATE:   4/14/2023


**********************************************************************************

     TITLE:  11213132 DAWSON CREEK LANDFILL - SIDE SLOPE, LOW PERM

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
               COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                    TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER  12
          THICKNESS                    =     15.00   CM
          POROSITY                     =      0.4710 VOL/VOL
          FIELD CAPACITY               =      0.3420 VOL/VOL
          WILTING POINT                =      0.2100 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.3059 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.419999997000E-04 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

THICKNESS	=	60.00	CM
POROSITY	=	0.4270	VOL/VOL
FIELD CAPACITY	=	0.4180	VOL/VOL
WILTING POINT	=	0.3670	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	1000.00	CM
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2920	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	680.00	CM
POROSITY	=	0.4270	VOL/VOL
FIELD CAPACITY	=	0.4180	VOL/VOL
WILTING POINT	=	0.3670	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.459999995000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #12 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 27.% AND A SLOPE LENGTH OF 35. METERS.

SCS RUNOFF CURVE NUMBER	=	85.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	15.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	4.589	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	7.065	CM

LOWER LIMIT OF EVAPORATIVE STORAGE	=	3.150	CM
INITIAL SNOW WATER	=	2.347	CM
INITIAL WATER IN LAYER MATERIALS	=	612.569	CM
TOTAL INITIAL WATER	=	614.915	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
DAWSON CREEK BC

STATION LATITUDE	=	55.70	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	130	
END OF GROWING SEASON (JULIAN DATE)	=	270	
EVAPORATIVE ZONE DEPTH	=	15.0	CM
AVERAGE ANNUAL WIND SPEED	=	13.50	KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	60.50	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	41.60	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	47.80	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	62.10	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR SPOKANE WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
29.1	18.6	22.6	19.8	34.4	67.4
84.9	54.2	41.2	29.9	29.0	22.2

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR SPOKANE WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
-13.2	-10.2	-5.0	3.5	9.3	13.6
15.5	14.4	9.8	3.3	-6.8	-11.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR SPOKANE WASHINGTON
AND STATION LATITUDE = 55.70 DEGREES

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AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	28.86	18.95	23.80	19.61	37.19	62.22
	89.06	64.74	40.37	28.36	27.14	21.97
STD. DEVIATIONS	12.14	8.28	10.13	9.57	19.12	40.72
	67.03	45.32	21.33	16.31	13.33	7.81
RUNOFF						
TOTALS	0.000	0.209	14.767	29.057	6.924	5.932
	27.889	10.323	1.962	0.893	0.772	0.070
STD. DEVIATIONS	0.000	1.091	17.808	25.228	9.744	11.192
	44.999	20.217	6.708	2.942	2.227	0.409
EVAPOTRANSPIRATION						
TOTALS	11.586	13.410	17.848	11.366	48.760	59.301
	56.588	56.018	33.485	20.146	14.105	12.913
STD. DEVIATIONS	1.994	2.286	2.820	6.990	17.488	32.079
	30.484	32.584	18.251	9.092	3.617	1.920
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	0.0000	0.0000	0.0461	0.2875	1.4146	0.8734
	0.6246	0.7460	0.9621	1.3393	1.2947	0.5441
STD. DEVIATIONS	0.0000	0.0000	0.2075	0.4846	0.7780	0.6666
	0.4684	0.5943	0.8473	1.2239	1.3247	0.7512
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0000	0.0000	0.0461	0.2875	1.4146	0.8734
	0.6246	0.7460	0.9621	1.3393	1.2947	0.5441
STD. DEVIATIONS	0.0000	0.0000	0.2075	0.4846	0.7780	0.6666
	0.4684	0.5943	0.8473	1.2239	1.3247	0.7512

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 2						
AVERAGES	0.0000	0.0000	0.0036	0.2282	2.2081	1.4713
	1.3651	1.6217	1.6411	2.4808	1.4829	0.1228
STD. DEVIATIONS	0.0000	0.0000	0.0200	0.5304	1.4031	1.3729

	1.1728	1.4555	1.9536	3.3158	2.1012	0.2073

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0000	0.0000	0.0000	0.0003	0.0015	0.0010
	0.0007	0.0008	0.0011	0.0014	0.0014	0.0006
STD. DEVIATIONS	0.0000	0.0000	0.0002	0.0005	0.0008	0.0007
	0.0005	0.0006	0.0009	0.0013	0.0015	0.0008

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM	CU. METERS	PERCENT
PRECIPITATION	462.27 (101.696)	4622.7	100.00
RUNOFF	98.800 (56.9422)	988.00	21.373
EVAPOTRANSPIRATION	355.526 (68.1341)	3555.26	76.909
PERCOLATION/LEAKAGE THROUGH LAYER 2	8.13248 (3.39671)	81.325	1.75925
AVERAGE HEAD ON TOP OF LAYER 2	10.521 (5.543)		
PERCOLATION/LEAKAGE THROUGH LAYER 4	8.13248 (3.39671)	81.325	1.75925
AVERAGE HEAD ON TOP OF LAYER 4	0.007 (0.003)		
CHANGE IN WATER STORAGE	-0.189 (0.9685)	-1.89	-0.041

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	156.70	1567.000
RUNOFF	135.109	1351.0894
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.107998	1.07998
AVERAGE HEAD ON TOP OF LAYER 2	150.000	
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.107998	1.07998
AVERAGE HEAD ON TOP OF LAYER 4	0.036	
SNOW WATER	135.25	1352.4823

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4710
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2100

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(CM)	(VOL/VOL)
1	3.4683	0.2312
2	25.6200	0.4270
3	292.0000	0.2920
4	290.3600	0.4270
SNOW WATER	1.578	

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**               HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                  **
**                 HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY                      **
**                     USAE WATERWAYS EXPERIMENT STATION                        **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                 **
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PRECIPITATION DATA FILE:    C:\DC\DC2PP.D4
TEMPERATURE DATA FILE:      C:\DC\DC2TM.D7
SOLAR RADIATION DATA FILE:  C:\DC\DC2SLRD.D13
EVAPOTRANSPIRATION DATA:    C:\DC\DC2ET.D11
SOIL AND DESIGN DATA FILE:  C:\DC\DC2SOIL.D10
OUTPUT DATA FILE:           C:\DC\DC2OUT.OUT


TIME:   8:45     DATE:   4/14/2023


**********************************************************************************

     TITLE:  11213132 DAWSON CREEK LANDFILL - PLATEAU, LOW PERM

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                LAYER  1
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER  12
          THICKNESS                    =     15.00   CM
          POROSITY                     =      0.4710 VOL/VOL
          FIELD CAPACITY               =      0.3420 VOL/VOL
          WILTING POINT                =      0.2100 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2925 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.419999997000E-04 CM/SEC


                                LAYER  2
                                --------
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TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

THICKNESS	=	60.00	CM
POROSITY	=	0.4270	VOL/VOL
FIELD CAPACITY	=	0.4180	VOL/VOL
WILTING POINT	=	0.3670	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	1000.00	CM
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2920	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	680.00	CM
POROSITY	=	0.4270	VOL/VOL
FIELD CAPACITY	=	0.4180	VOL/VOL
WILTING POINT	=	0.3670	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.449999987000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #12 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 1.% AND A SLOPE LENGTH OF 25. METERS.

SCS RUNOFF CURVE NUMBER	=	95.20	
FRACTION OF AREA ALLOWING RUNOFF	=	50.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	15.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	4.388	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	7.065	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	3.150	CM
INITIAL SNOW WATER	=	2.347	CM

INITIAL WATER IN LAYER MATERIALS	=	612.368	CM
TOTAL INITIAL WATER	=	614.715	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
DAWSON CREEK BC

STATION LATITUDE	=	55.70	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	130	
END OF GROWING SEASON (JULIAN DATE)	=	270	
EVAPORATIVE ZONE DEPTH	=	15.0	CM
AVERAGE ANNUAL WIND SPEED	=	13.50	KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	60.50	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	41.60	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	47.80	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	62.10	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR SPOKANE WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
29.1	18.6	22.6	19.8	34.4	67.4
84.9	54.2	41.2	29.9	29.0	22.2

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR SPOKANE WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
-13.2	-10.2	-5.0	3.5	9.3	13.6
15.5	14.4	9.8	3.3	-6.8	-11.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR SPOKANE WASHINGTON
AND STATION LATITUDE = 55.70 DEGREES

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AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	28.86	18.95	23.80	19.61	37.19	62.22
	89.06	64.74	40.37	28.36	27.14	21.97
STD. DEVIATIONS	12.14	8.28	10.13	9.57	19.12	40.72
	67.03	45.32	21.33	16.31	13.33	7.81
RUNOFF						
TOTALS	0.000	0.129	10.459	23.802	6.664	9.188
	32.066	16.446	4.376	1.285	0.544	0.038
STD. DEVIATIONS	0.000	0.615	14.752	22.907	7.960	11.643
	41.314	21.150	6.861	2.742	1.673	0.229
EVAPOTRANSPIRATION						
TOTALS	11.577	13.395	17.982	13.750	55.358	49.242
	52.797	49.393	32.430	22.072	14.441	12.917
STD. DEVIATIONS	1.985	2.272	2.571	8.653	17.283	30.805
	30.046	31.976	20.219	10.540	3.662	1.930
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	0.0009	0.0025	0.3933	1.9395	1.5288	0.9814
	1.1726	1.2863	1.3260	1.4830	1.3465	0.6037
STD. DEVIATIONS	0.0065	0.0185	0.6951	1.0449	0.6685	0.8016
	0.7221	0.8006	0.9466	1.1929	1.3318	0.8420
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0009	0.0025	0.3933	1.9395	1.5288	0.9814
	1.1726	1.2863	1.3260	1.4830	1.3465	0.6037
STD. DEVIATIONS	0.0065	0.0185	0.6951	1.0449	0.6685	0.8016
	0.7221	0.8006	0.9466	1.1929	1.3318	0.8420

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 2						
AVERAGES	0.0000	0.0003	0.5262	2.8888	2.7893	1.4391
	1.9902	2.4503	2.3111	2.5865	1.5313	0.1517
STD. DEVIATIONS	0.0001	0.0023	1.0216	2.0909	1.4552	1.4532
	1.4320	1.8627	2.2696	3.1417	2.1432	0.2614

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0000	0.0000	0.0004	0.0021	0.0016	0.0011
	0.0012	0.0014	0.0015	0.0016	0.0015	0.0006
STD. DEVIATIONS	0.0000	0.0000	0.0007	0.0011	0.0007	0.0009
	0.0008	0.0009	0.0010	0.0013	0.0015	0.0009

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM		CU. METERS	PERCENT
PRECIPITATION	462.27	(101.696)	4622.7	100.00
RUNOFF	104.996	(52.0383)	1049.96	22.713
EVAPOTRANSPIRATION	345.354	(65.3345)	3453.54	74.708
PERCOLATION/LEAKAGE THROUGH LAYER 2	12.06452	(3.59003)	120.645	2.60985
AVERAGE HEAD ON TOP OF LAYER 2	15.554	(5.648)		
PERCOLATION/LEAKAGE THROUGH LAYER 4	12.06452	(3.59003)	120.645	2.60985
AVERAGE HEAD ON TOP OF LAYER 4	0.011	(0.003)		
CHANGE IN WATER STORAGE	-0.146	(0.9700)	-1.46	-0.032

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	156.70	1567.000
RUNOFF	103.222	1032.2169
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.107998	1.07998
AVERAGE HEAD ON TOP OF LAYER 2	150.000	
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.107998	1.07998
AVERAGE HEAD ON TOP OF LAYER 4	0.036	
SNOW WATER	135.25	1352.4823

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4710
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2100

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(CM)	(VOL/VOL)
1	3.6996	0.2466
2	25.6200	0.4270
3	292.0000	0.2920
4	290.3600	0.4270
SNOW WATER	1.578	

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**               HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                  **
**                 HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY                      **
**                     USAE WATERWAYS EXPERIMENT STATION                        **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                 **
**                                                                              **
**                                                                              **
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PRECIPITATION DATA FILE:    C:\DC\DC1PP.D4
TEMPERATURE DATA FILE:      C:\DC\DC1TM.D7
SOLAR RADIATION DATA FILE:  C:\DC\DC1SLRD.D13
EVAPOTRANSPIRATION DATA:    C:\DC\DC1ET.D11
SOIL AND DESIGN DATA FILE:  C:\DC\DC3SOIL.D10
OUTPUT DATA FILE:           C:\DC\DC3OUT.OUT


TIME:   9: 7     DATE:   4/14/2023


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     TITLE:  11213132 DAWSON CREEK LANDFILL - SIDE SLOPE, MED PERM

**********************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
               COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                    TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER  12
          THICKNESS                    =     15.00   CM
          POROSITY                     =      0.4710 VOL/VOL
          FIELD CAPACITY               =      0.3420 VOL/VOL
          WILTING POINT                =      0.2100 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.3042 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.419999997000E-04 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	60.00	CM
POROSITY	=	0.4270	VOL/VOL
FIELD CAPACITY	=	0.4180	VOL/VOL
WILTING POINT	=	0.3670	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999975000E-05	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	1000.00	CM
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2920	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	680.00	CM
POROSITY	=	0.4270	VOL/VOL
FIELD CAPACITY	=	0.4180	VOL/VOL
WILTING POINT	=	0.3670	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.459999995000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #12 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 27.% AND A SLOPE LENGTH OF 35. METERS.

SCS RUNOFF CURVE NUMBER	=	85.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	15.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	4.563	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	7.065	CM

LOWER LIMIT OF EVAPORATIVE STORAGE	=	3.150	CM
INITIAL SNOW WATER	=	2.347	CM
INITIAL WATER IN LAYER MATERIALS	=	612.543	CM
TOTAL INITIAL WATER	=	614.890	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
DAWSON CREEK BC

STATION LATITUDE	=	55.70	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	130	
END OF GROWING SEASON (JULIAN DATE)	=	270	
EVAPORATIVE ZONE DEPTH	=	15.0	CM
AVERAGE ANNUAL WIND SPEED	=	13.50	KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	60.50	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	41.60	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	47.80	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	62.10	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR SPOKANE WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
29.1	18.6	22.6	19.8	34.4	67.4
84.9	54.2	41.2	29.9	29.0	22.2

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR SPOKANE WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
-13.2	-10.2	-5.0	3.5	9.3	13.6
15.5	14.4	9.8	3.3	-6.8	-11.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR SPOKANE WASHINGTON
AND STATION LATITUDE = 55.70 DEGREES

****

AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	28.86	18.95	23.80	19.61	37.19	62.22
	89.06	64.74	40.37	28.36	27.14	21.97
STD. DEVIATIONS	12.14	8.28	10.13	9.57	19.12	40.72
	67.03	45.32	21.33	16.31	13.33	7.81
RUNOFF						
TOTALS	0.000	0.181	13.778	28.044	6.468	3.229
	23.112	6.326	0.551	0.009	0.514	0.039
STD. DEVIATIONS	0.000	0.912	16.854	25.152	9.157	7.681
	40.188	14.335	3.458	0.062	1.616	0.317
EVAPOTRANSPIRATION						
TOTALS	11.586	13.410	17.850	10.993	38.605	47.728
	44.557	44.395	29.247	19.248	14.007	12.912
STD. DEVIATIONS	1.994	2.286	2.799	6.309	15.877	25.446
	22.231	25.244	15.315	9.071	3.688	1.920
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	0.0000	0.0000	0.0000	2.0600	11.5229	12.7969
	19.1095	16.8903	7.5467	5.0983	0.6468	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	4.3290	5.8156	13.6926
	16.5111	16.1300	9.9598	7.9466	2.5067	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	3.3693	1.6321	0.8469	0.6039	7.9666	8.4859
	8.4698	9.9121	10.3306	10.1246	7.9491	5.9585
STD. DEVIATIONS	5.2296	3.6866	2.7724	2.1592	2.6270	3.7182
	4.4464	4.1787	3.5179	4.2518	5.1792	5.7891

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 2						
AVERAGES	0.0000	0.0000	0.0000	0.0410	0.2062	0.2455
	0.4545	0.3564	0.1229	0.0415	0.0062	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0926	0.1214	0.3192

	0.4438	0.4343	0.2301	0.0776	0.0336	0.0000

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	1.2566	0.6046	0.2801	0.1549	1.0782	1.3723
	2.5840	4.8923	6.3005	5.5687	4.2117	2.4750
STD. DEVIATIONS	2.9405	2.0729	1.4050	0.8727	0.7065	1.2797
	2.8317	4.4379	5.4351	5.4218	4.9547	3.9872

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM	CU. METERS	PERCENT
PRECIPITATION	462.27 (101.696)	4622.7	100.00
RUNOFF	82.250 (51.3747)	822.50	17.793
EVAPOTRANSPIRATION	304.539 (54.7062)	3045.39	65.879
PERCOLATION/LEAKAGE THROUGH LAYER 2	75.67147 (30.26457)	756.715	16.36958
AVERAGE HEAD ON TOP OF LAYER 2	1.229 (0.595)		
PERCOLATION/LEAKAGE THROUGH LAYER 4	75.64935 (25.13580)	756.493	16.36479
AVERAGE HEAD ON TOP OF LAYER 4	25.649 (22.422)		
CHANGE IN WATER STORAGE	-0.169 (1.1578)	-1.69	-0.037

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	156.70	1567.000
RUNOFF	124.417	1244.1724
PERCOLATION/LEAKAGE THROUGH LAYER 2	10.799844	107.99844
AVERAGE HEAD ON TOP OF LAYER 2	150.000	
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.413274	4.13274
AVERAGE HEAD ON TOP OF LAYER 4	271.025	
SNOW WATER	135.25	1352.4823

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4710
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2100

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(CM)	(VOL/VOL)
1	3.4229	0.2282
2	25.6200	0.4270
3	292.2212	0.2922
4	290.3600	0.4270
SNOW WATER	1.578	

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**                                                                              **
**                                                                              **
**               HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                  **
**                 HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY                      **
**                     USAE WATERWAYS EXPERIMENT STATION                        **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                 **
**                                                                              **
**                                                                              **
**********************************************************************************
**********************************************************************************


PRECIPITATION DATA FILE:    C:\DC\DC2PP.D4
TEMPERATURE DATA FILE:      C:\DC\DC2TM.D7
SOLAR RADIATION DATA FILE:  C:\DC\DC2SLRD.D13
EVAPOTRANSPIRATION DATA:    C:\DC\DC2ET.D11
SOIL AND DESIGN DATA FILE:  C:\DC\DC4SOIL.D10
OUTPUT DATA FILE:           C:\DC\DC4OUT.OUT


TIME:   9:21     DATE:   4/14/2023


**********************************************************************************

     TITLE:  11213132 DAWSON CREEK LANDFILL - PLATEAU, MED PERM

**********************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                LAYER  1
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER  12
          THICKNESS                    =     15.00   CM
          POROSITY                     =      0.4710 VOL/VOL
          FIELD CAPACITY               =      0.3420 VOL/VOL
          WILTING POINT                =      0.2100 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2830 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.419999997000E-04 CM/SEC



                                LAYER  2
                                --------
```

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	60.00	CM
POROSITY	=	0.4270	VOL/VOL
FIELD CAPACITY	=	0.4180	VOL/VOL
WILTING POINT	=	0.3670	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999975000E-05	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	1000.00	CM
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2920	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	680.00	CM
POROSITY	=	0.4270	VOL/VOL
FIELD CAPACITY	=	0.4180	VOL/VOL
WILTING POINT	=	0.3670	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.449999987000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #12 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 1.% AND A SLOPE LENGTH OF 25. METERS.

SCS RUNOFF CURVE NUMBER	=	95.20	
FRACTION OF AREA ALLOWING RUNOFF	=	50.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	15.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	4.245	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	7.065	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	3.150	CM
INITIAL SNOW WATER	=	2.347	CM

INITIAL WATER IN LAYER MATERIALS	=	612.225	CM
TOTAL INITIAL WATER	=	614.572	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
DAWSON CREEK BC

STATION LATITUDE	=	55.70	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	130	
END OF GROWING SEASON (JULIAN DATE)	=	270	
EVAPORATIVE ZONE DEPTH	=	15.0	CM
AVERAGE ANNUAL WIND SPEED	=	13.50	KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	60.50	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	41.60	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	47.80	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	62.10	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR SPOKANE WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
29.1	18.6	22.6	19.8	34.4	67.4
84.9	54.2	41.2	29.9	29.0	22.2

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR SPOKANE WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
-13.2	-10.2	-5.0	3.5	9.3	13.6
15.5	14.4	9.8	3.3	-6.8	-11.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR SPOKANE WASHINGTON
AND STATION LATITUDE = 55.70 DEGREES

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AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	28.86	18.95	23.80	19.61	37.19	62.22
	89.06	64.74	40.37	28.36	27.14	21.97
STD. DEVIATIONS	12.14	8.28	10.13	9.57	19.12	40.72
	67.03	45.32	21.33	16.31	13.33	7.81
RUNOFF						
TOTALS	0.000	0.106	7.927	16.990	4.661	7.959
	27.298	12.118	3.086	0.675	0.326	0.025
STD. DEVIATIONS	0.000	0.532	9.829	15.599	5.270	9.404
	34.799	14.510	4.063	1.068	0.944	0.200
EVAPOTRANSPIRATION						
TOTALS	11.586	13.410	17.822	11.000	40.376	42.588
	40.705	38.357	27.499	20.118	14.222	12.910
STD. DEVIATIONS	1.994	2.286	2.810	6.929	15.953	25.799
	22.076	24.521	16.821	10.110	3.675	1.922
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	0.0000	0.0000	2.8901	12.6396	15.2791	9.9834
	19.3918	17.2927	7.9557	4.5624	0.6492	0.0000
STD. DEVIATIONS	0.0000	0.0000	6.3632	11.9841	8.7909	10.7628
	16.3568	15.8089	8.7977	6.8449	2.2673	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	3.8498	1.6956	1.7818	6.0526	10.6107	10.4192
	9.5867	10.5408	10.8703	11.1086	8.3844	5.7433
STD. DEVIATIONS	5.3414	3.7523	3.4981	4.3014	2.5187	2.6666
	3.9420	3.3682	2.4405	2.9361	4.7344	5.7013

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 2						
AVERAGES	0.0000	0.0000	0.0212	0.1655	0.2731	0.1672
	0.4734	0.3425	0.0953	0.0352	0.0052	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0878	0.2777	0.1587	0.2377
	0.5034	0.4228	0.1593	0.0677	0.0226	0.0000

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	1.4502	0.7337	0.4047	1.1796	3.1384	3.2340
	3.4879	5.6494	7.0419	6.1199	4.4695	2.7067
STD. DEVIATIONS	3.2039	2.3376	1.6144	1.8854	2.6962	2.6520
	3.1436	4.1198	5.2119	5.4347	5.1835	4.2577

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM		CU. METERS	PERCENT
PRECIPITATION	462.27	(101.696)	4622.7	100.00
RUNOFF	81.171	(42.1197)	811.71	17.559
EVAPOTRANSPIRATION	290.592	(52.4513)	2905.92	62.862
PERCOLATION/LEAKAGE THROUGH LAYER 2	90.64408	(29.06356)	906.441	19.60852
AVERAGE HEAD ON TOP OF LAYER 2	1.316	(0.591)		
PERCOLATION/LEAKAGE THROUGH LAYER 4	90.64403	(22.39571)	906.440	19.60851
AVERAGE HEAD ON TOP OF LAYER 4	33.013	(25.443)		
CHANGE IN WATER STORAGE	-0.138	(1.1440)	-1.38	-0.030

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	156.70	1567.000
RUNOFF	97.884	978.8351
PERCOLATION/LEAKAGE THROUGH LAYER 2	10.799844	107.99844
AVERAGE HEAD ON TOP OF LAYER 2	150.000	
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.404161	4.04161
AVERAGE HEAD ON TOP OF LAYER 4	268.776	
SNOW WATER	135.25	1352.4823

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4710
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2100

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(CM)	(VOL/VOL)
1	3.6380	0.2425
2	25.6200	0.4270
3	292.0000	0.2920
4	290.3600	0.4270
SNOW WATER	1.578	

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Appendix C

Analytical Results (2021 Annual Monitoring Report)

TABLE 5a

Monitoring Well Summary

Peace River Regional District

PRRD Landfill - Dawson Creek

Monitoring Well	Elevation[g] (masl)					Depth (m)											Hydraulic Conductivity (m/s)	Method	Stratigraphy of Screened Interval
			19-May-21	14-Jul-21	06-Oct-21			19-May-21			14-Jul-21			06-Oct-21					
	Ground Surface	Top of Casing	Water Level	Water Level	Water Level	Grnd. to Top of Screen	Grnd. to Base of Screen	Top of Casing to Water	Grnd. to Water	Product Thickness (cm)	Top of Casing to Water	Grnd. to Water	Product Thickness (cm)	Top of Casing to Water	Grnd. to Water	Product Thickness (cm)			
DC-95-1	---	631.54	decommissioned			---	---	---	---	---	---	---	---	---	---	---	1E-07	---	---
DC-19-1	630.92	631.84	630.08	629.71	629.35	1.5	3.0	1.77	0.84	ND	2.13	1.21	ND	2.50	1.57	ND	---	---	clay
DC-95-2	635.86	636.55	632.84	632.86	632.85	---	---	3.70	3.02	ND	3.69	3.00	ND	3.70	3.01	ND	---	---	---
DC-98-1	631.59	632.53	630.26	630.00	630.01	---	---	2.27	1.33	ND	2.52	1.59	ND	2.52	1.58	ND	1E-04	---	---
DC-98-2	---	---	decommissioned			---	---	---	---	---	---	---	---	---	---	---	5E-07	---	---
DC-98-3	633.74	634.55	629.80	629.80	629.85	---	---	4.75	3.94	ND	4.76	3.94	ND	4.70	3.89	ND	---	---	---
DC-98-5	652.36	653.18	641.16	642.45	648.63	---	---	12.03	11.20	ND	10.73	9.91	ND	4.56	3.73	ND	5E-06	---	---
DC-99-1A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	3E-09	---	---
DC-99-1B	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	8E-09	---	---
DC-99-2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	3E-08	---	---
DC-BH101	651.83	652.78	643.01	641.81	641.14	13.2	15.8	9.77	8.82	ND	10.96	10.02	ND	11.63	10.69	ND	---	---	till/clay

Notes:

^ - water level measured July 4, 2019

g - elevations are geodetic

masl - metres above sea level

--- - not available

ND - not detected

TABLE 5b

Groundwater Quality Results - Field Parameters

Peace River Regional District

PRRD Landfill - Dawson Creek

Monitoring Well	Sample Date	MSI Sample Number	Temp °C	Field pH	Field EC^{25} µS/cm	Field DO mg/L	ORP mV
DC-19-1	19-May-21	26254210519071	2.1	5.8	3905	9.3	180
DC-19-1	14-Jul-21	26254210714212	8.2	6.7	5500	1.4	55
DC-19-1	05-Oct-21	26254211005311	7.3	6.7	3836	0.5	-68
DC-95-2	19-May-21	26254210519073	4.4	6.0	3609	6.5	9
DC-95-2	14-Jul-21	26254210714213	6.9	6.5	4995	1.1	30
DC-95-2	05-Oct-21	26254211005313	6.0	6.7	4032	4.3	120
DC-98-1	19-May-21	26254210519072	2.8	5.9	4381	8.0	-80
DC-98-1	14-Jul-21	26254210714211	7.2	6.9	5906	1.5	-115
DC-98-1	05-Oct-21	26254211005312	7.4	6.8	4136	0.8	-29
DC-98-3	05-Oct-21	WL only	---	---	---	---	---
DC-98-5	05-Oct-21	WL only	---	---	---	---	---
DC-BH101	19-May-21	26254210519074	8.7	6.0	4099	6.4	203
DC-BH101	14-Jul-21	26254210714214	11.6	6.9	3582	7.2	208
DC-BH101	05-Oct-21	26254211005314	5.4	7.5	3868	---	130
B.C. CSR 375/96 - Freshwater Aquatic Standards*			**NS**	**NS**	**NS**	**NS**	**NS**
B.C. CSR 375/96 - Drinking Water Standards*			**NS**	**NS**	**NS**	**NS**	**NS**

Notes:

NS - not specified

^{25} - field EC corrected to 25°C

* - *Contaminated Sites Regulation 375/96* (Province of British Columbia February 2021)

Italics - indicates value does not meet applicable standards

TABLE 5c

Groundwater Quality Results - General and Inorganic Parameters

Peace River Regional District

PRRD Landfill - Dawson Creek

Monitoring Well	Sample Date	MSI Sample Number	pH	EC µS/cm	Ca mg/L	Mg mg/L	Na mg/L	K mg/L	Cl mg/L	SO_4 mg/L	NO_2-N mg/L	NO_3-N mg/L	NO_2+NO_3-N mg/L	NH_3-N mg/L	Total PO_4-P mg/L	Orthophosphate mg/L	Sulphide as S mg/L	Sulphide as H_2S mg/L	T-Alkalinity mg/L	HCO_3 mg/L	Hardness mg/L	TDS mg/L	Phenol mg/L
DC-19-1	19-May-21	26254210519071	7.10	4150	554	227	***297***	9.7	173	***1860***	<0.020	<0.05	<0.07	<0.025	<0.05	<0.01	<0.002	<0.002	621	757	2320	3490	<0.001
DC-19-1	14-Jul-21	26254210714212	6.98	4220	523	216	***262***	11	214	***1840***	<0.020	<0.05	<0.07	<0.025	<0.05	<0.01	<0.002	<0.002	635	775	2200	3450	<0.001
DC-19-1	05-Oct-21	26254211005311	6.82	4170	603	207	***236***	18	235	***1800***	<0.020	<0.05	<0.07	0.273	0.06	<0.01	0.002	0.002	670	816	2360	3500	<0.001
DC-95-2	19-May-21	26254210519073	7.12	3850	551	190	***261***	9.3	15.1	***1960***	<0.020	<0.05	<0.07	1.26	0.06	<0.01	<0.002	<0.002	543	663	2160	3310	0.001
DC-95-2	14-Jul-21	26254210714213	7.17	3740	512	176	***241***	8.4	14.6	***1920***	<0.020	<0.05	<0.07	1.3	<0.05	<0.01	<0.002	<0.002	538	655	2000	3200	<0.001
DC-95-2	05-Oct-21	26254211005313	6.99	3860	547	188	***259***	9.3	14.1	***2090***	<0.020	<0.05	<0.07	1.44	0.08	<0.01	0.002	0.002	503	613	2140	3410	<0.001
DC-98-1	19-May-21	26254210519072	7.01	4620	421	256	***343***	148	***307***	***504***	<0.020	<0.05	<0.07	***31.2***	0.26	<0.01	0.008	0.009	1950	2380	2100	3180	0.003
DC-98-1	14-Jul-21	26254210714211	7.01	4520	320	237	***334***	160	***311***	340	<0.020	<0.05	<0.07	***23.4***	0.26	<0.01	0.003	0.003	1860	2270	1770	2840	0.005
DC-98-1	05-Oct-21	26254211005312	6.93	4560	419	238	***313***	120	***330***	***616***	<0.020	<0.05	<0.07	***31.7***	0.27	<0.01	0.005	0.005	2050	2500	2020	3300	0.001
DC-BH101	19-May-21	26254210519074	7.18	4480	577	244	***341***	9.6	7.6	***2380***	<0.020	0.97	0.97	0.191	0.09	0.02	<0.002	<0.002	562	685	2440	3900	<0.001
DC-BH101	14-Jul-21	26254210714214	7.26	4270	539	237	***317***	8.8	7.7	***2370***	<0.020	0.97	0.97	0.081	<0.05	0.02	<0.002	<0.002	531	648	2320	3800	<0.001
DC-BH101	05-Oct-21	26254211005314	6.91	4260	545	253	***319***	9	7.6	***2480***	<0.020	2.6	2.6	0.032	0.09	<0.01	0.002	0.002	519	633	2400	3920	<0.001
B.C. CSR 375/96 - Freshwater Aquatic Standards*			**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**1500**	**H**	**Cl**	**400^{amph}**	**400^{amph}**	**pH/T**	**NS**	**NS**	**NS**	**0.02**	**NS**	**NS**	**NS**	**NS**	**2**
B.C. CSR 375/96 - Drinking Water Standards*			**NS**	**NS**	**NS**	**NS**	**200^{HH}**	**NS**	**250^{TAO}**	**500^{TAO}**	**1**	**10**	**10**	**NS**	**NS**	**NS**	**NS**	**0.05^{TAO}**	**NS**	**NS**	**NS**	**NS**	**1**

Notes:

NS - not specified

Cl - dependent on chloride value

H - standard level is dependent on hardness value

^{amph} - standard may not protect all amphibians

^{HH} - standard is specific to protection of human health

pH/T - standard pH and temperature dependant, 10°C is assumed, see B.C. CSR for standard information

^{TAO} - standard to protect against taste and odour concerns

* - *Contaminated Sites Regulation 375/96* (Province of British Columbia February 2021)

Italics - indicates value does not meet applicable standards

TABLE 5d

Groundwater Quality Results - Dissolved Metals

Peace River Regional District

PRRD Landfill - Dawson Creek

Monitoring Well	Sample Date	MSI Sample Number	Al mg/L	Sb mg/L	As mg/L	Ba mg/L	Be mg/L	Bi mg/L	B mg/L	Cd mg/L	Cr mg/L	Co mg/L	Cu mg/L	Fe mg/L	Pb mg/L	Li mg/L	Mn mg/L	Hg mg/L	Mo mg/L	Ni mg/L	Se mg/L	Si mg/L	Ag mg/L	Sr mg/L	Tl mg/L	Sn mg/L	Ti mg/L	U mg/L	V mg/L	Zn mg/L	Zr mg/L
DC-19-1	19-May-21	26254210519071	0.014	<0.0010	<0.0010	0.02	<0.0005	<0.0020	0.19	0.00007	<0.0020	0.0008	<0.005	0.30	<0.0005	***0.17***	0.593	<0.000005	<0.005	0.022	<0.0010	5.11	<0.00005	2.49	<0.00030	<0.005	<0.0020	***0.022***	<0.0005	0.013	<0.005
DC-19-1	14-Jul-21	26254210714212	0.065	<0.0010	<0.0010	0.03	<0.0005	<0.0020	0.3	0.00009	<0.0020	***0.002***	<0.005	0.84	<0.0005	***0.18***	1.34	<0.000005	<0.005	0.029	<0.0010	6.09	<0.00005	***2.74***	<0.00030	<0.005	<0.0020	***0.021***	0.0007	0.007	<0.005
DC-19-1	05-Oct-21	26254211005311	<0.01	<0.001	0.002	0.04	<0.0005	<0.002	0.43	<0.00005	<0.002	***0.0068***	<0.005	4.90	<0.0005	***0.16***	***2.70***	<0.000005	<0.005	0.032	<0.001	7.68	<0.00005	***3.27***	<0.0003	<0.005	<0.002	0.017	<0.0005	0.045	<0.005
DC-95-2	19-May-21	26254210519073	<0.01	<0.0010	<0.0010	0.01	<0.0005	<0.0020	0.44	<0.00005	<0.0020	***0.007***	<0.005	0.85	<0.0005	***0.17***	***1.72***	<0.000005	<0.005	0.011	<0.0010	6.58	<0.00005	***4.36***	<0.00030	<0.005	<0.0020	0.014	<0.0005	0.009	<0.005
DC-95-2	14-Jul-21	26254210714213	<0.01	<0.0010	<0.0010	0.01	<0.0005	<0.0020	0.45	0.00005	<0.0020	***0.0067***	<0.005	1.40	<0.0005	***0.17***	***1.52***	<0.000005	<0.005	0.0095	<0.0010	6.48	<0.00005	***4.08***	<0.00030	<0.005	<0.0020	0.016	<0.0005	0.006	<0.005
DC-95-2	05-Oct-21	26254211005313	<0.01	<0.001	<0.001	0.01	<0.0005	<0.002	0.41	<0.00005	<0.002	***0.004***	<0.005	1.50	<0.0005	***0.16***	***1.55***	<0.000005	<0.005	0.0075	<0.001	6.65	<0.00005	***4.17***	<0.0003	<0.005	<0.002	0.014	<0.0005	0.007	<0.005
DC-98-1	19-May-21	26254210519072	0.043	<0.0010	***0.031***	0.31	<0.0005	<0.0020	1.52	<0.00005	<0.0020	***0.026***	<0.005	***62.2***	<0.0005	***0.14***	***2.46***	<0.000005	<0.005	0.044	<0.0010	7.95	<0.00005	***2.91***	<0.00030	<0.005	<0.0020	0.0091	0.003	0.007	0.008
DC-98-1	14-Jul-21	26254210714211	0.031	<0.0010	***0.031***	0.35	<0.0005	<0.0020	1.8	<0.00005	<0.0020	***0.025***	<0.005	***60.4***	<0.0005	***0.11***	***1.68***	<0.000005	<0.005	0.044	<0.0010	7.53	<0.00005	***2.52***	<0.00030	<0.005	<0.0020	0.008	0.003	0.006	0.01
DC-98-1	05-Oct-21	26254211005312	0.025	<0.001	***0.035***	0.26	<0.0005	<0.002	1.5	<0.00005	<0.002	***0.025***	<0.005	***55.60***	<0.0005	***0.15***	***2.73***	<0.000005	<0.005	0.046	<0.001	7.88	<0.00005	***3.17***	<0.0003	<0.005	<0.002	0.011	0.002	0.005	0.008
DC-BH101	19-May-21	26254210519074	0.086	<0.0010	<0.0010	0.02	<0.0005	<0.0020	0.3	0.0004	<0.0020	0.0006	0.006	0.20	0.0006	***0.21***	0.50	<0.000005	<0.005	0.017	<0.0010	5.97	<0.00005	***4.88***	<0.00030	<0.005	0.0053	***0.045***	<0.0005	0.017	<0.005
DC-BH101	14-Jul-21	26254210714214	0.025	<0.0010	<0.0010	0.01	<0.0005	<0.0020	0.31	0.0002	<0.0020	<0.0005	<0.005	<0.05	<0.0005	***0.22***	0.17	<0.000005	<0.005	0.011	<0.0010	5.84	<0.00005	***4.86***	<0.00030	<0.005	<0.0020	***0.0524***	0.0006	0.007	<0.005
DC-BH101	05-Oct-21	26254211005314	<0.01	<0.001	<0.001	0.01	<0.0005	<0.002	0.3	0.0024	<0.002	<0.0005	<0.005	<0.05	<0.0005	***0.21***	<0.02	0.000006	<0.005	0.0088	<0.001	6.04	<0.00005	***4.73***	<0.0003	<0.005	<0.002	***0.044***	<0.0005	0.013	<0.005
B.C. CSR 375/96 - Freshwater Aquatic Standards*			**NS**	**0.09**	**0.05**	**10**	**0.0015**	**NS**	**12**	**H**	**0.01^{Cr6}**	**0.04**	**H**	**NS**	**H**	**NS**	**NS**	**0.00025**	**10**	**H**	**0.02**	**NS**	**H**	**NS**	**0.003**	**NS**	**1**	**0.085**	**NS**	**H**	**NS**
B.C. CSR 375/96 - Drinking Water Standards*			**9.5^{HH}**	**0.006**	**0.01**	**1**	**0.008**	**NS**	**5**	**0.005**	**0.05^{Cr6}**	**0.001**	**1.5$^{HH, WT}$**	**6.5$^{HH, IC2, WT}$**	**0.01**	**0.008**	**1.5$^{HH, IC2, WT}$**	**0.001**	**0.25**	**0.08**	**0.01**	**NS**	**0.02**	**2.5**	**NS**	**2.5**	**NS**	**0.02**	**0.02**	**3^{HH}**	**NS**

Notes:

NS - not specified

H - standard level is dependent on hardness value

^{Cr6} - guideline value for Cr(VI)

^{HH} - standard is specific to protection of human health

^{IC2} - standard applies to a site used for an industrial or commercial purpose or activity set out in Schedule 2

^{WT} - standard may not address aesthetic (organoleptic) concerns related to drinking water quality. Water treatment may be required.

* - *Contaminated Sites Regulation 375/96* (Province of British Columbia February 2021)

Italics - indicates value does not meet applicable standards

TABLE 5e

Groundwater Quality Results - Hydrocarbons

Peace River Regional District

PRRD Landfill - Dawson Creek

Monitoring Well	Sample Date	MSI Sample Number	Benzene mg/L	Toluene mg/L	Ethylbenzene mg/L	Xylenes mg/L	Styrene mg/L	VPHw mg/L	VHw (C_6-C_{10}) mg/L	EPHw (C_{10}-C_{19}) mg/L	EPHw (C_{19}-C_{32}) mg/L
DC-19-1	19-May-21	26254210519071	<0.0010	<0.0005	<0.0010	<0.0010	<0.0010	<0.05	<0.05	<0.2	<0.2
DC-95-2	19-May-21	26254210519073	<0.0010	<0.0005	<0.0010	<0.0010	<0.0010	<0.05	<0.05	<0.2	<0.2
DC-98-1	19-May-21	26254210519072	<0.0010	<0.0005	<0.0010	<0.0010	<0.0010	<0.05	<0.05	<0.2	<0.2
DC-BH101	19-May-21	26254210519074	<0.0010	<0.0005	<0.0010	<0.0010	<0.0010	<0.05	<0.05	<0.2	<0.2
B.C. CSR 375/96 - Freshwater Aquatic Standards**			**0.4**	**0.005**	**2**	**0.3**	**0.72**	**1.5**	**15^{IWU}**	**5^{IWU}**	**NS**
B.C. CSR 375/96 - Drinking Water Standards**			**0.005**	**0.06^{WT}**	**0.14^{WT}**	**0.09**	**0.8**	**NS**	**15^{IWU}**	**5^{IWU}**	**NS**

Notes:

NS - not specified

^{IWU} - standard is applicable to all sites, irrespective of water use

^{WT} - standard may not address aesthetic (organoleptic) concerns related to drinking water quality. Water treatment may be required.

** - *Contaminated Sites Regulation 375/96* (Province of British Columbia February 2021)

VPHw - does not include BTEX

VHw (C_6-C_{10}) - includes BTEX

Italics - indicates value does not meet applicable standards

TABLE 5f

Surface Water Quality Results - Field Parameters

Peace River Regional District

PRRD Landfill - Dawson Creek

Sample Point	Sample Date	MSI Sample Number	Temp °C	Field pH	Field EC^{25} µS/cm	Field DO mg/L	ORP mV	Field Turbidity NTU
DC-SW2	19-May-21	26254210519077	*17.1* DW	8.57	583	8.85	160	90.77
DC-SW2	14-Jul-21	26254210714219	*22.7* DW	8.84	*1277* Irr	10.28	118	68.86
DC-SW2	05-Oct-21	26254211005316	4	8.65	*1062* Irr	*1.2* FAL	126	23.89
DC-SW4	19-May-21	26254210519078	---	---	---	---	---	---
DC-SW4	14-Jul-21	dry	---	---	---	---	---	---
DC-SW4	05-Oct-21	dry	---	---	---	---	---	---
DC-SW6	19-May-21	26254210519076	*17.0* DW	7.94	586	8.64	152	83.83
DC-SW6	14-Jul-21	26254210714218	*23.6* DW	8.28	*2012* Irr	9.59	125	21.49
DC-SW6	05-Oct-21	26254211005318	2.9	8.19	*962* Irr	9.69	128	37.5
DC-SW7	19-May-21	26254210519075	*16.7* DW	8.29	671	9.53	167	88.56
DC-SW7	14-Jul-21	26254210714217	*22.7* DW	9.2 Irr	*1038* Irr	10.2	149	25.95
DC-SW7	05-Oct-21	26254211005317	3.7	9.3 Irr	*1188* Irr	10.5	135	18.01
B.C. Approved WQG - Drinking Water (DW)^{BCSW1}			**15^{AO}**	**NS**	**NS**	**NS**	**NS**	**narrative**
B.C. Approved WQG - Freshwater Aquatic Life (FAL)^{BCSW2}			**narrative^{mean}**	**narrative^{mean}**	**NS**	**<8^{mean,LS}**	**NS**	**narrative**
B.C. Approved WQG - Irrigation Water (Irr)^{BCSW2}			**natural^{mean}**	**5.0-9.5^{mean}**	**NS**	**NS**	**NS**	**narrative**
B.C. Approved WQG - Livestock Water (LW)^{BCSW2}			**natural^{mean}**	**5.0-9.5^{mean}**	**NS**	**NS**	**NS**	**narrative**
B.C. Approved WQG - Wildlife Water (WW)^{BCSW2}			**natural^{mean}**	**NS**	**NS**	**NS**	**NS**	**narrative**
B.C. Working WQG - Freshwater Aquatic Life (FAL)^{BCSW4}			**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
B.C. Working WQG - Irrigation Water (Irr)^{BCSW4}			**NS**	**NS**	**700^{mean,crop}**	**NS**	**NS**	**NS**
B.C. Working WQG - Livestock Water (LW)^{BCSW4}			**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
B.C. Working WQG - Wildlife Water (WW)^{BCSW4}			**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Notes:

--- - not analyzed

NS - not specified

25 - field EC corrected to 25°C

AO - aesthetic objective

mean - 30-day mean; calculated from at least 5 weekly samples taken in a period of 30 days

crop - guideline level is crop and soil dependent; criterion shown is most stringent value

LS - guideline is dependent upon life stage; criterion shown is most stringent value

narrative - see applicable guidelines for further details

natural - temperature should not change more than + or - 1 deg C from natural ambient background.

BCSW1 - *Source Drinking Water Quality Guidelines* (B.C. ENV 2020)

BCSW2 - *British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture* (B.C. ENV 2021)

BCSW4 - *British Columbia Working Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture* (B.C. ENV 2021)

Italics - indicates value does not meet Working Water Quality Guidelines

Italics - indicates value does not meet Approved Water Quality Guidelines

TABLE 5g

Surface Water Quality Results - General and Inorganic Parameters

Peace River Regional District

PRRD Landfill - Dawson Creek

Sample Point	Sample Date	MSI Sample Number	Lab pH	Lab EC µS/cm	Ca mg/L	Mg mg/L	Na mg/L	K mg/L	Cl mg/L	SO_4 mg/L	NO_2-N mg/L	NO_3-N mg/L	NO_2/NO_3-N mg/L	NH_3-N mg/L	PO_4-P-T mg/L	Orthophosphate mg/L	Sulphide as S mg/L	Sulphide as H_2S mg/L	T-Alkalinity mg/L	HCO_3 mg/L	Hardness mg/L	TDS mg/L	TSS mg/L	Phenols mg/L
DC-SW2	19-May-21	26254210519077	8.4	625	61.1	26.8	30.5	7.2	35.3	150	<0.005	0.03	0.03	<0.025	*0.24* DW,FAL	0.06	<0.002	<0.002	131	143	263	390	57	0.001
DC-SW2	14-Jul-21	26254210714219	8.72	*1120* Irr	75.5	44.2	88.6	11.1	*124* Irr	196	<0.005	0.04	0.04	0.026	*0.58* DW,FAL	0.41	*0.004* FAL	*0.004* FAL	229	241	371	*677* Irr	29	<0.001
DC-SW2	05-Oct-21	26254211005316	8.44	*1140* Irr	72.9	47.8	96.8	17.1	*128* Irr	137	0.058	1.43	1.49	*0.149* FAL	*1.08* DW,FAL	1.01	*0.004* FAL	*0.004* FAL	277	317	379	*667* Irr	27	<0.001
DC-SW4	19-May-21	26254210519078	7.54	*2800* Irr	398	146	165	13.0	*135* Irr	*1220* DW,FAL,LW	<0.020	<0.05	<0.07	<0.025	*0.05* DW,FAL	<0.01	0.002	0.002	335	408	1600	*2280* Irr,LW	9	<0.001
DC-SW6	19-May-21	26254210519076	7.92	597	59.2	25.6	25.1	6.2	28.5	154	<0.005	0.02	0.02	<0.025	*0.15* DW,FAL	<0.01	<0.002	<0.002	113	138	253	366	51	0.001
DC-SW6	14-Jul-21	26254210714218	8.31	*1760* Irr	162	82	117	10.2	*175* FAL,Irr	*482* FAL	<0.005	<0.01	<0.01	<0.025	<0.05	<0.01	0.002	0.002	242	295	742	*1170* Irr,LW	14	<0.001
DC-SW6	05-Oct-21	26254211005318	8.06	*916* Irr	82.5	37	57.5	4.8	87.8	215	<0.005	0.01	0.01	<0.025	<0.05	<0.01	0.002	0.002	136	166	358	*566* Irr	21	0.002
DC-SW7	19-May-21	26254210519075	8.37	628	61.6	26.8	31	7.4	35.3	151	<0.005	0.03	0.03	0.043	*0.24* DW,FAL	0.06	0.002	0.002	129	143	264	391	59	<0.001
DC-SW7	14-Jul-21	26254210714217	8.97	*1000* Irr	61	41.7	91.8	16.1	*117* Irr	127	<0.005	0.09	0.09	*0.105* FAL	*0.86* DW,FAL	0.7	*0.006* FAL	*0.006* FAL	233	215	324	*595* Irr	26	<0.001
DC-SW7	05-Oct-21	26254211005317	8.53	*1160* Irr	71.6	49	106	19.6	*137* Irr	121	0.092	2.02	2.11	*0.32* FAL	*1.23* DW,FAL	1.12	*0.005* FAL	*0.005* FAL	294	322	380	*682* Irr	9	<0.001
B.C. Approved WQG - Drinking Water (DW)[BCSW1]			**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**250[AO]**	**500[AO]**	**1[MAC]**	**10[MAC]**	**NS**	**NS**	**0.01[L,AO]**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
B.C. Approved WQG - Freshwater Aquatic Life (FAL)[BCSW2]			**narrative[mean]**	**NS**	**NS**	**NS**	**NS**	**NS**	**150[mean]**	**H[SO4,mean]**	**Cl[mean]**	**3[mean]**	**NS**	**pH/T[mean]**	**0.005-0.015[L]**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**narrative**	**0.05[ST]**
B.C. Approved WQG - Irrigation Water (Irr)[BCSW2]			**5.0-9.5[mean]**	**NS**	**NS**	**NS**	**NS**	**NS**	**100[mean]**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**narrative**	**NS**
B.C. Approved WQG - Livestock Water (LW)[BCSW2]			**5.0-9.5[mean]**	**NS**	**NS**	**NS**	**NS**	**NS**	**600[mean]**	**1000[mean]**	**10[ST]**	**100[ST]**	**100[ST]**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**narrative**	**NS**
B.C. Approved WQG - Wildlife Water (WW)[BCSW2]			**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**600[mean]**	**NS**	**10[ST]**	**100[ST]**	**100[ST]**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**narrative**	**NS**
B.C. Working WQG - Freshwater Aquatic Life (FAL)[BCSW4]			**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.002**	**0.002**	**narrative**	**NS**	**NS**	**NS**	**NS**	**NS**
B.C. Working WQG - Irrigation Water (Irr)[BCSW4]			**NS**	**700[mean,crop]**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**500[mean,crop]**	**NS**
B.C. Working WQG - Livestock Water (LW)[BCSW4]			**NS**	**NS**	**1000[mean]**	**NS**	**NS**	**NS**	**NS**	**1000[mean]**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**1000[mean]**	**NS**
B.C. Working WQG - Wildlife Water (WW)[BCSW4]			**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Notes:

NS - not specified

animal - guideline level is animal dependent; criterion shown is most stringent value

AO - aesthetic objective

mean - 30-day mean; calculated from at least 5 weekly samples taken in a period of 30 days

crop - guideline level is crop and soil dependent; criterion shown is most stringent value

Cl - dependent on chloride value

H - dependent on hardness value

L - guideline applies to lakes only

MAC - maximum acceptable concentration

narrative - see applicable guidelines for further details

pH/T - dependent on pH and temperature values, most stringent guideline of 0.102 mg/L applied, see applicable guideline for further details

SO4 - guideline level is hardness dependent; hardness values greater than 250 mg/L need to be determined based on site water

BCSW1 - *Source Drinking Water Quality Guidelines* (B.C. ENV 2020)

BCSW2 - *British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture* (B.C. ENV 2021)

BCSW4 - *British Columbia Working Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture* (B.C. ENV 2021)

Italics - indicates value does not meet Working Water Quality Guidelines

Italics - indicates value does not meet Approved Water Quality Guidelines

TABLE 5h

Surface Water Quality Results - Total Metals

Peace River Regional District

PRRD Landfill - Dawson Creek

Sample Point	Sample Date	MSI Sample Number	Al mg/L	Sb mg/L	As mg/L	Ba mg/L	Be mg/L	Bi mg/L	B mg/L	Cd mg/L	Cr mg/L	Cr3+ ^ mg/L	Cr6+ ^ mg/L	Co mg/L	Cu mg/L	Fe mg/L	Pb mg/L	Li mg/L	Mn mg/L	Hg mg/L	Mo mg/L	Ni mg/L	Se mg/L	Si mg/L	Ag mg/L	Sr mg/L	Tl mg/L	Sn mg/L	Ti mg/L	U mg/L	V mg/L	Zn mg/L	Zr mg/L
DC-SW2	19-May-21	26254210519077	1.03	0.0003	0.00232	0.0859	0.00007	<0.0001	0.07	0.00007	*0.0018* FAL	<0.0005	<0.01	*0.0016* DW	0.0055	*2.87* DW,FAL	0.0013	0.0128	*0.0807* DW	0.00001	0.00093	0.0112	0.0004	2.36	<0.00005	0.204	0.00001	<0.0001	0.0108	0.0012	0.0044	0.0181	0.0009
DC-SW2	14-Jul-21	26254210714219	0.846	0.0005	*0.00547* FAL	0.0605	<0.00005	<0.0001	0.231	0.00004	*0.0016* FAL	---	---	*0.0019* DW	0.0033	*1.73* DW,FAL	0.001	0.0281	*0.0983* DW	<0.000005	0.00211	0.0143	0.0005	2.31	<0.00005	0.355	0.00002	<0.0001	0.016	0.00231	0.0054	0.0086	0.0011
DC-SW2	05-Oct-21	26254211005316	0.251	0.0005	0.00403	0.0337	<0.00005	<0.0001	0.26	0.00003	0.0006	<0.0005	<0.01	*0.0017* DW	0.0026	*0.728* DW	0.0004	0.0297	*0.0801* DW	<0.000005	0.00199	0.015	0.0003	0.92	<0.00005	0.362	<0.00001	<0.0001	0.0043	0.00179	0.0035	0.0096	<0.0005
DC-SW4	19-May-21	26254210519078	0.037	<0.0002	0.00091	0.0342	<0.00010	<0.0002	0.466	<0.00002	<0.0010	<0.0005	<0.01	0.0009	0.001	*0.758* DW	<0.0002	0.0509	*0.677* DW,Irr	<0.000005	0.00097	0.0065	0.0003	3.04	<0.00010	1.58	<0.00002	<0.0002	<0.0010	0.00695	<0.0002	<0.0020	<0.0010
DC-SW6	19-May-21	26254210519076	1.24	0.0003	0.00239	0.093	0.00008	<0.0001	0.049	0.00007	*0.0023* FAL	<0.0005	<0.01	*0.0016* DW	0.006	*3.46* DW,FAL	0.0015	0.012	*0.0842* DW	0.000009	0.00096	0.011	0.0004	3.37	<0.00005	0.198	0.00002	<0.0001	0.0144	0.00116	0.0053	0.0193	0.001
DC-SW6	14-Jul-21	26254210714218	0.393	0.0004	0.00143	0.0972	<0.00005	<0.0001	0.114	0.00004	0.0008	---	---	0.0006	0.0042	*0.383* DW	0.0003	0.0345	*0.0662* DW	<0.000005	0.0028	0.0067	0.0007	1.29	<0.00005	0.723	0.00004	<0.0001	0.019	0.00581	0.0017	0.005	0.0008
DC-SW6	05-Oct-21	26254211005318	0.494	0.0002	0.00087	0.0578	<0.00005	<0.0001	0.053	0.00003	*0.0012* FAL	<0.0005	<0.01	0.0006	0.0033	*0.779* DW	0.0005	0.0179	*0.0382* DW	<0.000005	0.00167	0.0065	0.0003	1.26	<0.00005	0.415	0.00002	<0.0001	0.0156	0.00197	0.0021	0.0073	0.0012
DC-SW7	19-May-21	26254210519075	1.14	0.0003	0.00246	0.0862	0.00009	<0.0001	0.07	0.00006	*0.002* FAL	<0.0005	<0.01	*0.0016* DW	0.0055	*3.11* DW,FAL	0.0014	0.0134	*0.0859* DW	0.00001	0.00101	0.011	0.0004	3.54	<0.00005	0.204	0.00002	<0.0001	0.0134	0.00123	0.0048	0.0167	0.0009
DC-SW7	14-Jul-21	26254210714217	0.402	0.0005	0.00484	0.0382	<0.00005	<0.0001	0.277	0.00002	0.0008	---	---	*0.0014* DW	0.0016	*0.814* DW	0.0004	0.026	*0.0636* DW	<0.000005	0.00172	0.0139	0.0005	0.88	<0.00005	0.281	<0.00001	<0.0001	0.0085	0.00141	0.0034	0.0053	0.0006
DC-SW7	05-Oct-21	26254211005317	0.128	0.0005	0.00423	0.0284	<0.00005	<0.0001	0.29	0.00002	<0.0005	<0.0005	<0.01	*0.0017* DW	0.0015	*0.435* DW	0.0002	0.0303	*0.0743* DW	<0.000005	0.00196	0.0154	0.0004	0.65	<0.00005	0.343	<0.00001	<0.0001	0.0024	0.00172	0.0036	0.005	<0.0005
B.C. Approved WQG - Drinking Water (DW)[BCSW1]			**9.5[MAC]**	**0.006[MAC]**	**0.01[MAC]**	**NS**	**NS**	**NS**	**5[MAC]**	**0.005[MAC]**	**0.05[MAC]**	**NS**	**NS**	**0.001[MAC]**	**1[AO]**	**0.3[AO]**	**0.005[MAC]**	**NS**	**0.02[AO]**	**0.001[MAC]**	**0.088[MAC]**	**0.08[MAC]**	**0.01[MAC]**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.02[MAC]**	**NS**	**3[MAC]**	**NS**
B.C. Approved WQG - Freshwater Aquatic Life (FAL)[BCSW2]			**NS[DM]**	**NS**	**0.005[ST]**	**NS**	**NS**	**NS**	**1.2[mean]**	**NS[DM]**	**NS**	**NS**	**NS**	**0.004[mean]**	**NS[DM]**	**1.0[ST]**	**H[mean]**	**NS**	**H[mean]**	**MeHg[mean]**	**7.6[mean]**	**NS**	**0.001[mean]**	**NS**	**H[mean]**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**H[mean]**	**NS**
B.C. Approved WQG - Irrigation Water (Irr)[BCSW2]			**5**	**NS**	**0.1[ST]**	**NS**	**NS**	**NS**	**0.5[mean,crop]**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.2[ST]**	**NS**	**0.2[ST]**	**NS**	**NS**	**0.002[ST]**	**0.01[mean,crop]**	**NS**	**0.01[mean]**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**soil pH**	**NS**
B.C. Approved WQG - Livestock Water (LW)[BCSW2]			**5**	**NS**	**0.025[ST]**	**NS**	**NS**	**NS**	**5[mean]**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.3[mean]**	**NS**	**0.1[ST]**	**NS**	**NS**	**0.003[ST]**	**0.016**	**NS**	**0.03[mean]**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**2[mean]**	**NS**
B.C. Approved WQG - Wildlife Water (WW)[BCSW2]			**5**	**NS**	**0.025[ST]**	**NS**	**NS**	**NS**	**5[mean]**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.3[mean]**	**NS**	**0.1[ST]**	**NS**	**NS**	**MeHg[mean]**	**0.034**	**NS**	**0.002[mean]**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
B.C. Working WQG - Freshwater Aquatic Life (FAL)[BCSW4]			**NS**	**0.009[mean,Sb3]**	**NS**	**1[mean]**	**0.00013[mean]**	**NS**	**NS**	**NS**	**0.001[mean,Cr6]**	**0.0089[Cr3]**	**0.001[Cr6]**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**H[mean]**	**NS**	**NS**	**NS**	**NS**	**0.0008[mean,Riv]**	**NS**	**NS**	**0.0085[mean]**	**NS**	**NS**	**NS**
B.C. Working WQG - Irrigation Water (Irr)[BCSW4]			**NS**	**NS**	**NS**	**NS**	**0.1[mean]**	**NS**	**NS**	**0.0051[ST]**	**0.0049[mean,Cr3]**	**0.0049[Cr3]**	**0.008[Cr6]**	**0.05[mean,CU]**	**NS**	**NS**	**NS**	**0.75[mean,crop]**	**0.2[mean]**	**NS**	**NS**	**0.2[mean]**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.01[mean]**	**0.1[mean]**	**NS**	**NS**
B.C. Working WQG - Livestock Water (LW)[BCSW4]			**NS**	**NS**	**NS**	**NS**	**0.1[mean]**	**NS**	**NS**	**0.080[ST]**	**0.05[mean,Cr3,Cr6]**	**0.05[Cr3]**	**0.05[Cr6]**	**1[mean]**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**1[mean]**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.2[mean]**	**0.1[mean]**	**NS**	**NS**
B.C. Working WQG - Wildlife Water (WW)[BCSW4]			**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Notes:

NS - not specified

[AO] - aesthetic objective

[mean] - 30-day mean; calculated from at least 5 weekly samples taken in a period of 30 days

[Cr3] - guideline is for total Cr^{3+}

[Cr6] - guideline is for total Cr^{6+}

[crop] - guideline level is crop-dependent; criterion shown is most stringent value

[CU] - continuous or intermittent use on all soils, see applicable guideline for further details

[DM] - guideline available for dissolved metal

H - guideline is hardness dependent

[MAC] - maximum acceptable concentration

[ST] - short-term acute guideline

MeHg - guideline dependent upon concentration of MeHg (assumed to be ≤0.5 % where no value provided); see applicable guideline for further details

[Riv] - 30-day average, site-specific objective for the lower Columbia River, BC

[Sb3] - guideline is for Sb^{3+}

soil pH - guideline is dependent upon soil pH

[^] - there is no acid digestion method available to recover speciated chromium, these soluble analytes are reported as dissolved

[BCSW1] - *Source Drinking Water Quality Guidelines* (B.C. ENV 2020)

[BCSW2] - *British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture* (B.C. ENV 2021)

[BCSW4] - *British Columbia Working Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture* (B.C. ENV 2021)

Italics - indicates value does not meet Working Water Quality Guidelines

Italics - indicates value does not meet Approved Water Quality Guidelines

TABLE 5i

Surface Water Quality Results - Hydrocarbons

Peace River Regional District
PRRD Landfill - Dawson Creek

Sample Point	Sample Date	MSI Sample Number	Benzene mg/L	Toluene mg/L	Ethylbenzene mg/L	Xylenes mg/L	Styrene mg/L	VPHw (C_6-C_{10}) mg/L	VHw (C_6-C_{10}) mg/L	EPHw (C_{10}-C_{19}) mg/L	EPHw (C_{19}-C_{32}) mg/L
DC-SW2	19-May-21	26254210519077	<0.0010	<0.0005	<0.0010	<0.0010	<0.0010	<0.05	<0.05	<0.2	<0.2
DC-SW4	19-May-21	26254210519078	<0.0010	<0.0005	<0.0010	<0.0010	<0.0010	<0.05	<0.05	<0.2	<0.2
DC-SW6	19-May-21	26254210519076	<0.0010	<0.0005	<0.0010	<0.0010	<0.0010	<0.05	<0.05	<0.2	<0.2
DC-SW7	19-May-21	26254210519075	<0.0010	<0.0005	<0.0010	<0.0010	<0.0010	<0.05	<0.05	<0.2	<0.2
B.C. Approved WQG - Drinking Water (DW)[BCSW1]			**0.005[MAC]**	**0.024[AO]**	**0.0016[AO]**	**0.02[AO]**	**NS**	**NS**	**NS**	**NS**	**NS**
B.C. Approved WQG - Freshwater Aquatic Life (FAL)[BCSW2]			**0.04[mean]**	**0.0005[mean]**	**0.2[mean]**	**0.03[mean]**	**NS**	**NS**	**NS**	**NS**	**NS**
B.C. Approved WQG - Irrigation Water (Irr)[BCSW2]			**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
B.C. Approved WQG - Livestock Water (LW)[BCSW2]			**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
B.C. Approved WQG - Wildlife Water (WW)[BCSW2]			**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
B.C. Working WQG - Freshwater Aquatic Life (FAL)[BCSW4]			**NS**	**NS**	**NS**	**NS**	**0.072**	**NS**	**NS**	**NS**	**NS**
B.C. Working WQG - Irrigation Water (Irr)[BCSW4]			**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
B.C. Working WQG - Livestock Water (LW)[BCSW4]			**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
B.C. Working WQG - Wildlife Water (WW)[BCSW4]			**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Notes:

NS - not specified
AO - aesthetic objective
mean - 30-day mean; calculated from at least 5 weekly samples taken in a period of 30 days
MAC - maximum acceptable concentration
VPHw (C_6-C_{10}) - does not include BTEX
BCSW1 - *Source Drinking Water Quality Guidelines* (B.C. ENV 2020)
BCSW2 - *British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture* (B.C. ENV 2021)
BCSW4 - *British Columbia Working Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture* (B.C. ENV 2021)
Italics - indicates value does not meet Working Water Quality Guidelines
Italics - indicates value does not meet Approved Water Quality Guidelines

TABLE 5j

Surface Water Quality Results - Microbiological Parameters

Peace River Regional District

PRRD Landfill - Dawson Creek

Sample Point	Sample Date	MSI Sample Number	Faecal Coliforms CFU/100mL	Total Coliforms CFU/100mL
DC-SW2	19-May-21	26254210519077	*10* LW	70
DC-SW2	14-Jul-21	26254210714219	*100* DW,FAL,LW	100
DC-SW2	05-Oct-21	26254211005316	*160* DW,FAL,LW	190
DC-SW4	19-May-21	26254210519078	<10	330
DC-SW6	19-May-21	26254210519076	*40* DW,FAL,LW	500
DC-SW6	14-Jul-21	26254210714218	<10	20
DC-SW6	05-Oct-21	26254211005318	*10* LW	60
DC-SW7	19-May-21	26254210519075	*20* DW,FAL,LW	180
DC-SW7	14-Jul-21	26254210714217	*80* DW,FAL,LW	80
DC-SW7	05-Oct-21	26254211005317	*3000* DW,FAL,Irr,LW	3000
B.C. Approved WQG - Drinking Water (DW)[BCSW1]			**10[MAC]**	**NS**
B.C. Approved WQG - Freshwater Aquatic Life (FAL)[BCSW2]			**14[mean,shell]**	**NS**
B.C. Approved WQG - Irrigation Water (Irr)[BCSW2]			**200[geo,irr]**	**NS**
B.C. Approved WQG - Livestock Water (LW)[BCSW2]			**0[animal]**	**NS**
B.C. Approved WQG - Wildlife Water (WW)[BCSW2]			**NS**	**NS**
B.C. Working WQG - Freshwater Aquatic Life (FAL)[BCSW4]			**NS**	**NS**
B.C. Working WQG - Irrigation Water (Irr)[BCSW4]			**NS**	**NS**
B.C. Working WQG - Livestock Water (LW)[BCSW4]			**NS**	**NS**
B.C. Working WQG - Wildlife Water (WW)[BCSW4]			**NS**	**NS**

Notes:

CFU - colony forming units

NS - not specified

mean - 30-day mean; calculated from at least 5 weekly samples taken in a period of 30 days

animal - guideline level is enclosure-dependent; criterion shown is most stringent value

geo - geometric mean

MAC - maximum acceptable concentration

shell - shelfish harvesting

BCSW1 - *Source Drinking Water Quality Guidelines* (B.C. ENV 2020)

BCSW2 - *British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture* (B.C. ENV 2021)

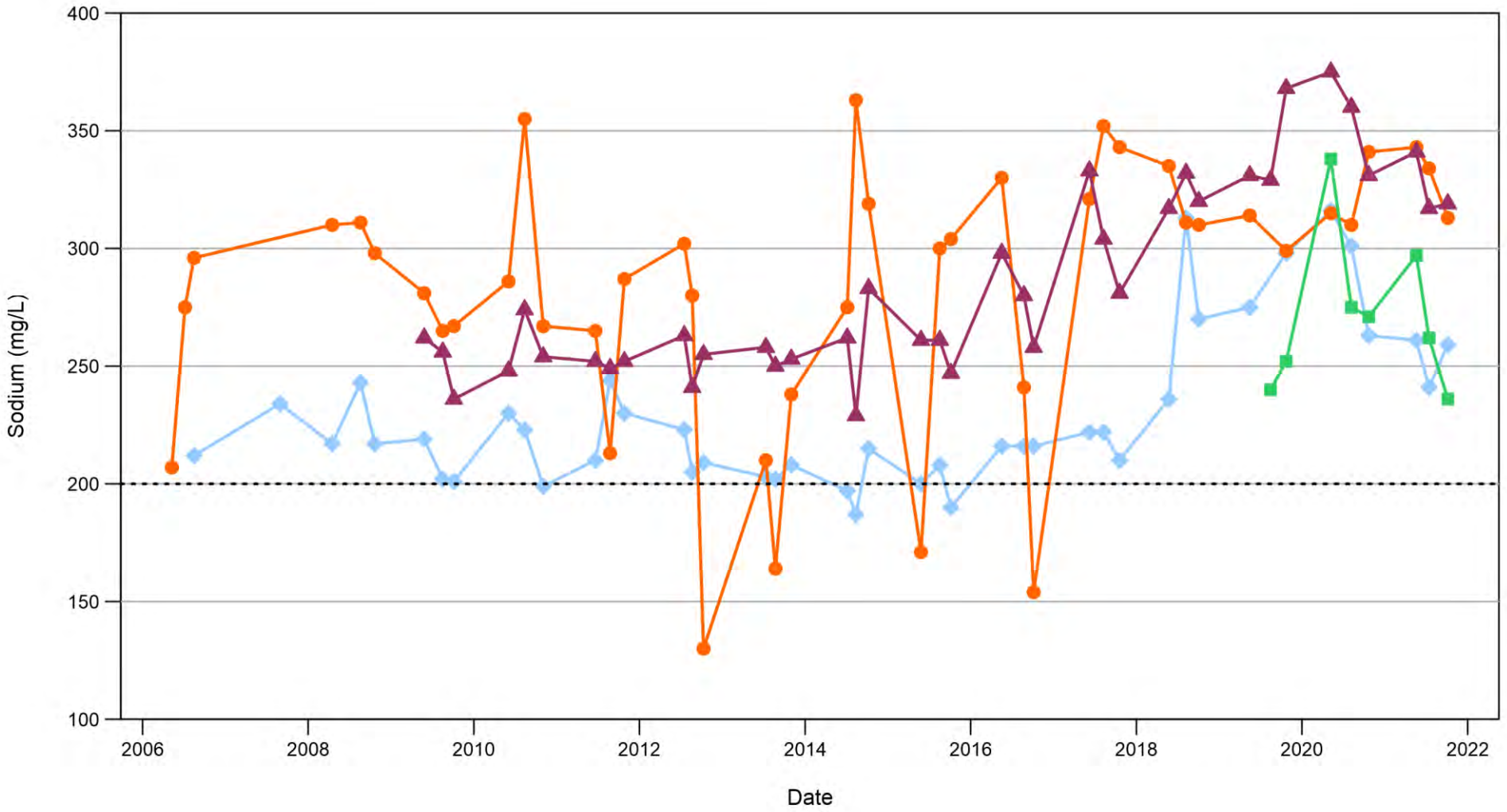
BCSW4 - *British Columbia Working Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture* (B.C. ENV 2021)

Italics - indicates value does not meet Working Water Quality Guidelines

Italics - indicates value does not meet Approved Water Quality guidelines, resampling is recommended to confirm the presence of coliforms

Appendix D

Historical groundwater and Surface Water Concentration Versus Time Plots (2021 Annual Monitoring Report)



DC-95-2
DC-98-1
DC-BH101
DC-19-1

B.C. CSR 375/96 - Drinking Water Standards (2021) = 200 mg/L

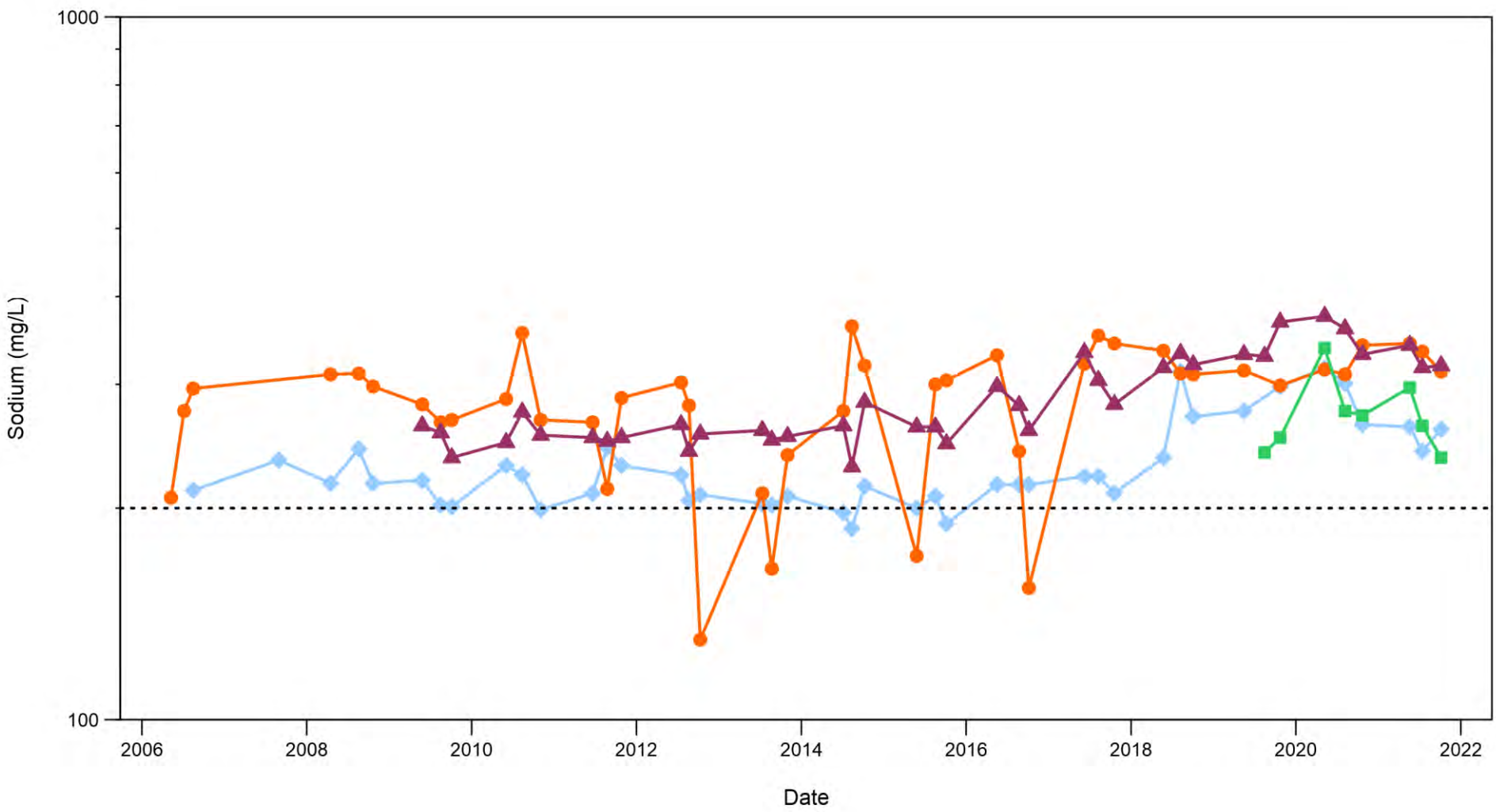
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Historical Groundwater Sodium Concentrations

Date:	Project:	Submitter:	Reviewer:
04 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5a



DC-95-2
DC-98-1
DC-BH101
DC-19-1

B.C. CSR 375/96 - Drinking Water Standards (2021) = 200 mg/L

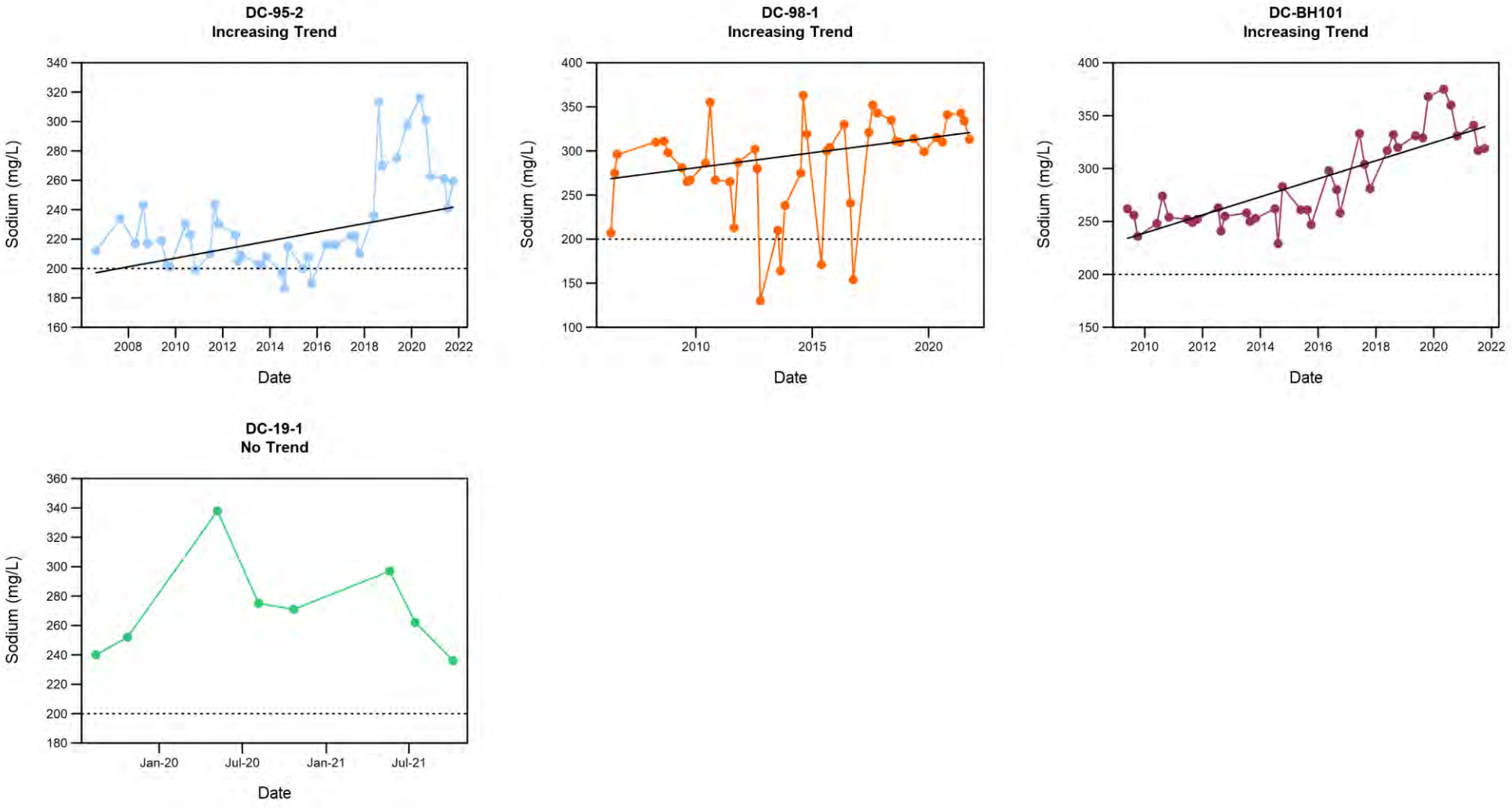
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Historical Groundwater Sodium Concentrations

Date:	Project:	Submitter:	Reviewer:
04 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5a



Sodium
Sen slope
B.C. CSR 375/96 - Drinking Water Standards (2021) = 200 mg/L

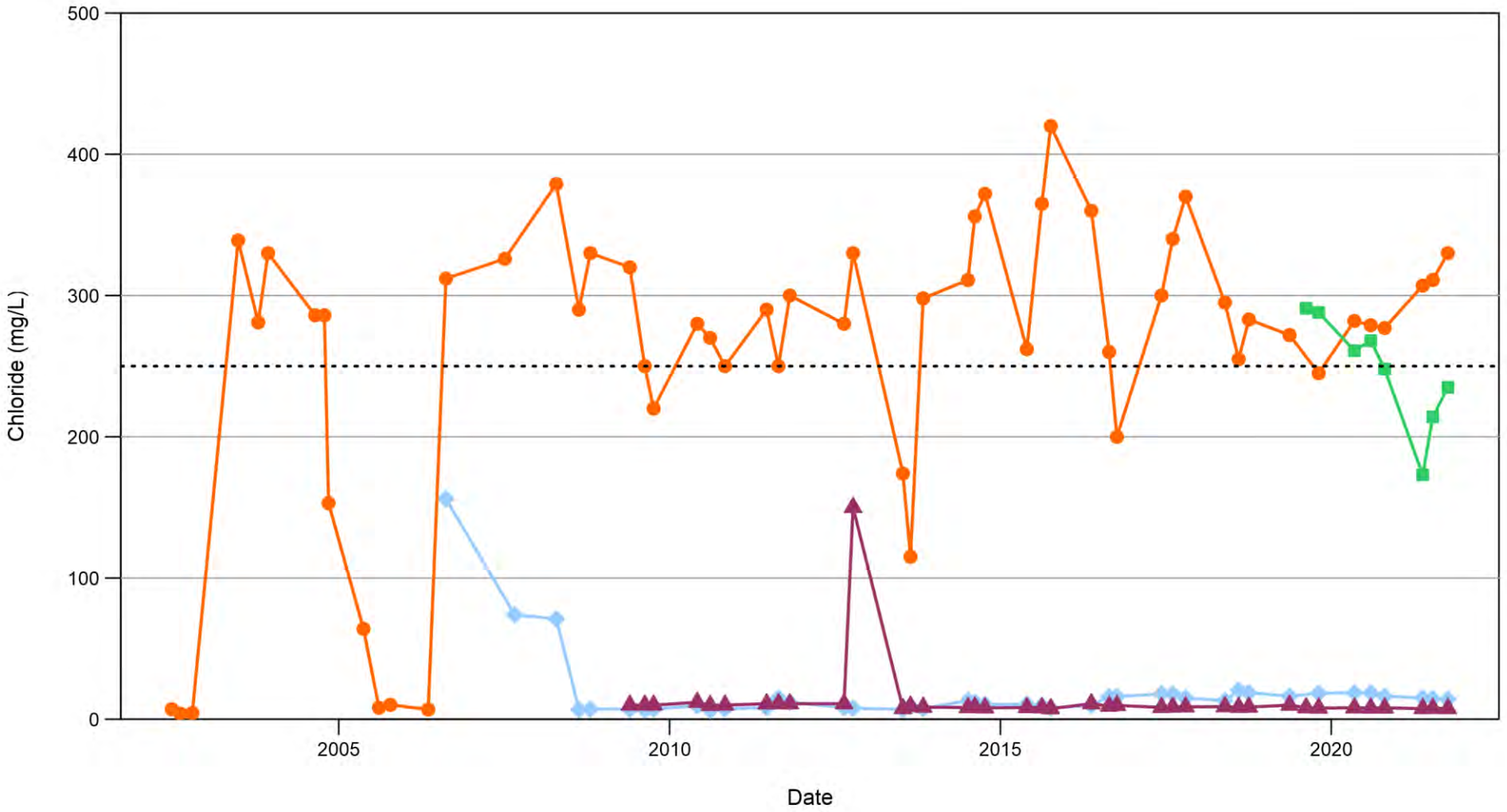
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Mann-Kendall Trend Analysis - Groundwater Sodium

Date:	Project:	Submitter:	Reviewer:
04 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5b



DC-95-2
DC-98-1
DC-BH101
DC-19-1

B.C. CSR 375/96 - Drinking Water Standards (2021) = 250 mg/L

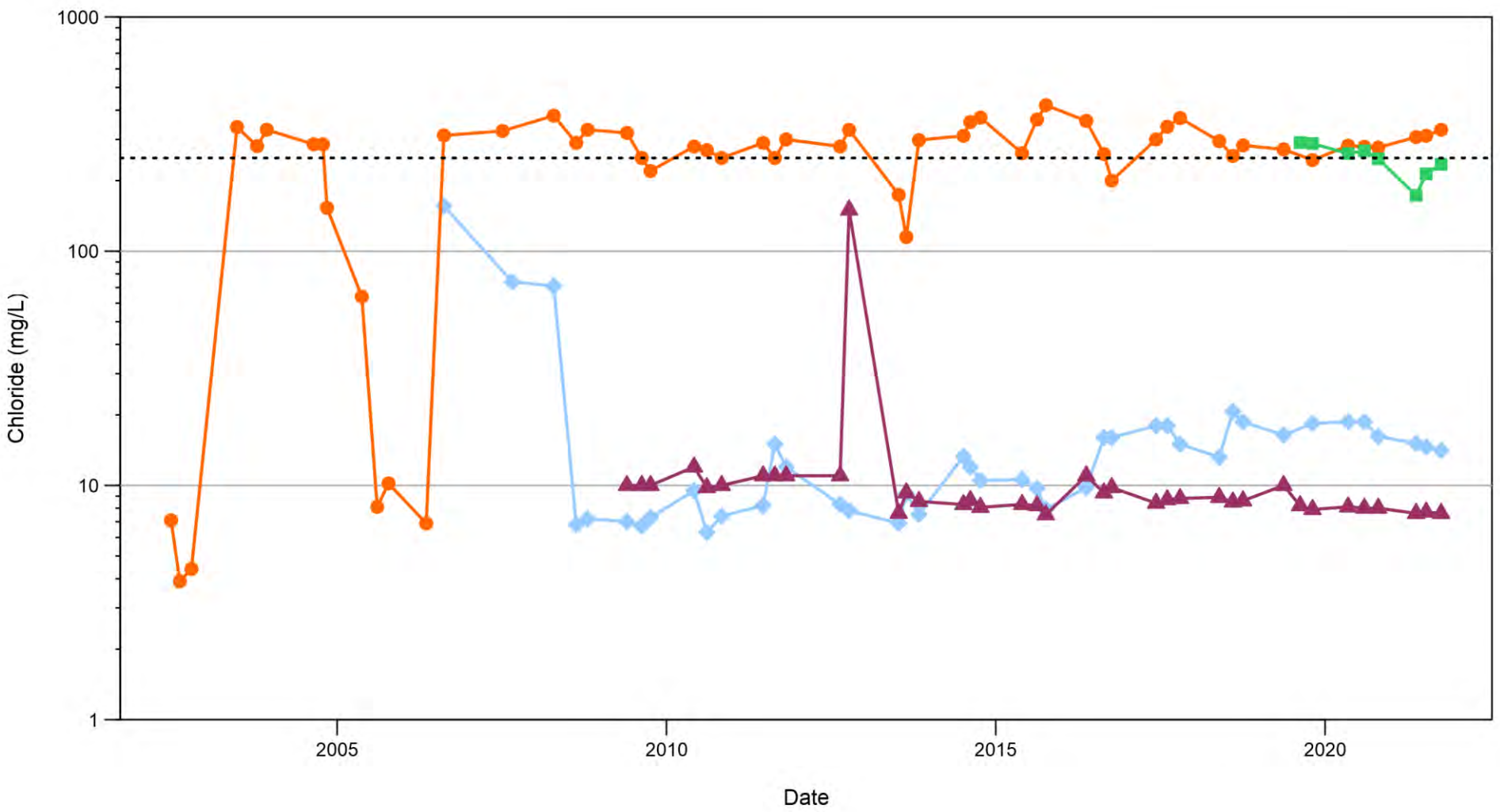
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Historical Groundwater Chloride Concentrations

Date:	Project:	Submitter:	Reviewer:
04 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5c



DC-95-2
DC-98-1
DC-BH101
DC-19-1

B.C. CSR 375/96 - Drinking Water Standards (2021) = 250 mg/L

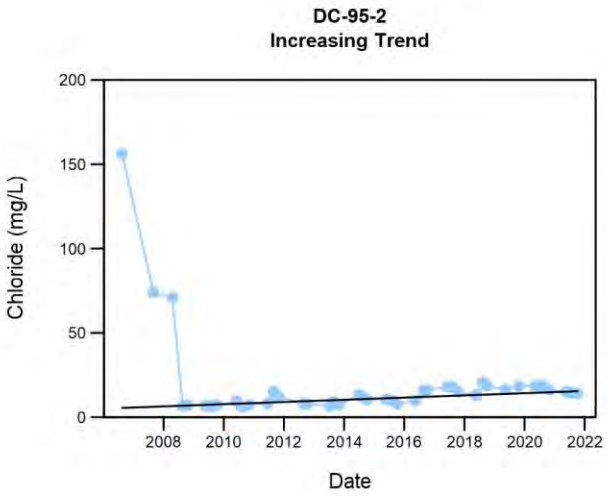
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

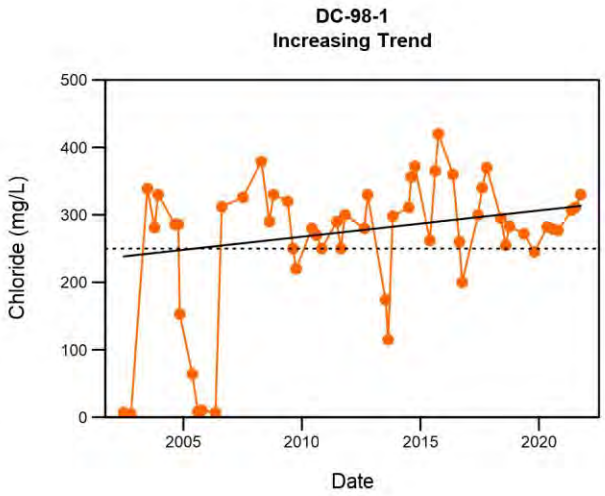
Peace River Regional District
Dawson Creek Landfill

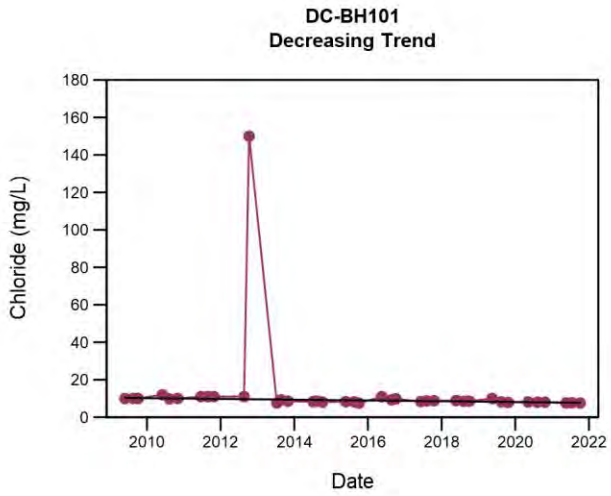
Historical Groundwater Chloride Concentrations

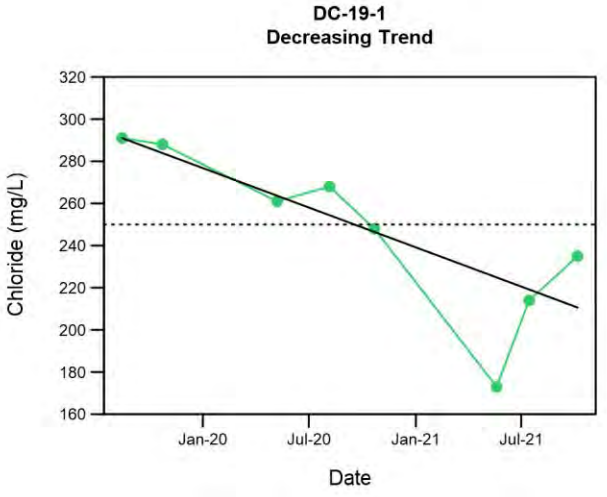
Date:	Project:	Submitter:	Reviewer:
04 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5c









Chloride
Sen slope
B.C. CSR 375/96 - Drinking Water Standards (2021) = 250 mg/L

Matrix Solutions Inc.
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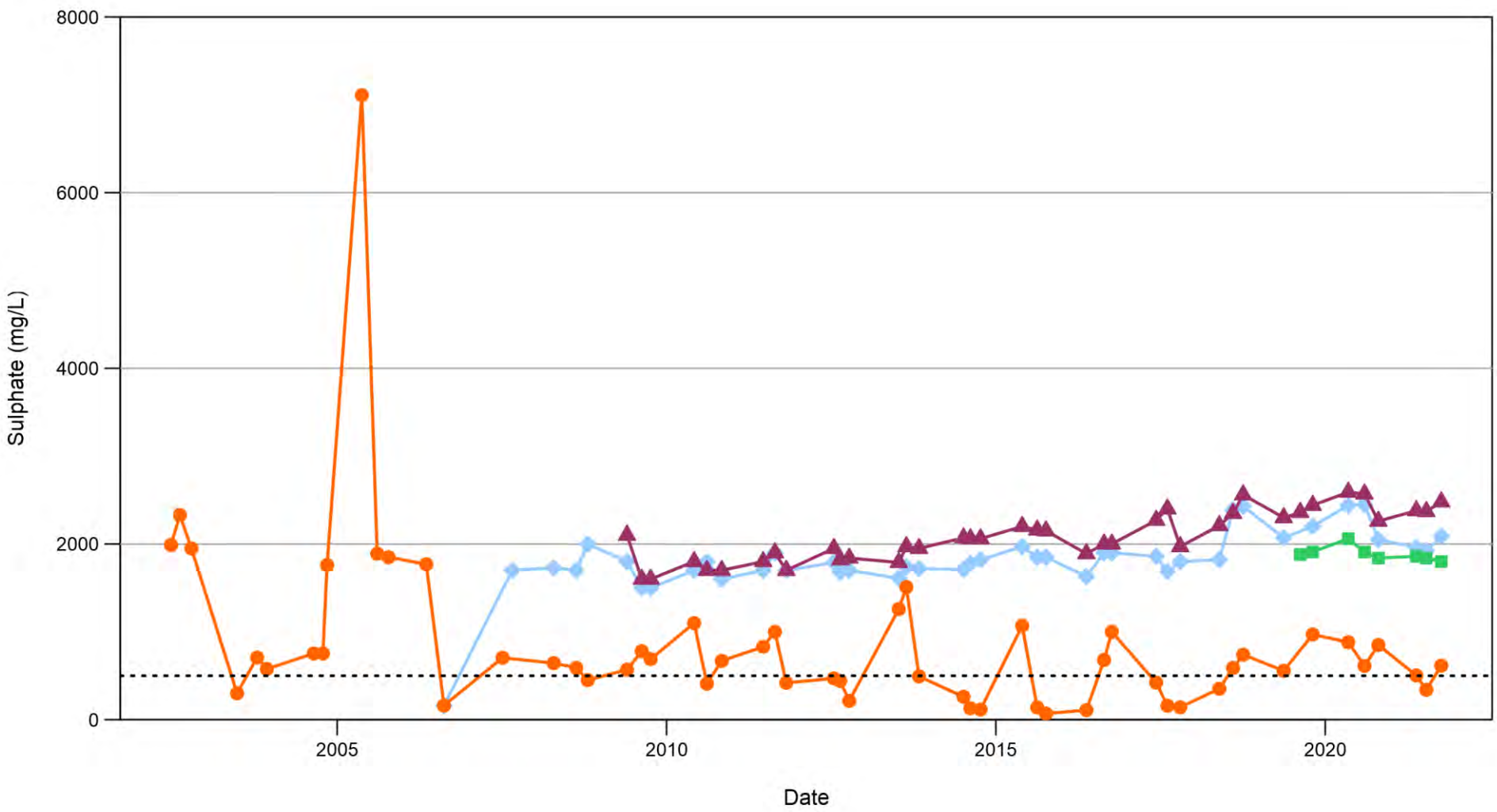
Peace River Regional District
Dawson Creek Landfill

Mann-Kendall Trend Analysis - Groundwater Chloride

Date:	Project:	Submitter:	Reviewer:
04 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5d



DC-95-2
DC-98-1
DC-BH101
DC-19-1

B.C. CSR 375/96 - Drinking Water Standards (2021) = 500 mg/L

Matrix Solutions Inc.
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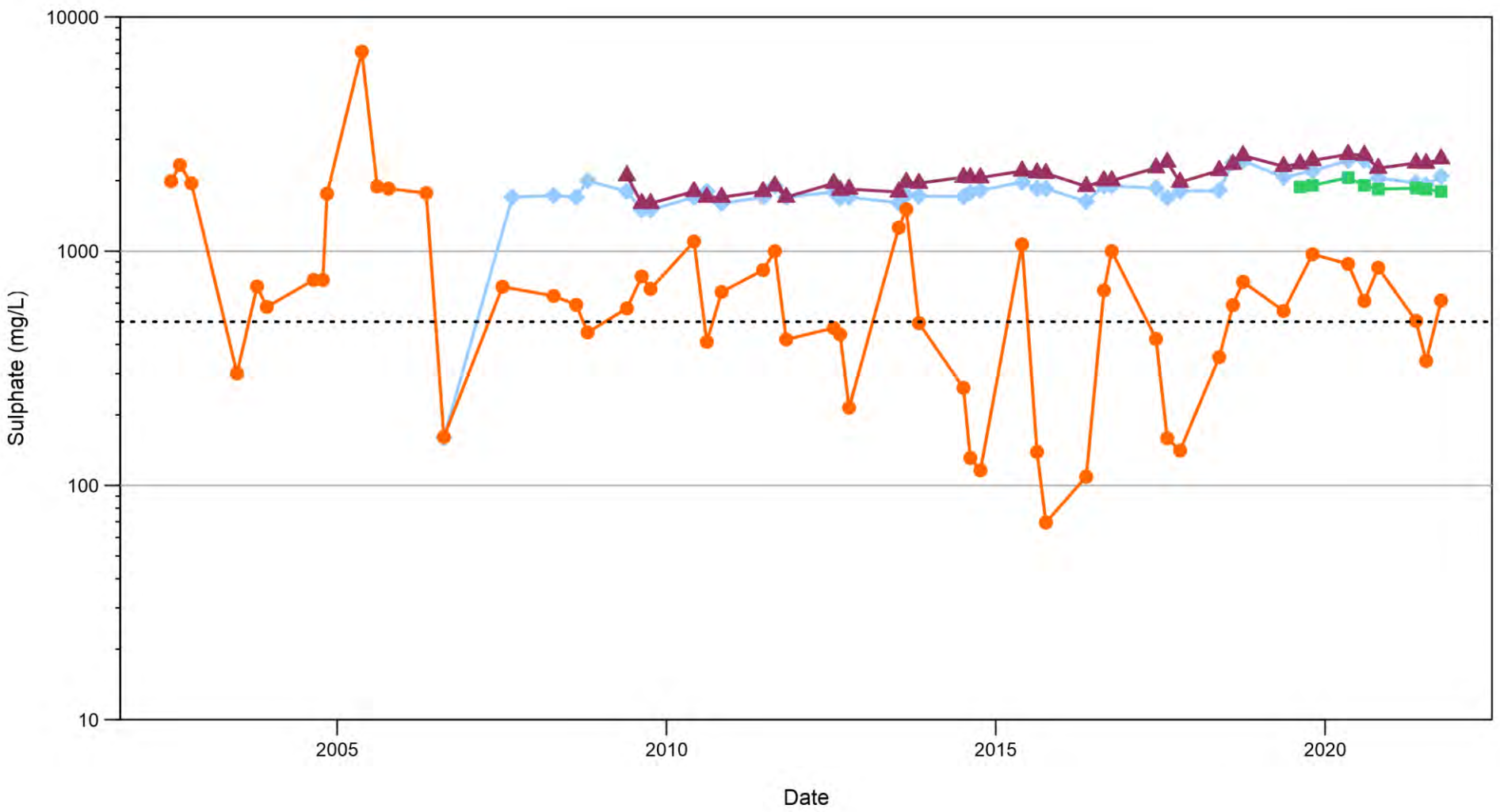
Peace River Regional District
Dawson Creek Landfill

Historical Groundwater Sulphate Concentrations

Date:	Project:	Submitter:	Reviewer:
04 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5e



DC-95-2
DC-98-1
DC-BH101
DC-19-1

B.C. CSR 375/96 - Drinking Water Standards (2021) = 500 mg/L

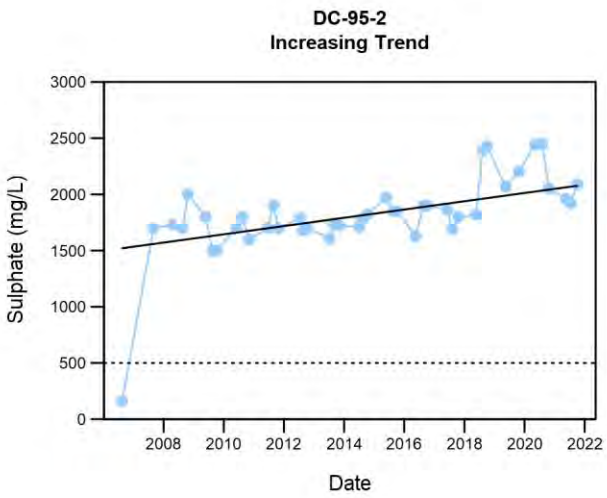
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

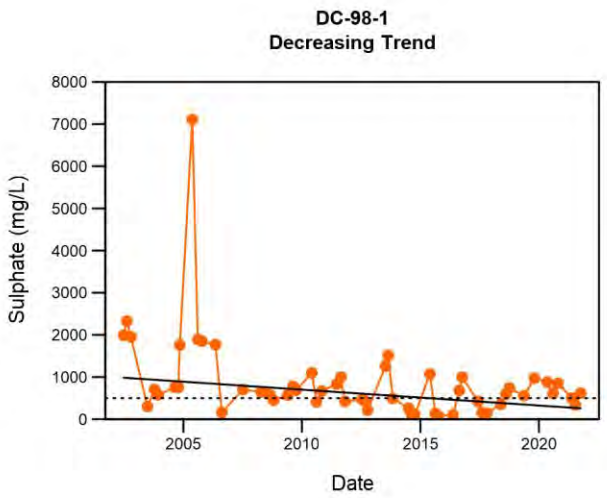
Peace River Regional District
Dawson Creek Landfill

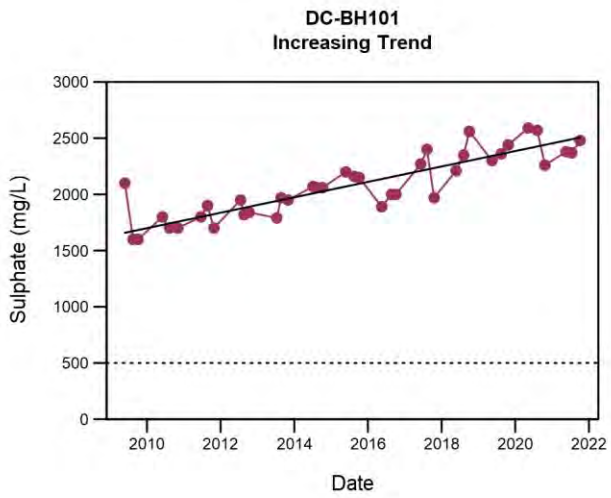
Historical Groundwater Sulphate Concentrations

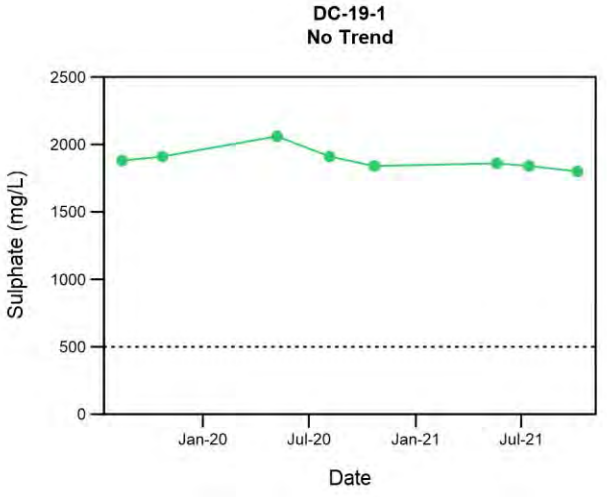
Date:	Project:	Submitter:	Reviewer:
04 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5e









Sulphate
Sen slope
B.C. CSR 375/96 - Drinking Water Standards (2021) = 500 mg/L

Matrix Solutions Inc.
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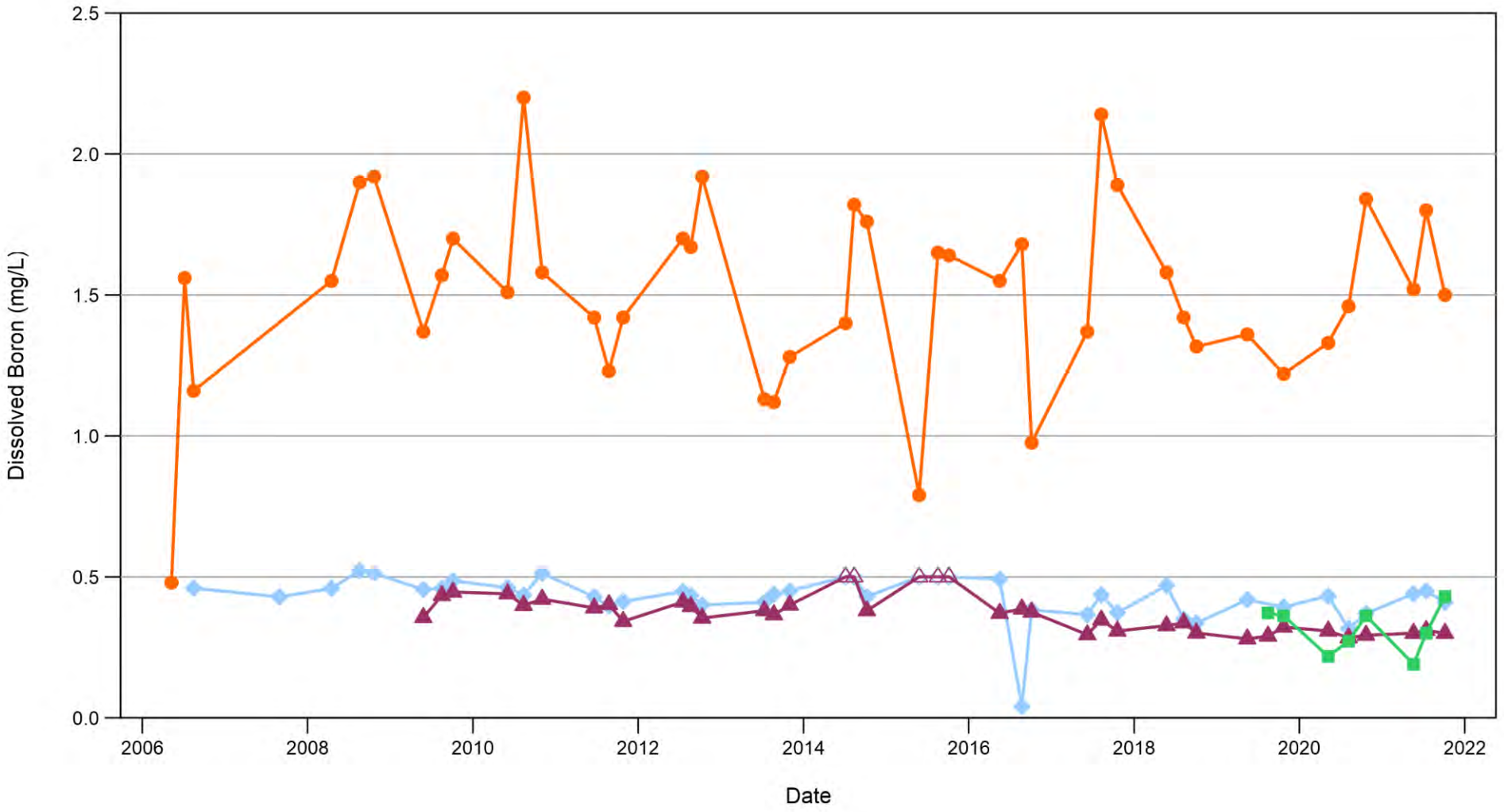
Peace River Regional District
Dawson Creek Landfill

Mann-Kendall Trend Analysis - Groundwater Sulphate

Date:	Project:	Submitter:	Reviewer:
04 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5f



DC-95-2
DC-98-1
DC-BH101
DC-19-1

Non Detect (Open Symbol)
B.C. CSR 375/96 - Drinking Water Standards (2021) = 5 mg/L

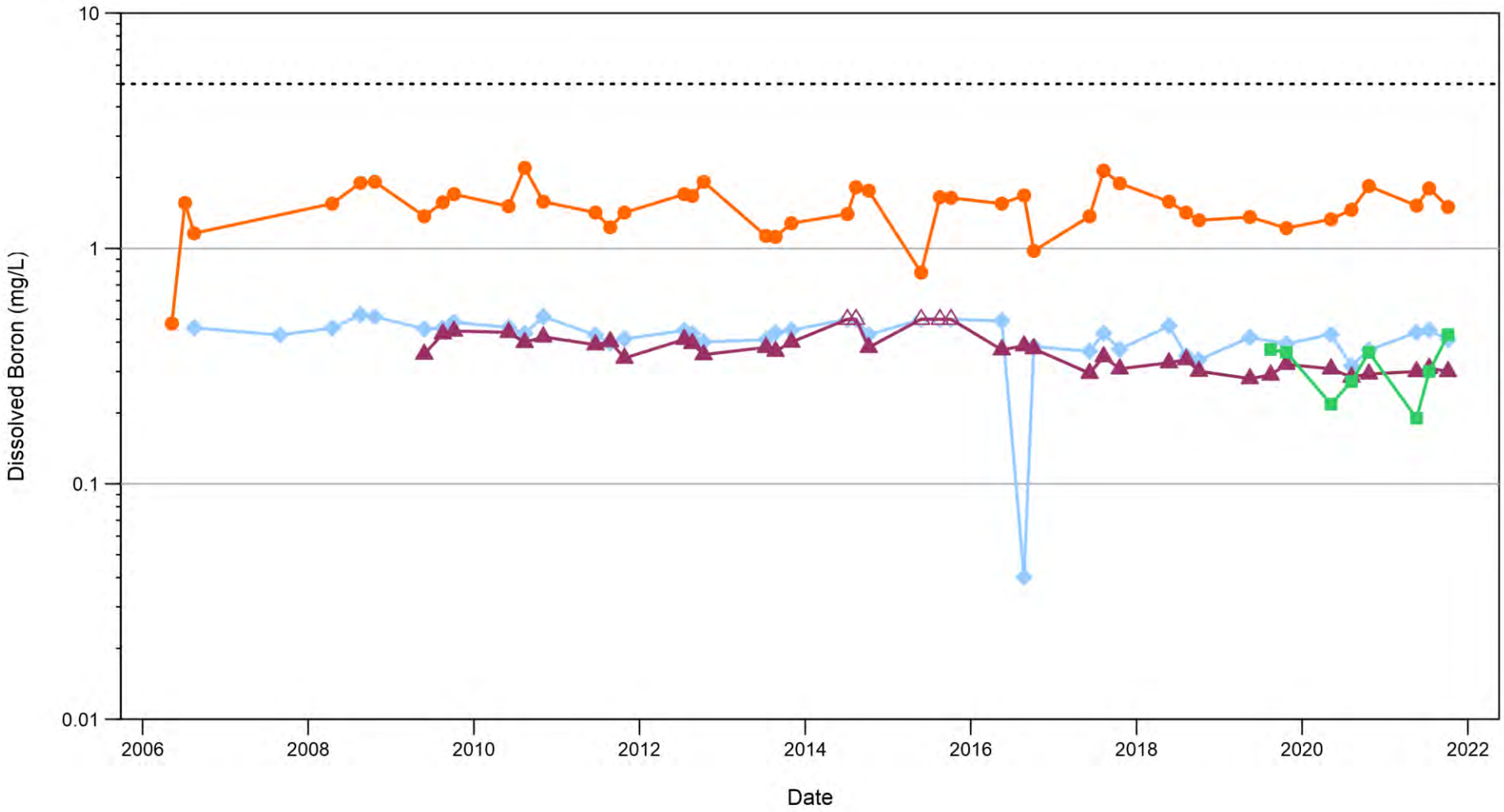
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Historical Groundwater Dissolved Boron Concentrations

Date:	Project:	Submitter:	Reviewer:
04 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5g



DC-95-2
DC-98-1
DC-BH101
DC-19-1

Non Detect (Open Symbol)
B.C. CSR 375/96 - Drinking Water Standards (2021) = 5 mg/L

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

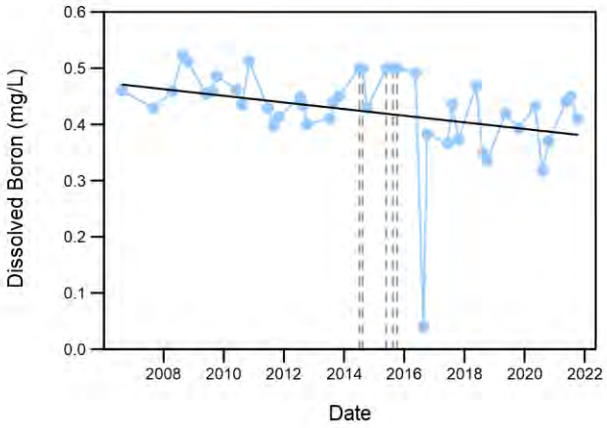
Peace River Regional District
Dawson Creek Landfill

Historical Groundwater Dissolved Boron Concentrations

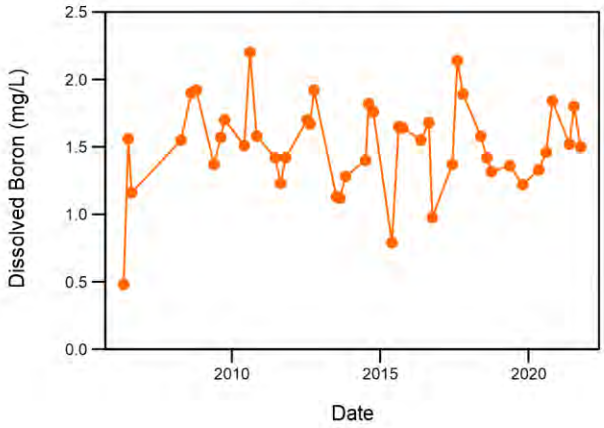
Date:	Project:	Submitter:	Reviewer:
04 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5g

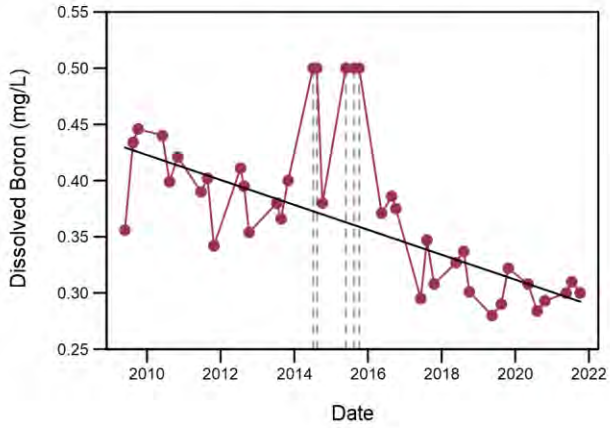
DC-95-2
Decreasing Trend



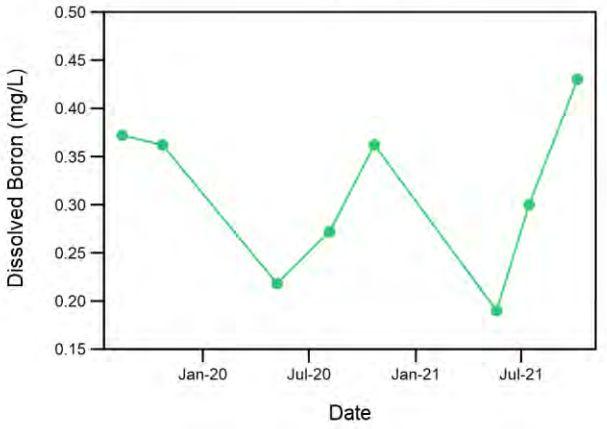
DC-98-1
No Trend



DC-BH101
Decreasing Trend



DC-19-1
No Trend



- Dissolved Boron
- Values below detection limit (DL)
- Sen slope
- B.C. CSR 375/96 - Drinking Water Standards (2021) = 5 mg/L

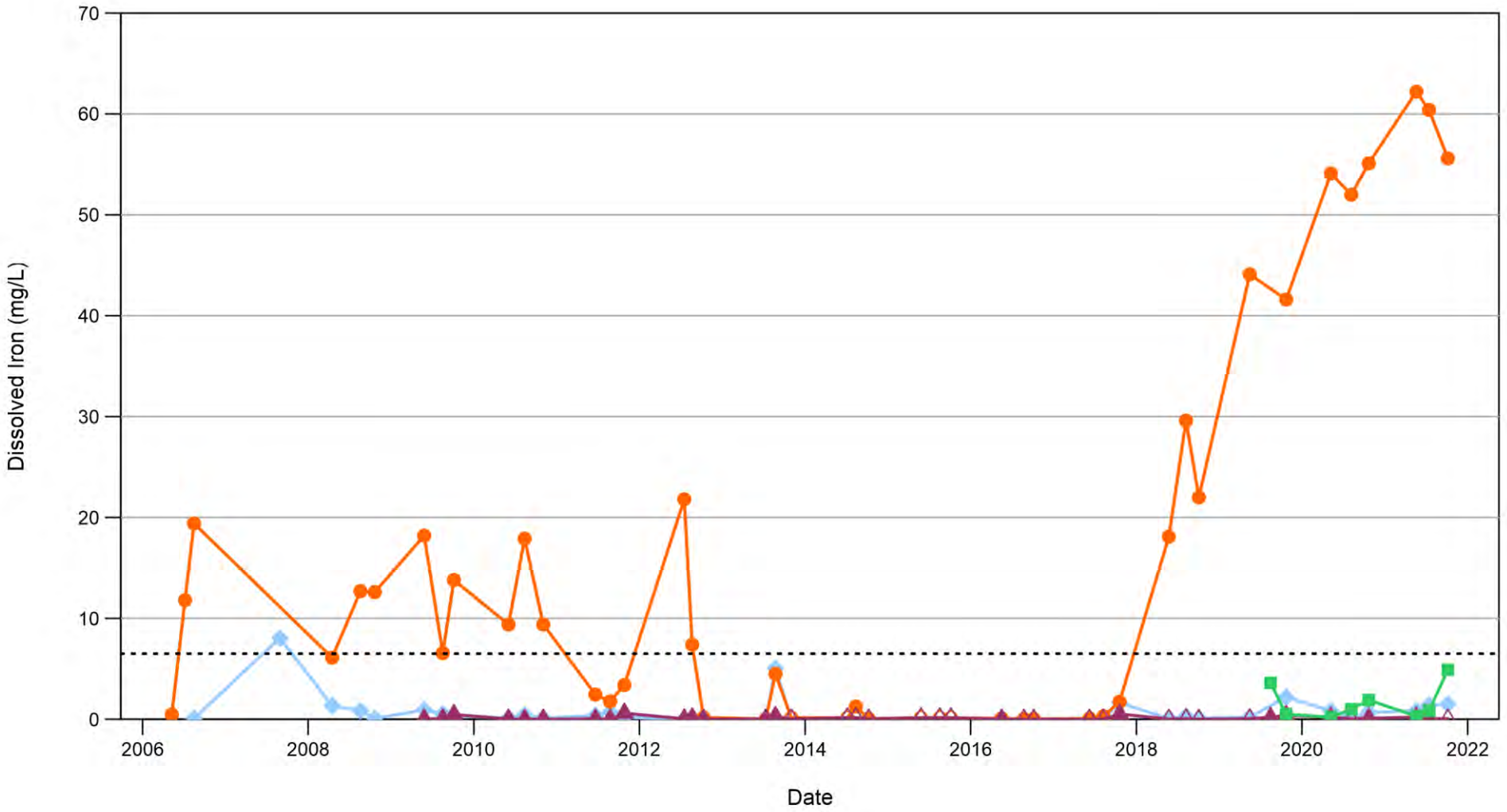
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Mann-Kendall Trend Analysis - Groundwater Dissolved Boron

Date:	Project:	Submitter:	Reviewer:
04 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5h



DC-95-2
DC-98-1
DC-BH101
DC-19-1

Non Detect (Open Symbol)
B.C. CSR 375/96 - Drinking Water Standards (2021) = 6.5 mg/L

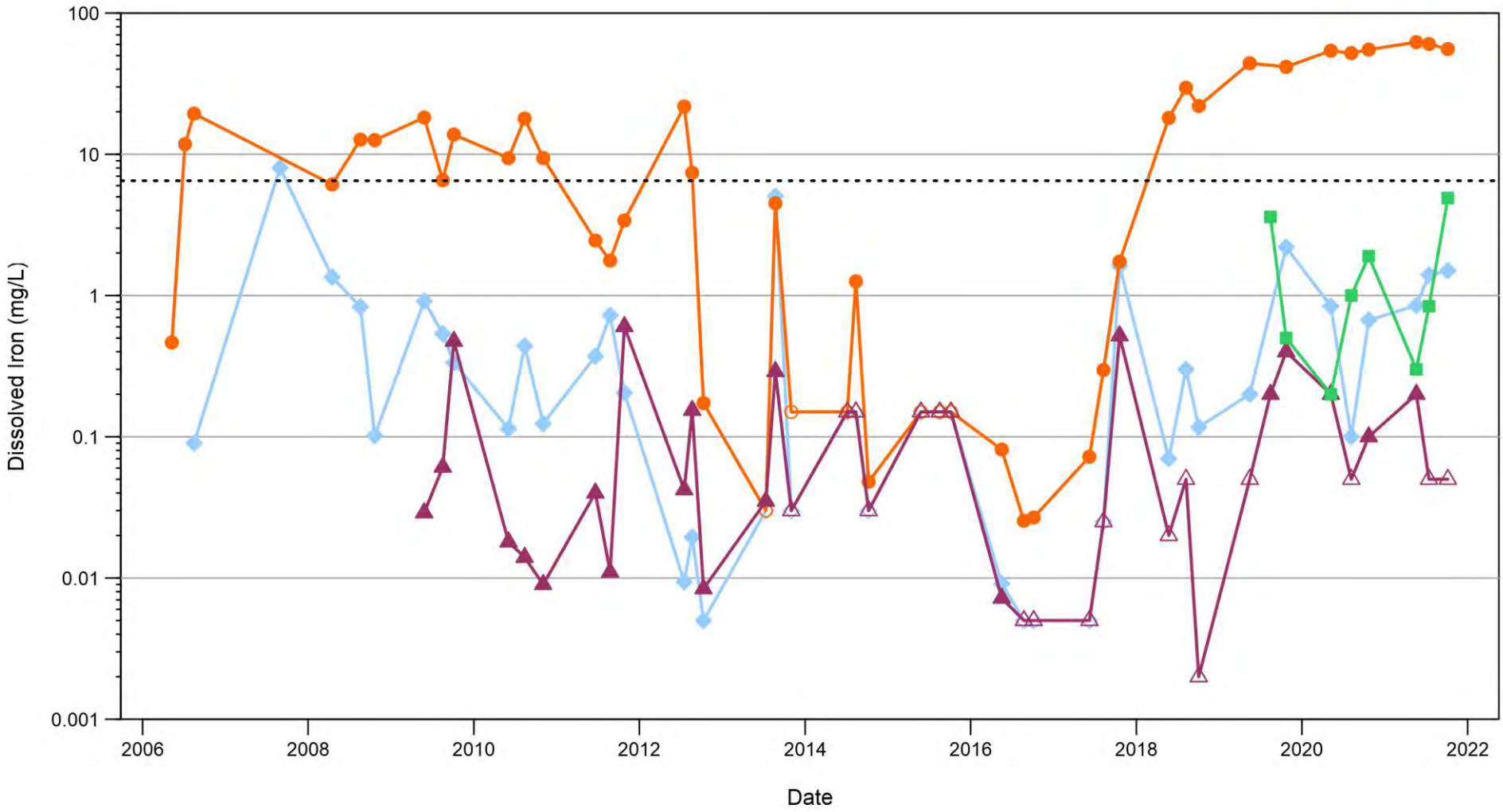
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Historical Groundwater Dissolved Iron Concentrations

Date:	Project:	Submitter:	Reviewer:
04 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5i



DC-95-2
DC-98-1
DC-BH101
DC-19-1

Non Detect (Open Symbol)
B.C. CSR 375/96 - Drinking Water Standards (2021) = 6.5 mg/L

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

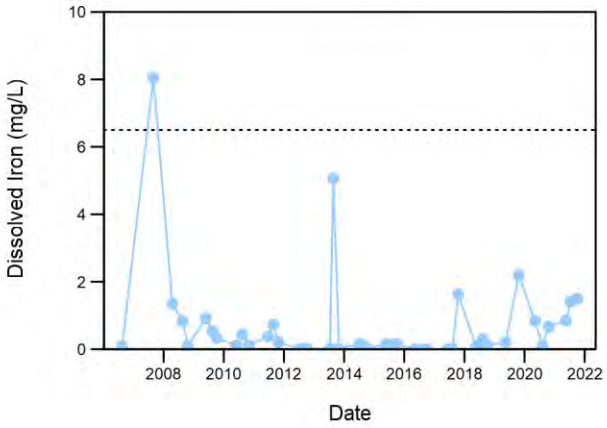
Peace River Regional District
Dawson Creek Landfill

Historical Groundwater Dissolved Iron Concentrations

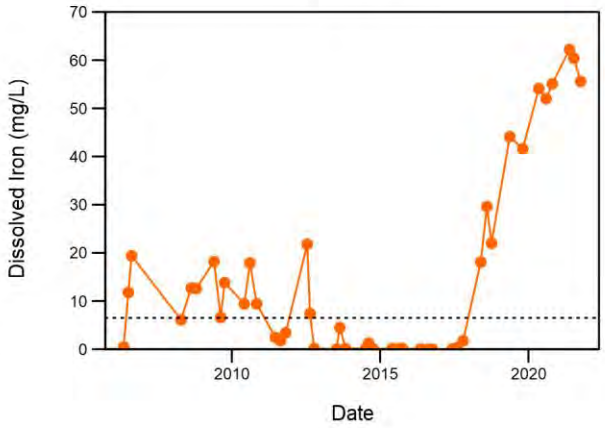
Date:	Project:	Submitter:	Reviewer:
04 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5i

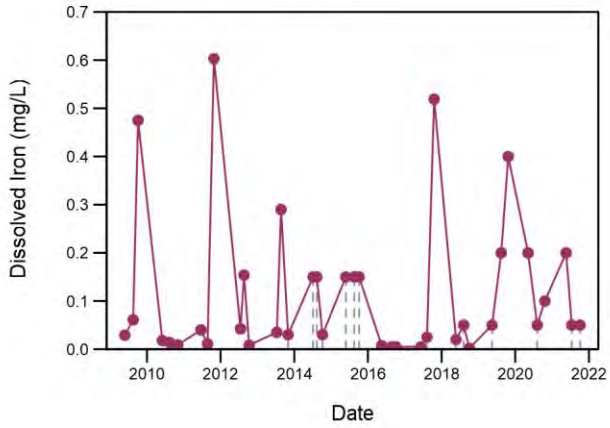
DC-95-2
No Trend



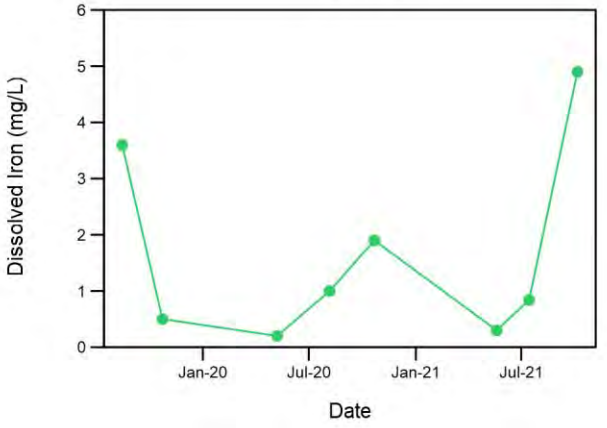
DC-98-1
No Trend



DC-BH101
No Trend



DC-19-1
No Trend



Dissolved Iron
Values below detection limit (DL)
B.C. CSR 375/96 - Drinking Water Standards (2021) = 6.5 mg/L

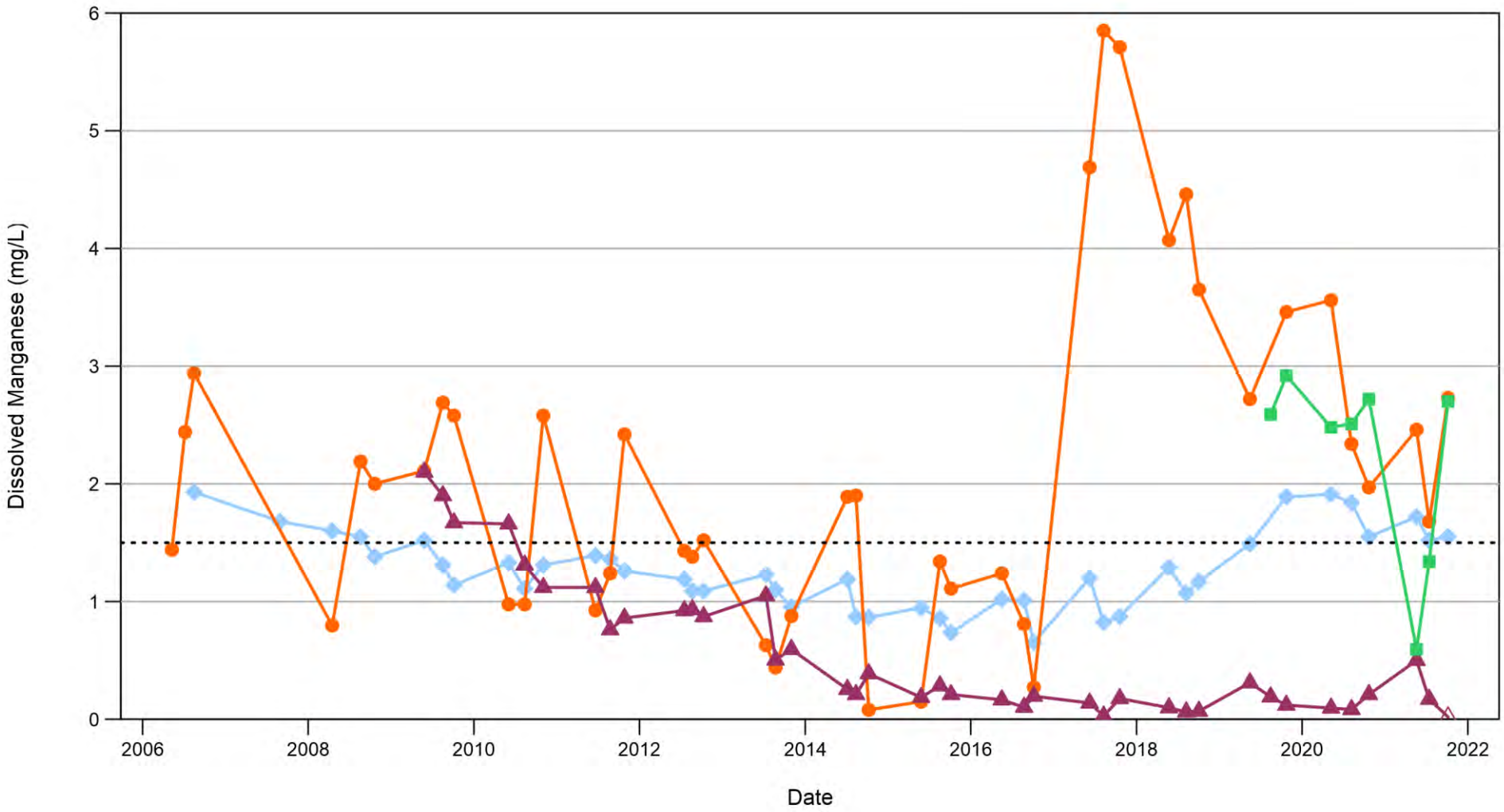
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Mann-Kendall Trend Analysis - Groundwater Dissolved Iron

Date:	Project:	Submitter:	Reviewer:
04 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5j



DC-95-2
DC-98-1
DC-BH101
DC-19-1

Non Detect (Open Symbol)
B.C. CSR 375/96 - Drinking Water Standards (2021) = 1.5 mg/L

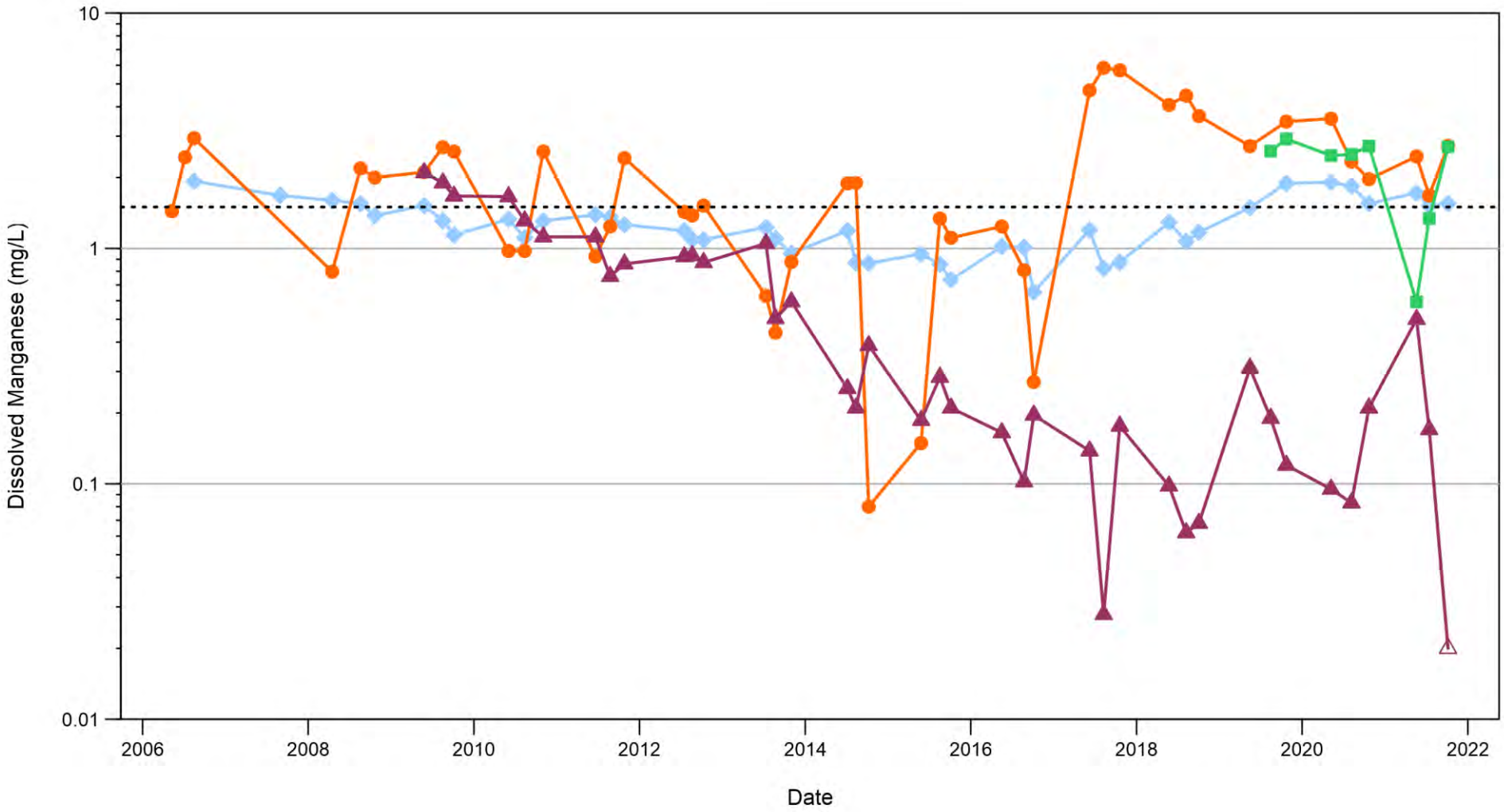
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Historical Groundwater Dissolved Manganese Concentrations

Date:	Project:	Submitter:	Reviewer:
04 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5k



DC-95-2
DC-98-1
DC-BH101
DC-19-1

Non Detect (Open Symbol)
B.C. CSR 375/96 - Drinking Water Standards (2021) = 1.5 mg/L

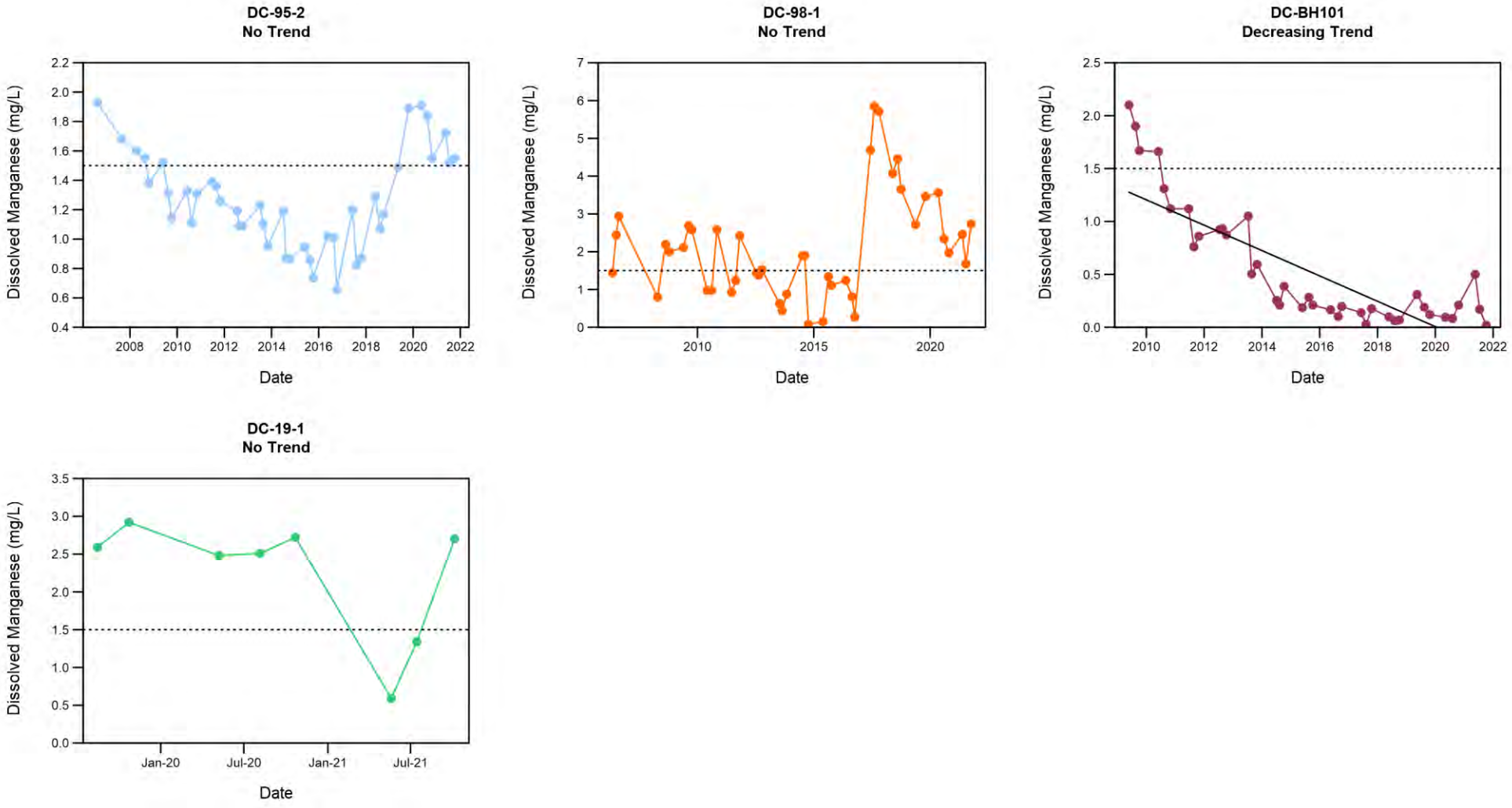
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Historical Groundwater Dissolved Manganese Concentrations

Date:	Project:	Submitter:	Reviewer:
04 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5k



- Dissolved Manganese
- Values below detection limit (DL)
- Sen slope
- B.C. CSR 375/96 - Drinking Water Standards (2021) = 1.5 mg/L

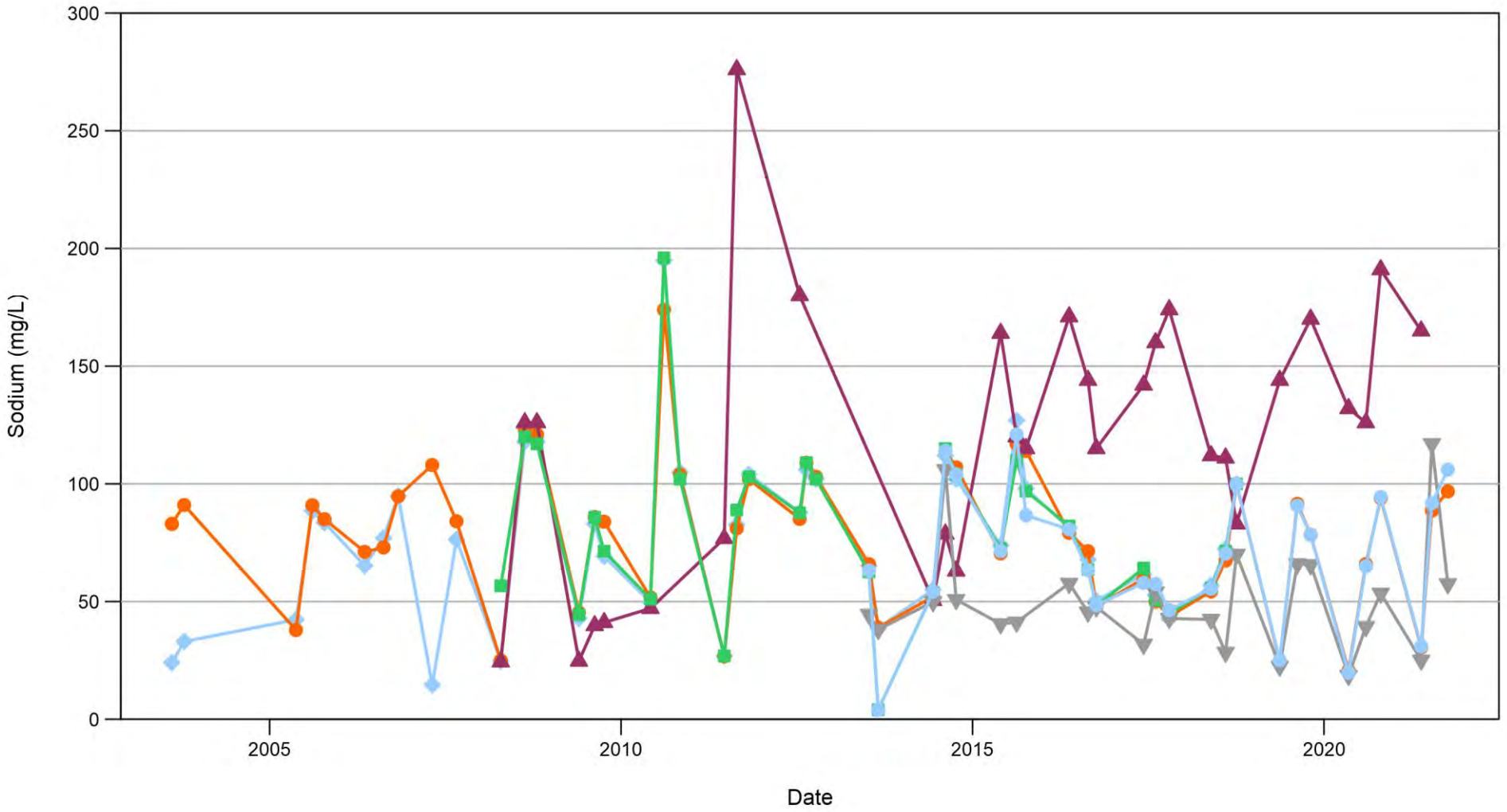
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Mann-Kendall Trend Analysis - Groundwater Dissolved Manganese

Date:	Project:	Submitter:	Reviewer:
04 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5I



DC-SW1
DC-SW2
DC-SW4
DC-SW5
DC-SW6
DC-SW7

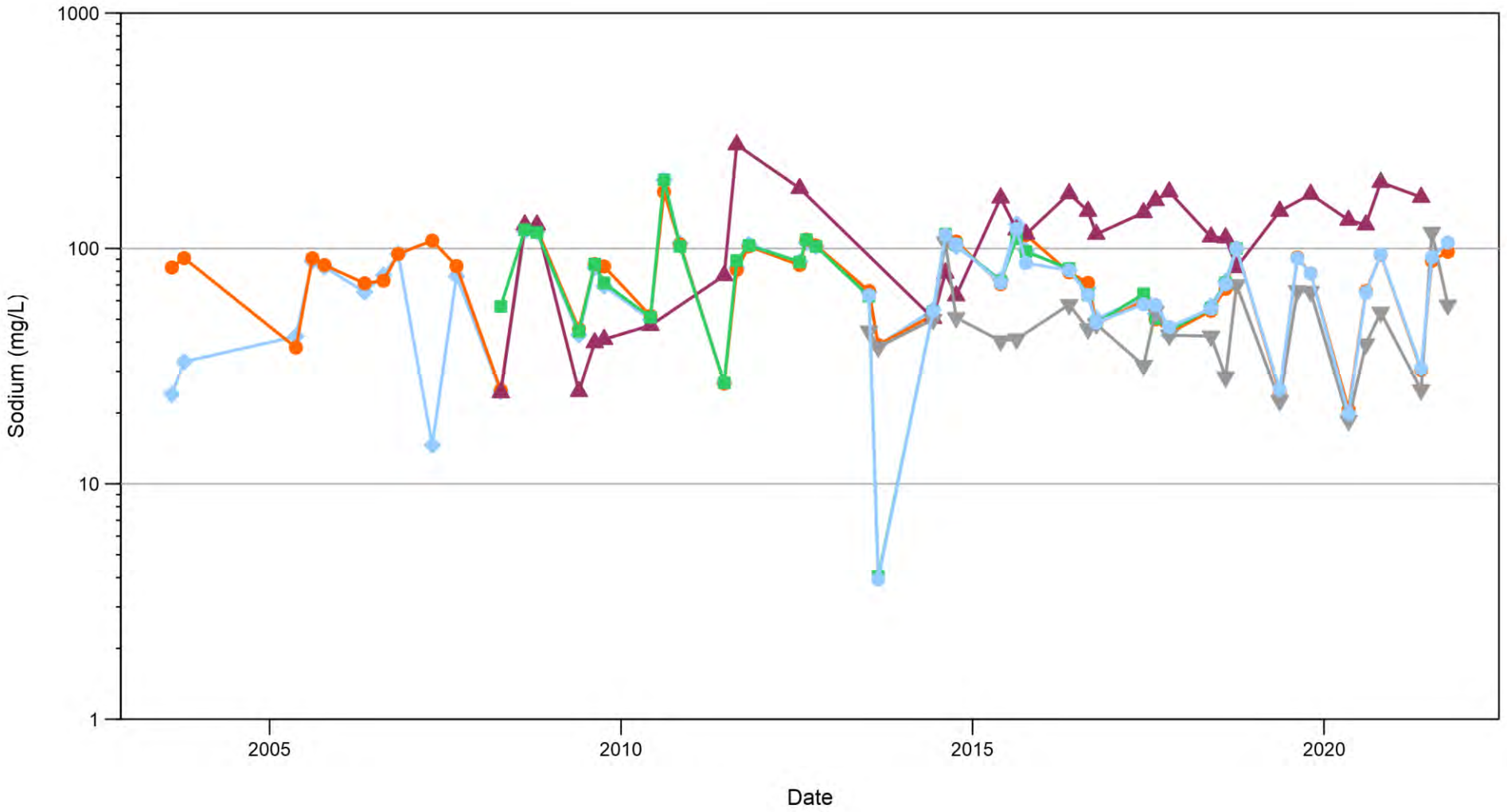
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Historical Surface Water Sodium Concentrations

Date:	Project:	Submitter:	Reviewer:
23 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5m



DC-SW1
DC-SW2
DC-SW4
DC-SW5
DC-SW6
DC-SW7

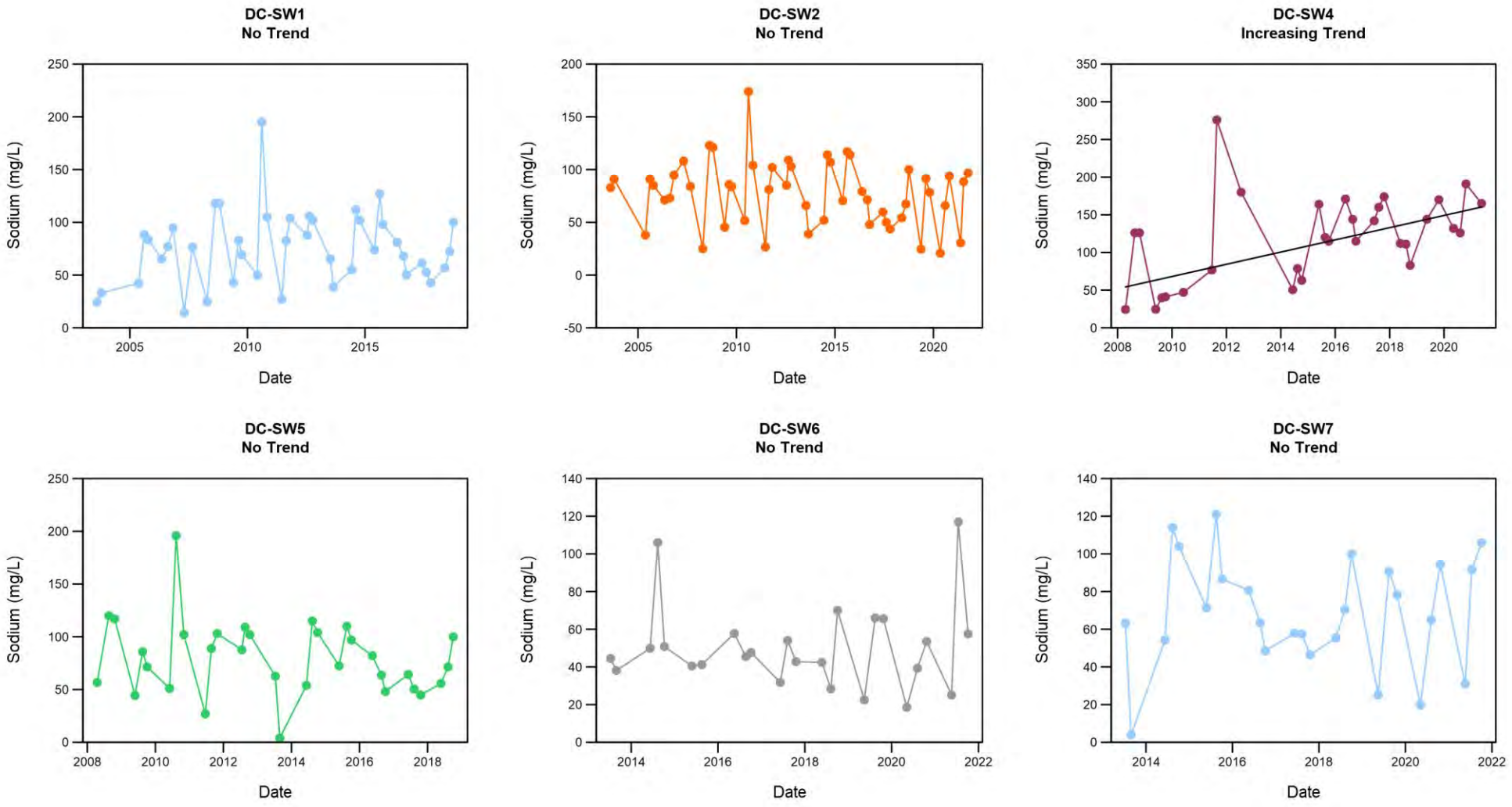
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Historical Surface Water Sodium Concentrations

Date:	Project:	Submitter:	Reviewer:
23 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5m



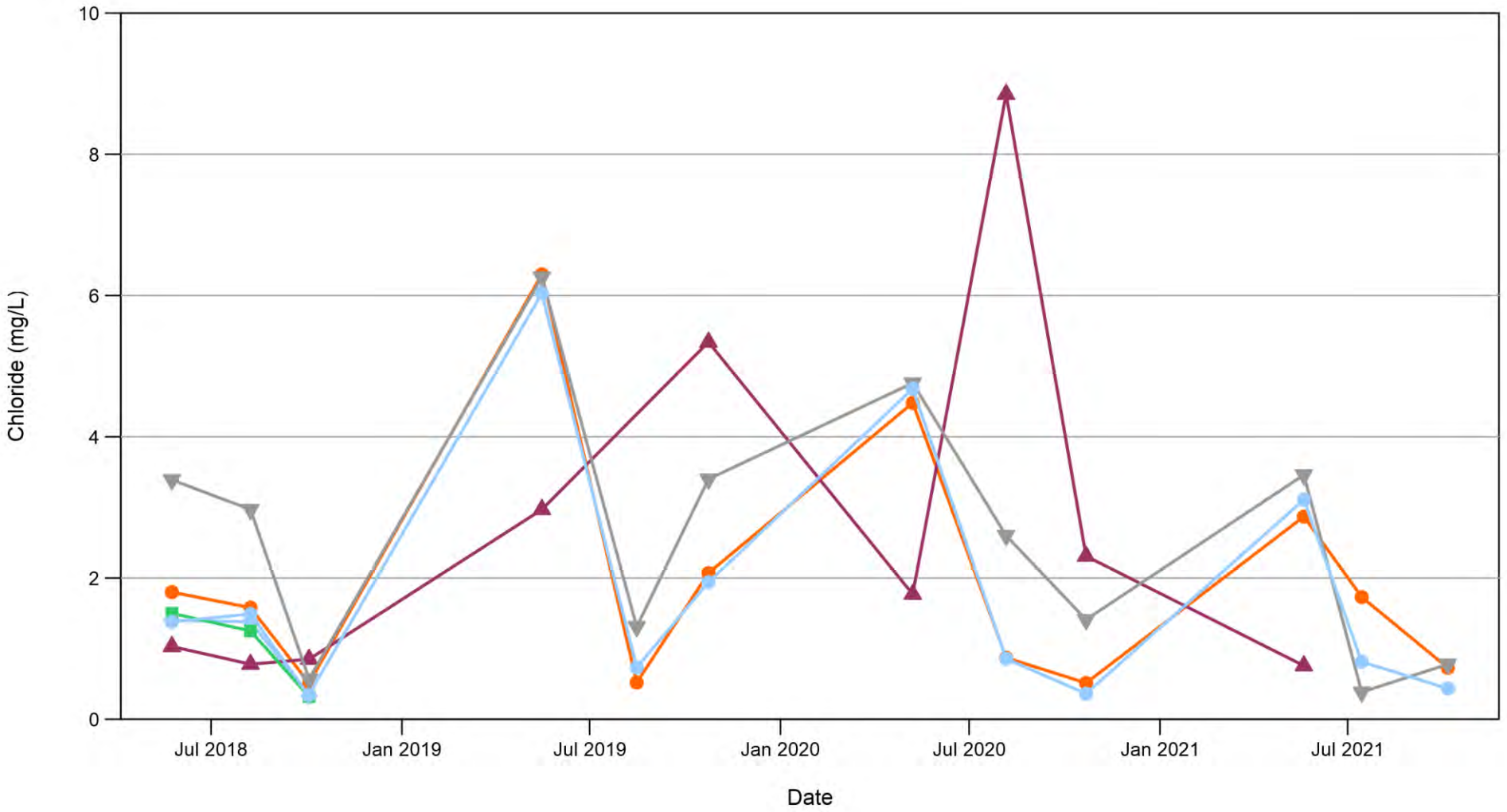
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Mann-Kendall Trend Analysis - Surface Water Sodium

Date:	Project:	Submitter:	Reviewer:
23 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5n



DC-SW1
DC-SW2
DC-SW4
DC-SW5
DC-SW6
DC-SW7

B.C. Approved Water Quality Guidelines - Irrigation (2019) = 100 mg/L

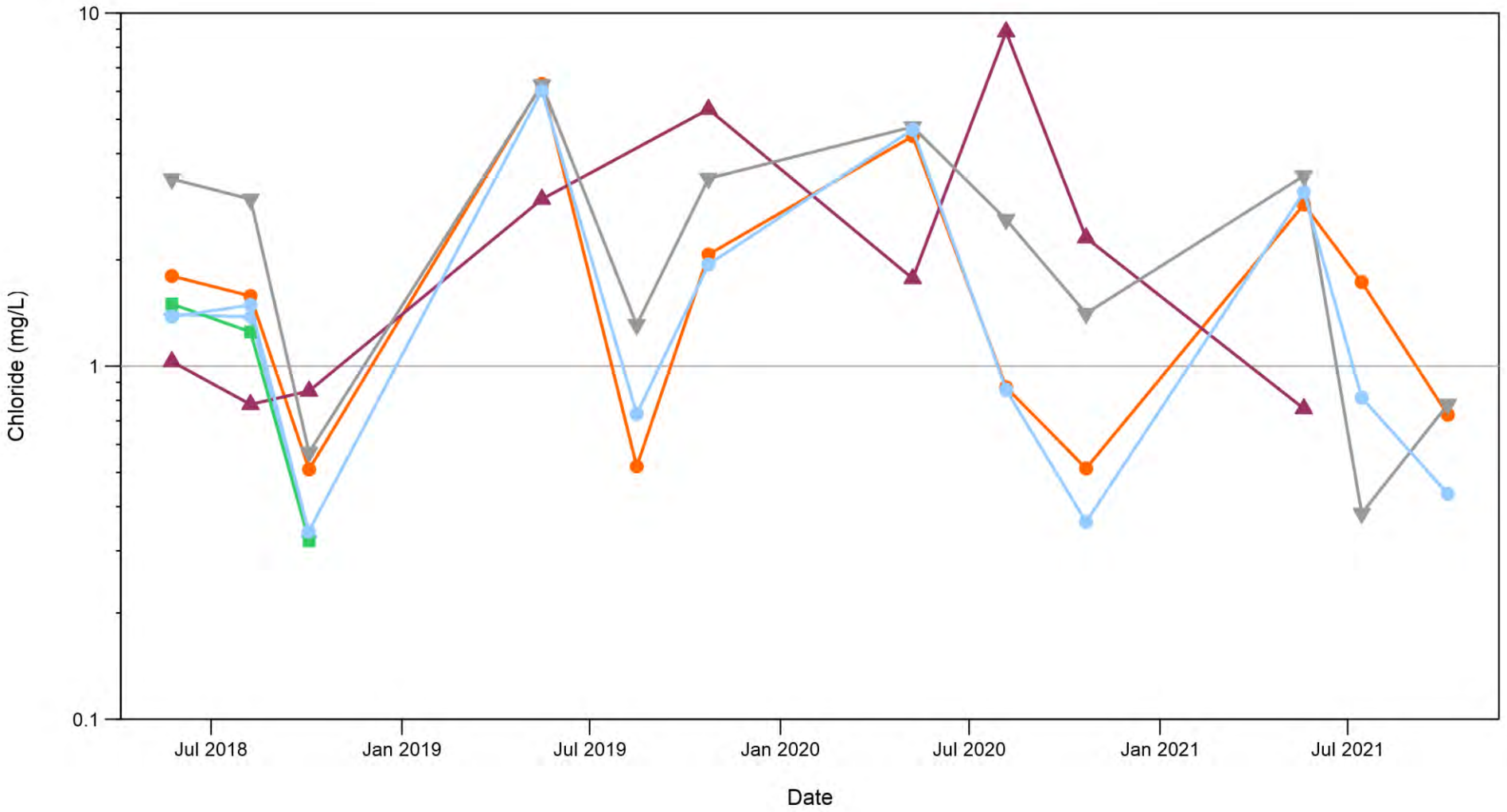
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Historical Surface Water Chloride Concentrations

Date:	Project:	Submitter:	Reviewer:
23 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5o



DC-SW1
DC-SW2
DC-SW4
DC-SW5
DC-SW6
DC-SW7

B.C. Approved Water Quality Guidelines - Irrigation (2019) = 100 mg/L

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

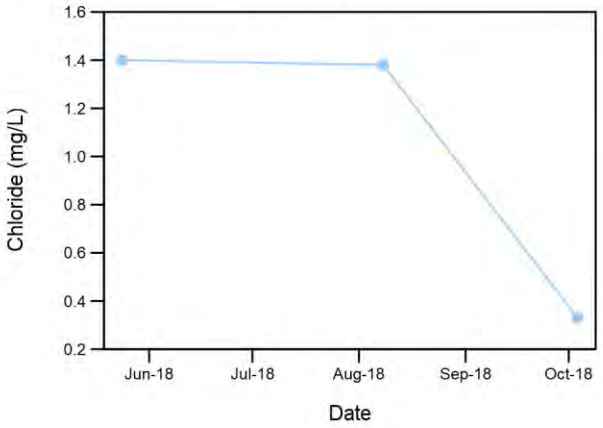
Peace River Regional District
Dawson Creek Landfill

Historical Surface Water Chloride Concentrations

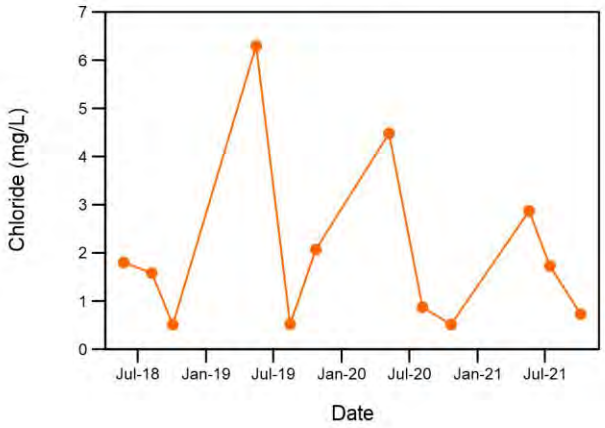
Date:	Project:	Submitter:	Reviewer:
23 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5o

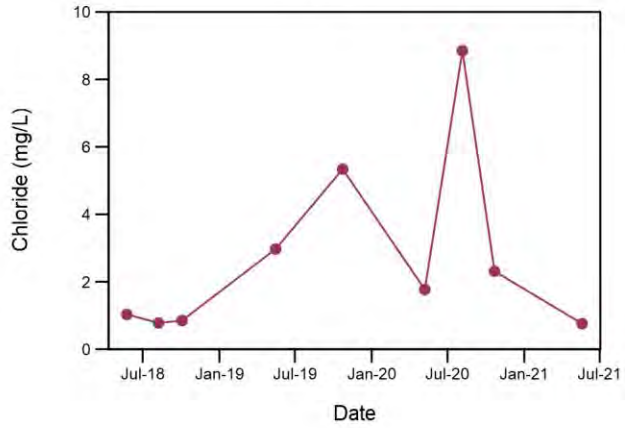
DC-SW1
Insufficient data for analysis



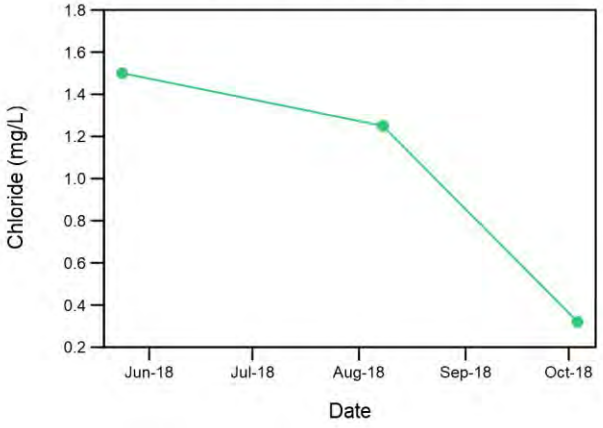
DC-SW2
No Trend



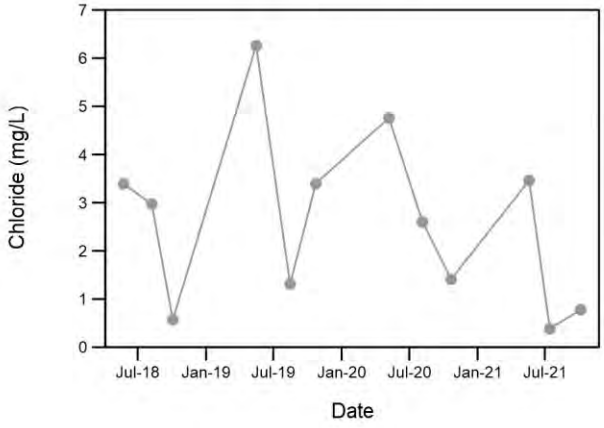
DC-SW4
No Trend



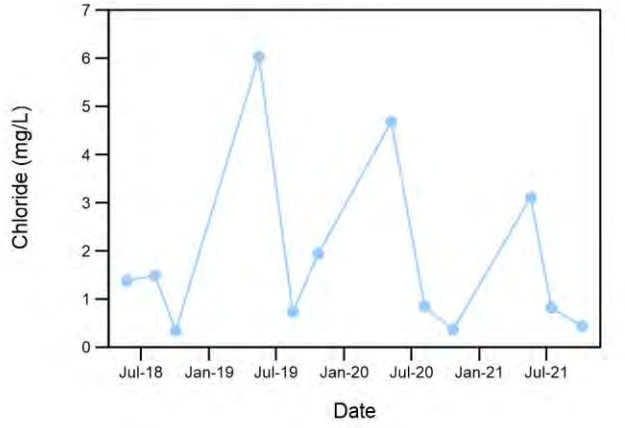
DC-SW5
Insufficient data for analysis



DC-SW6
No Trend



DC-SW7
No Trend



Chloride
B.C. Approved Water Quality Guidelines - Irrigation (2019) = 100 mg/L

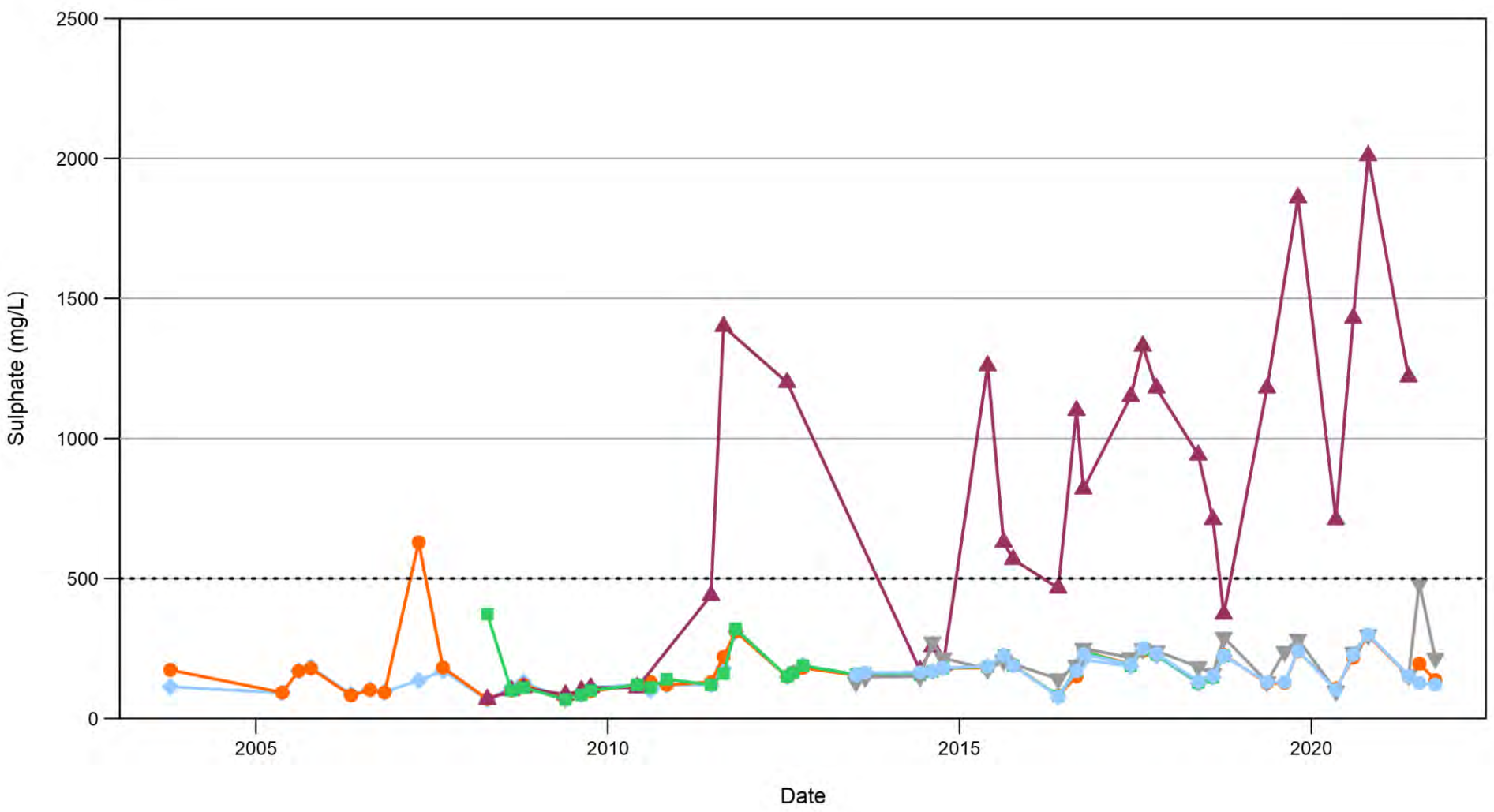
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Mann-Kendall Trend Analysis - Surface Water Chloride

Date:	Project:	Submitter:	Reviewer:
23 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5p



DC-SW1
DC-SW2
DC-SW4
DC-SW5
DC-SW6
DC-SW7

B.C. Approved Water Quality Guidelines - Drinking Water (2020) = 500 mg/L

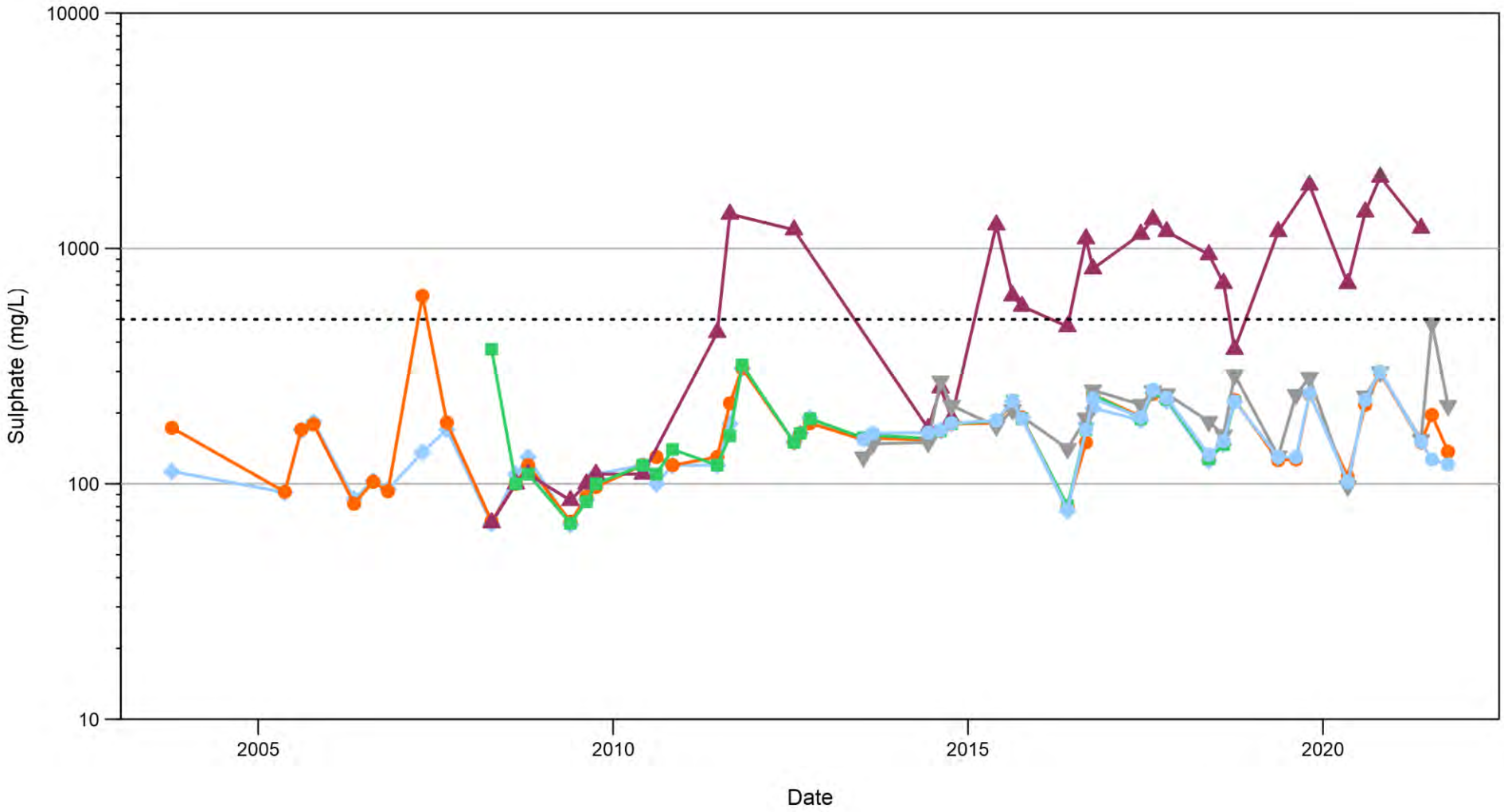
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Historical Surface Water Sulphate Concentrations

Date:	Project:	Submitter:	Reviewer:
23 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5q



DC-SW1
DC-SW2
DC-SW4
DC-SW5
DC-SW6
DC-SW7

B.C. Approved Water Quality Guidelines - Drinking Water (2020) = 500 mg/L

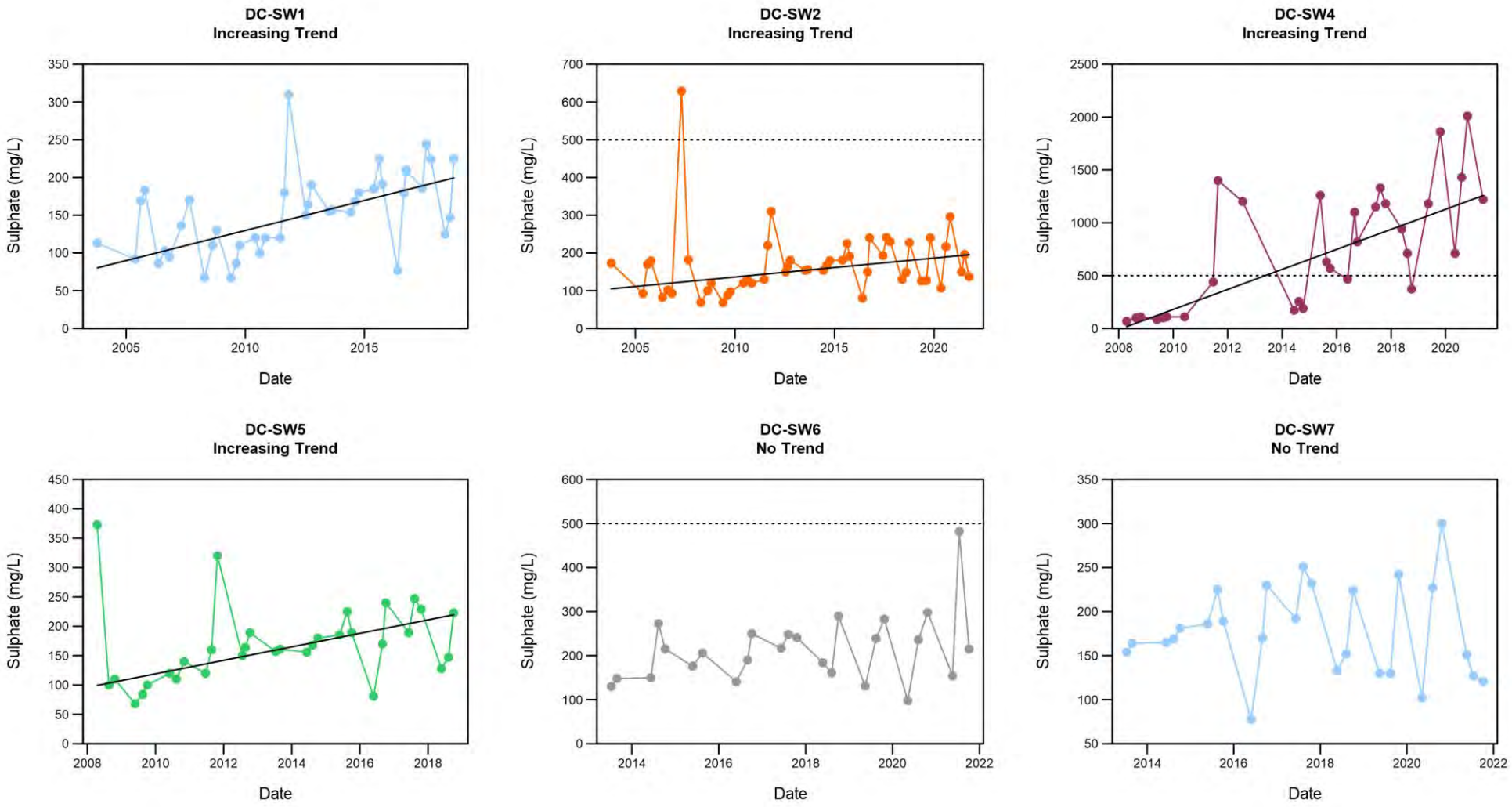
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Historical Surface Water Sulphate Concentrations

Date:	Project:	Submitter:	Reviewer:
23 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5q



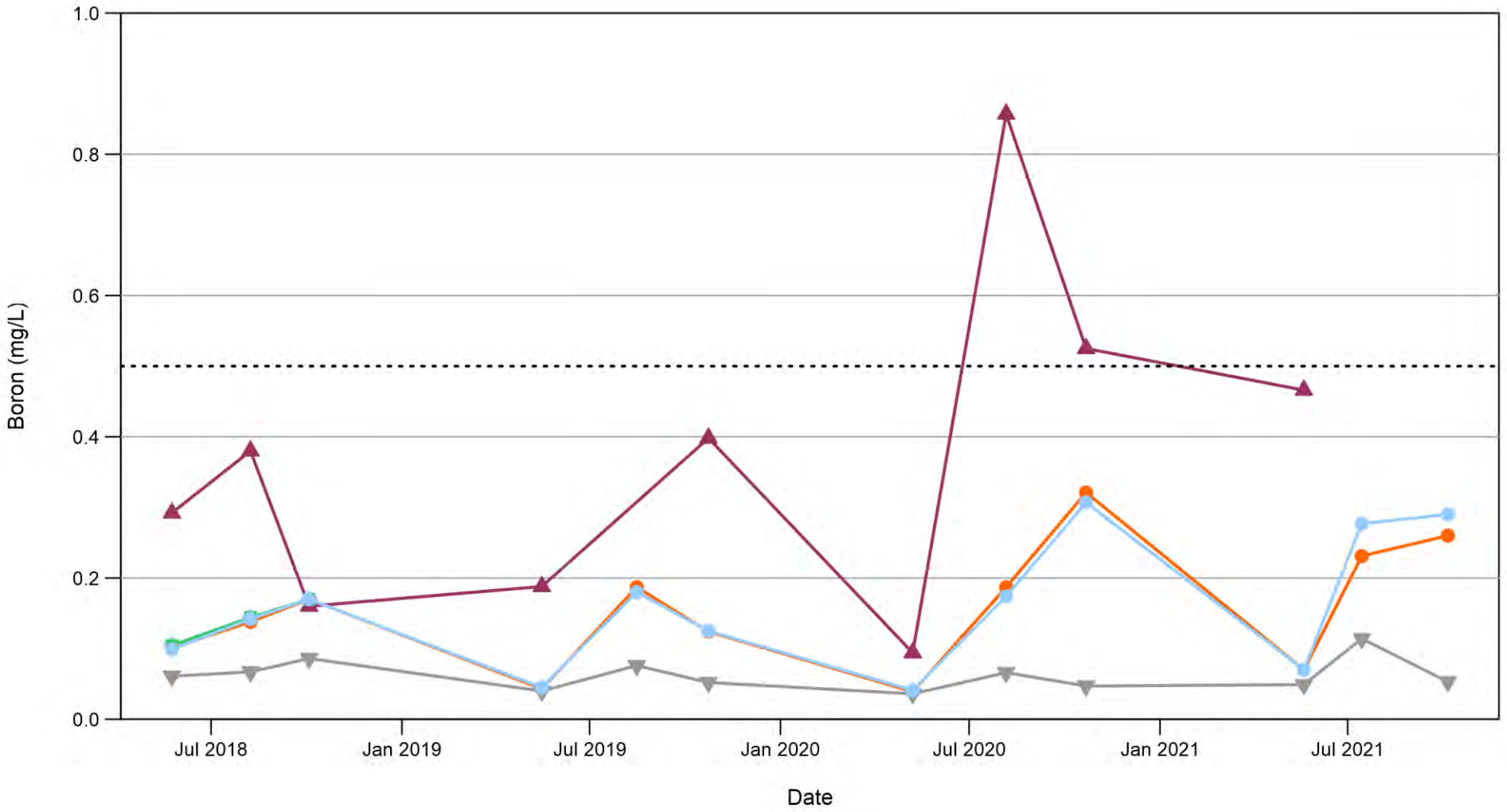
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Mann-Kendall Trend Analysis - Surface Water Sulphate

Date:	Project:	Submitter:	Reviewer:
23 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5r



DC-SW1
DC-SW2
DC-SW4
DC-SW5
DC-SW6
DC-SW7

B.C. Approved Water Quality Guidelines - Irrigation (2019) = 0.5 mg/L

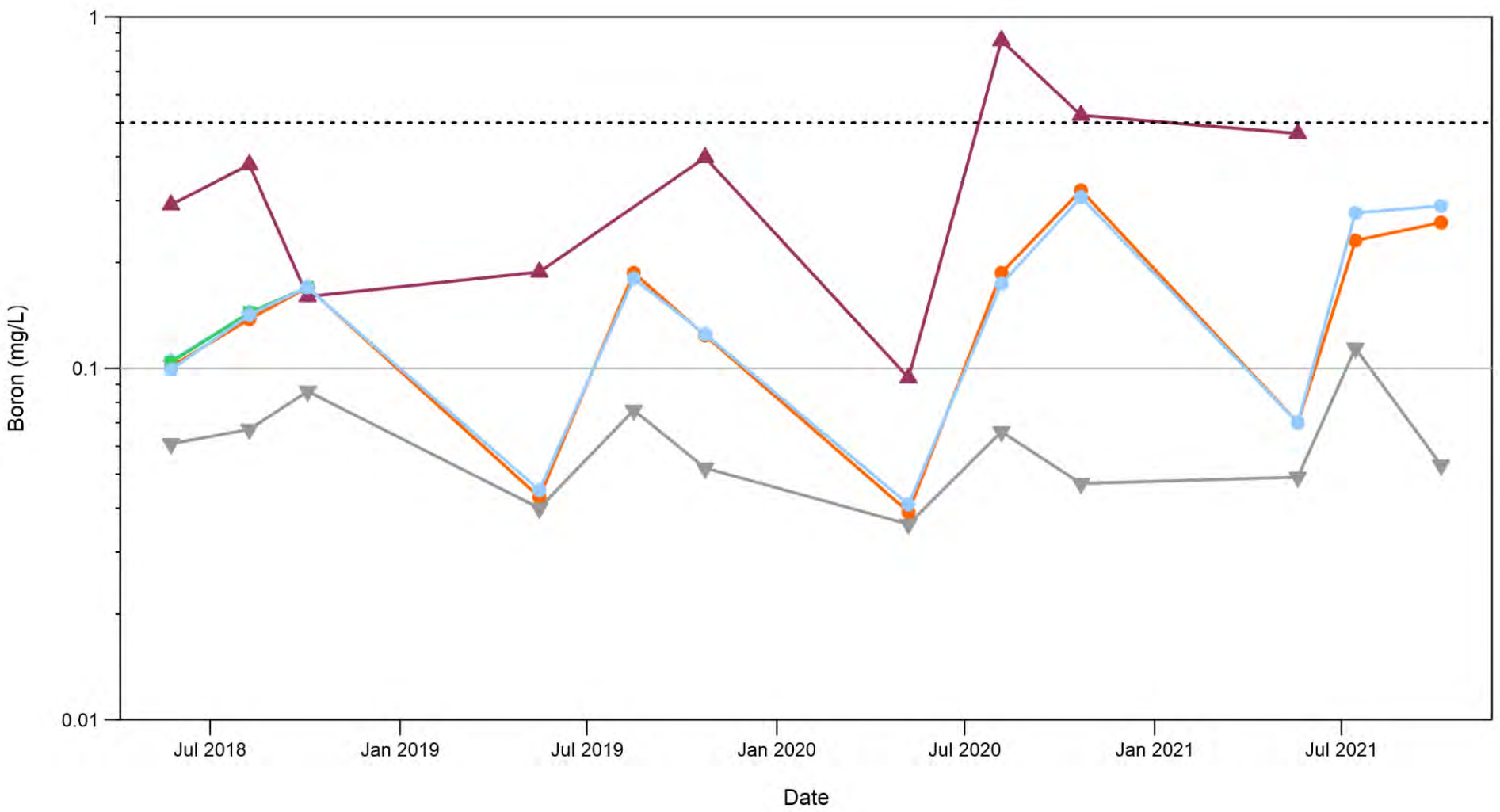
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Historical Surface Water Boron Concentrations

Date:	Project:	Submitter:	Reviewer:
23 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5s



DC-SW1
DC-SW2
DC-SW4
DC-SW5
DC-SW6
DC-SW7

B.C. Approved Water Quality Guidelines - Irrigation (2019) = 0.5 mg/L

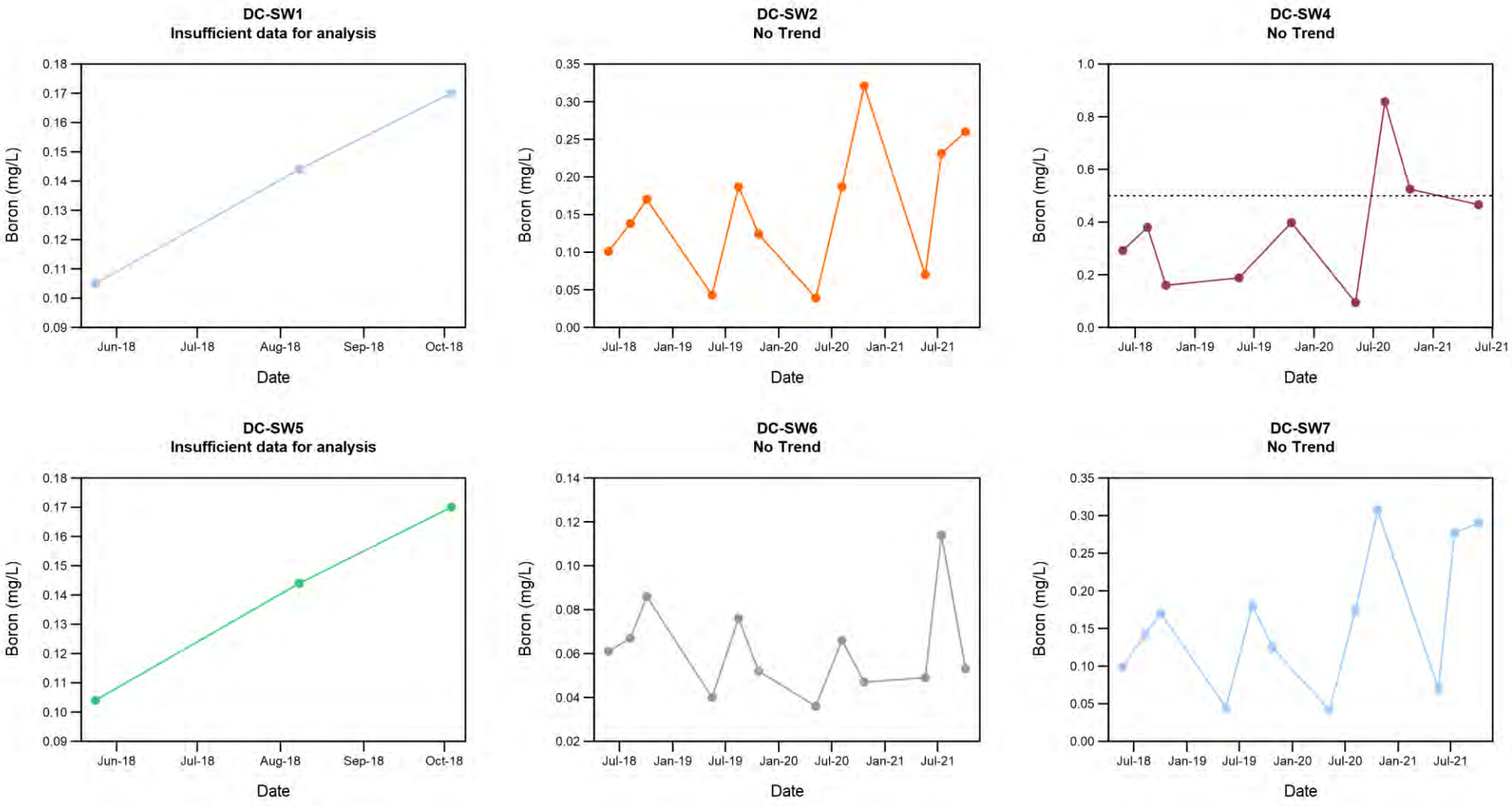
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Historical Surface Water Boron Concentrations

Date:	Project:	Submitter:	Reviewer:
23 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5s



Boron

B.C. Approved Water Quality Guidelines - Irrigation (2019) = 0.5 mg/L

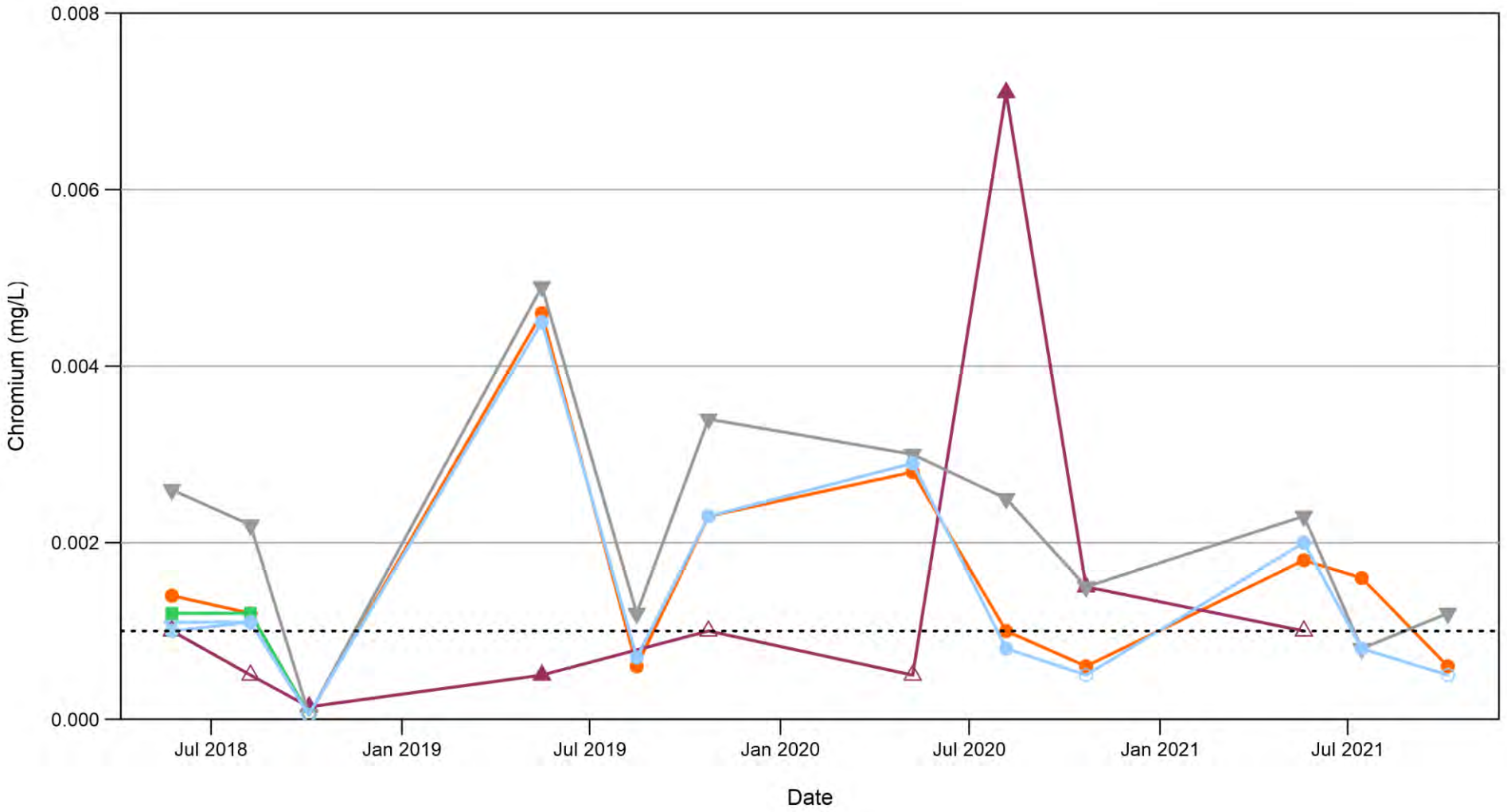
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Mann-Kendall Trend Analysis - Surface Water Boron

Date:	Project:	Submitter:	Reviewer:
23 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5t



DC-SW1
DC-SW2
DC-SW4
DC-SW5
DC-SW6
DC-SW7

Non Detect (Open Symbol)
B.C. Working Water Quality Guidelines - FAL (2021) = 0.001 mg/L

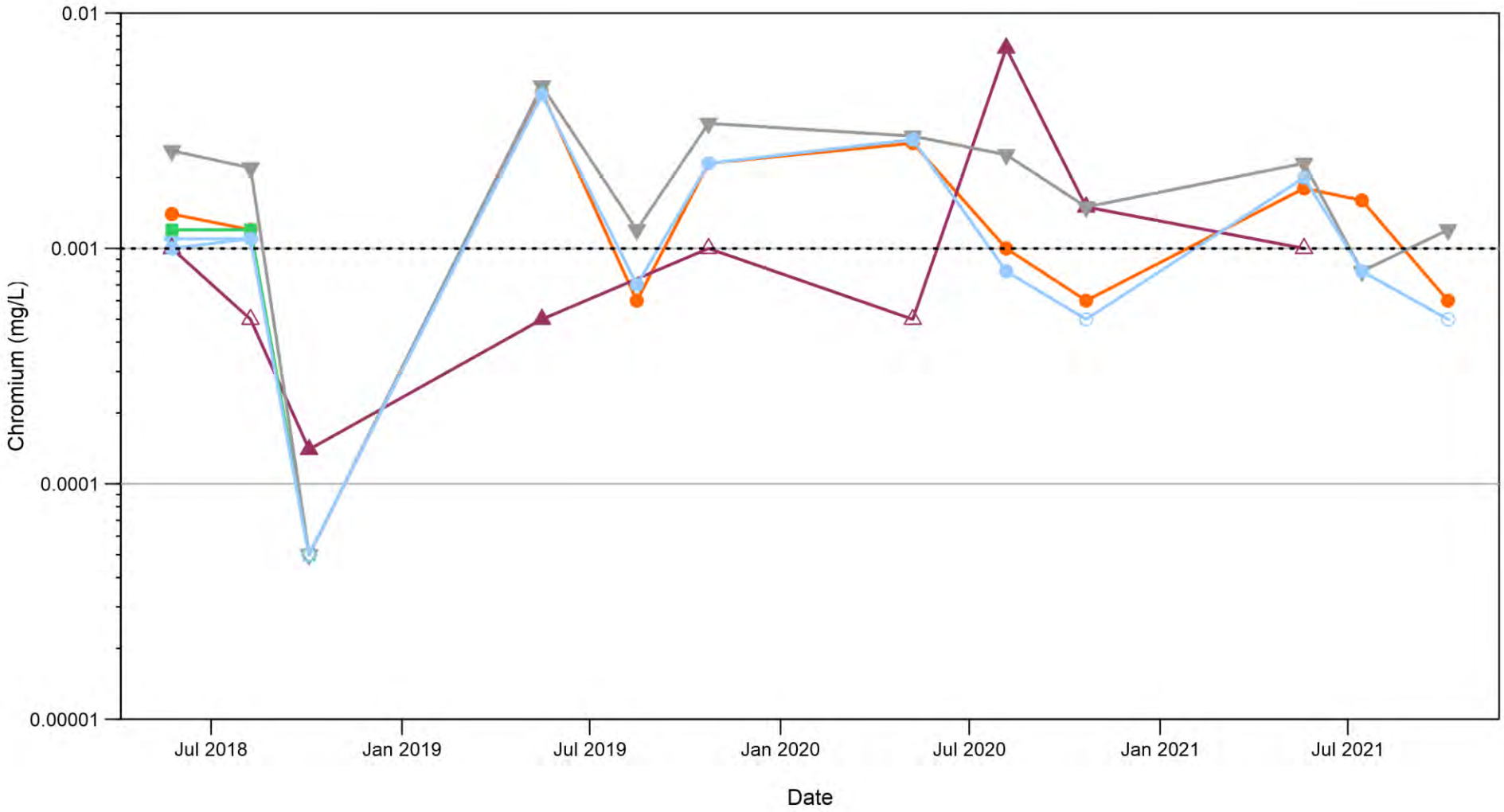
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Historical Surface Water Chromium Concentrations

Date:	Project:	Submitter:	Reviewer:
23 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5u



DC-SW1
DC-SW2
DC-SW4
DC-SW5
DC-SW6
DC-SW7

Non Detect (Open Symbol)
B.C. Working Water Quality Guidelines - FAL (2021) = 0.001 mg/L

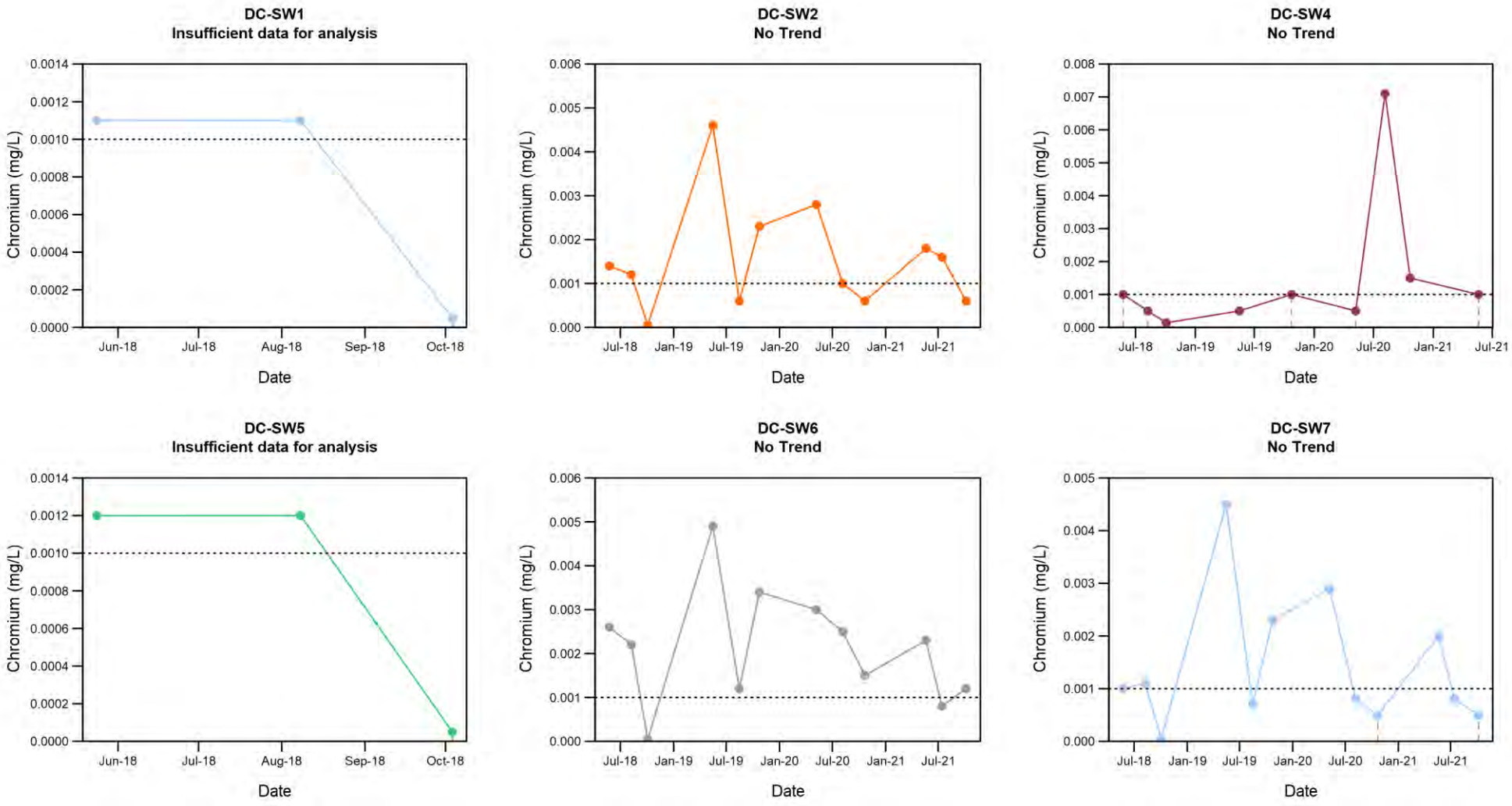
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Historical Surface Water Chromium Concentrations

Date:	Project:	Submitter:	Reviewer:
23 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5u



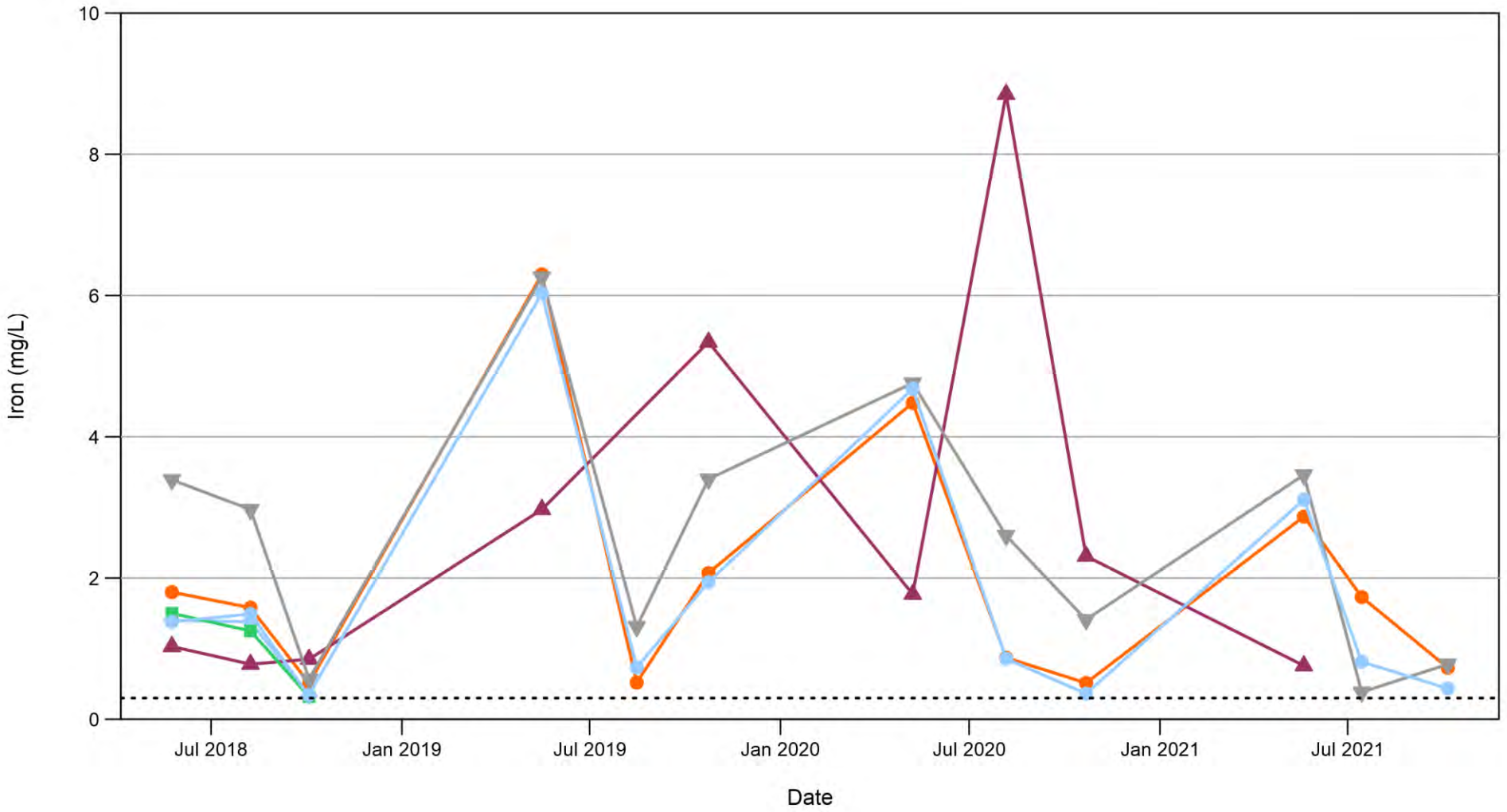
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Mann-Kendall Trend Analysis - Surface Water Chromium

Date:	Project:	Submitter:	Reviewer:
23 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5v



DC-SW1
DC-SW2
DC-SW4
DC-SW5
DC-SW6
DC-SW7

B.C. Approved Water Quality Guidelines - Drinking Water (2020) = 0.3 mg/L

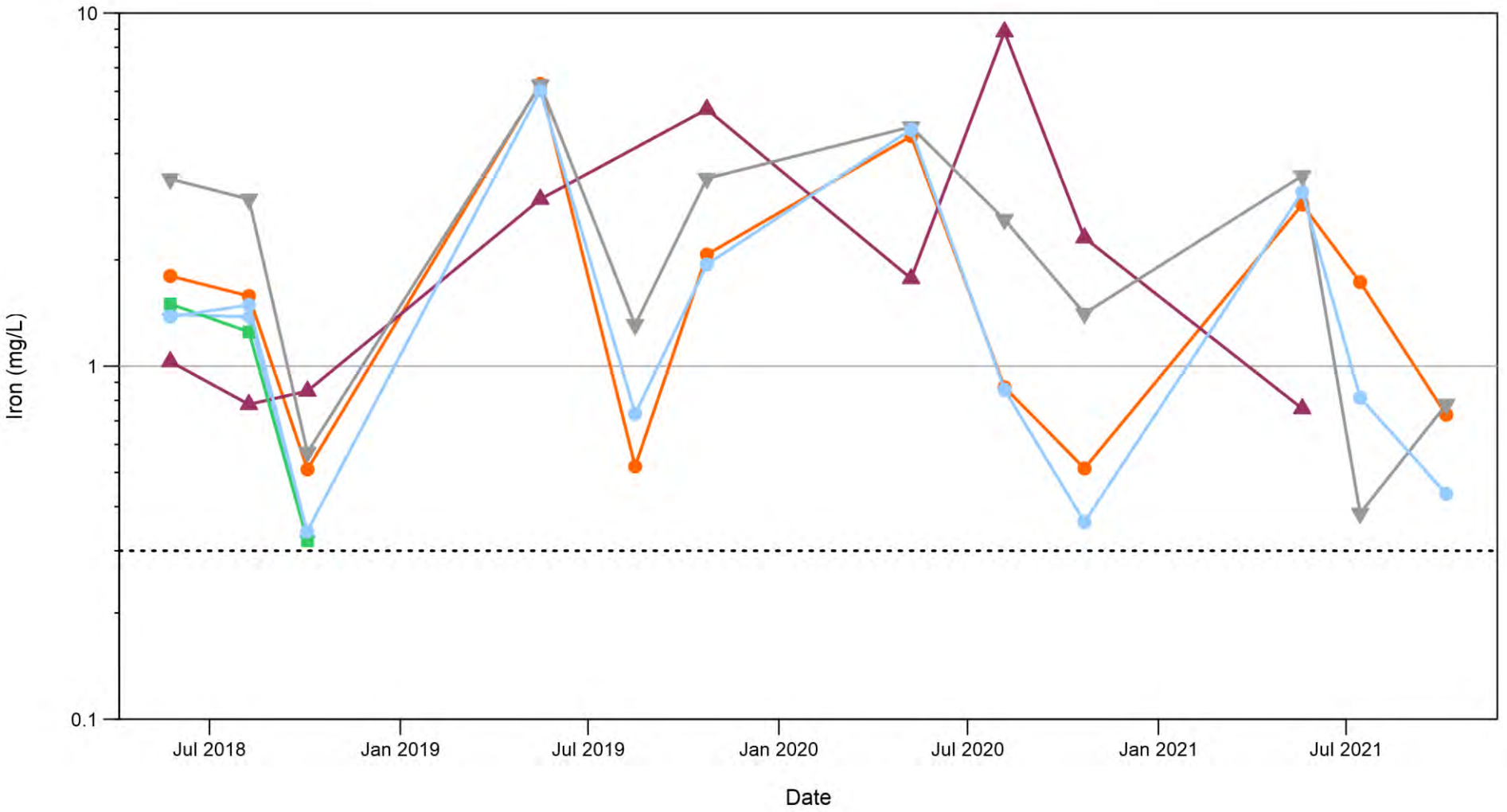
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Historical Surface Water Iron Concentrations

Date:	Project:	Submitter:	Reviewer:
23 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5w



DC-SW1
DC-SW2
DC-SW4
DC-SW5
DC-SW6
DC-SW7

B.C. Approved Water Quality Guidelines - Drinking Water (2020) = 0.3 mg/L

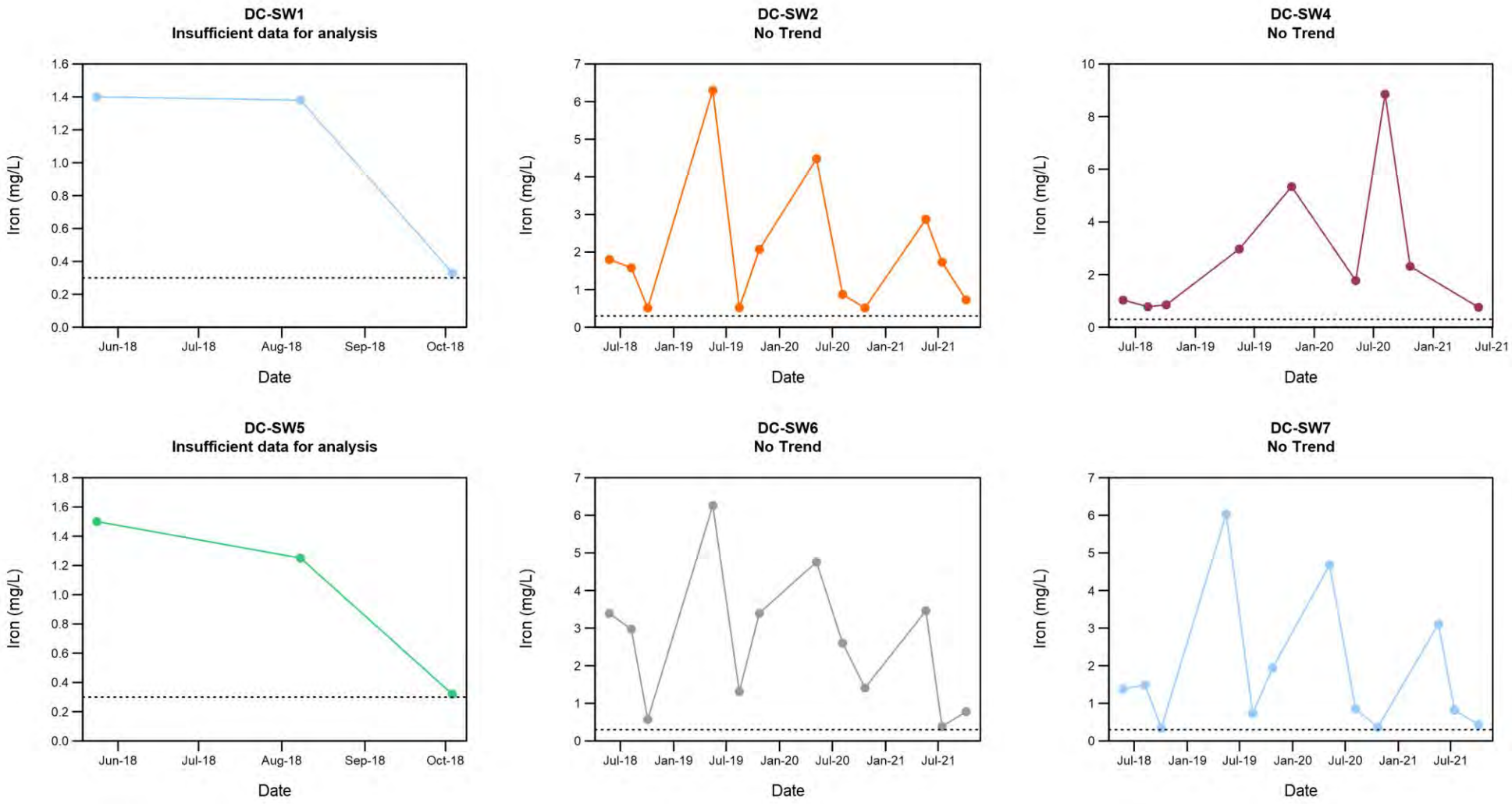
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Historical Surface Water Iron Concentrations

Date:	Project:	Submitter:	Reviewer:
23 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5w



Iron

B.C. Approved Water Quality Guidelines - Drinking Water (2020) = 0.3 mg/L

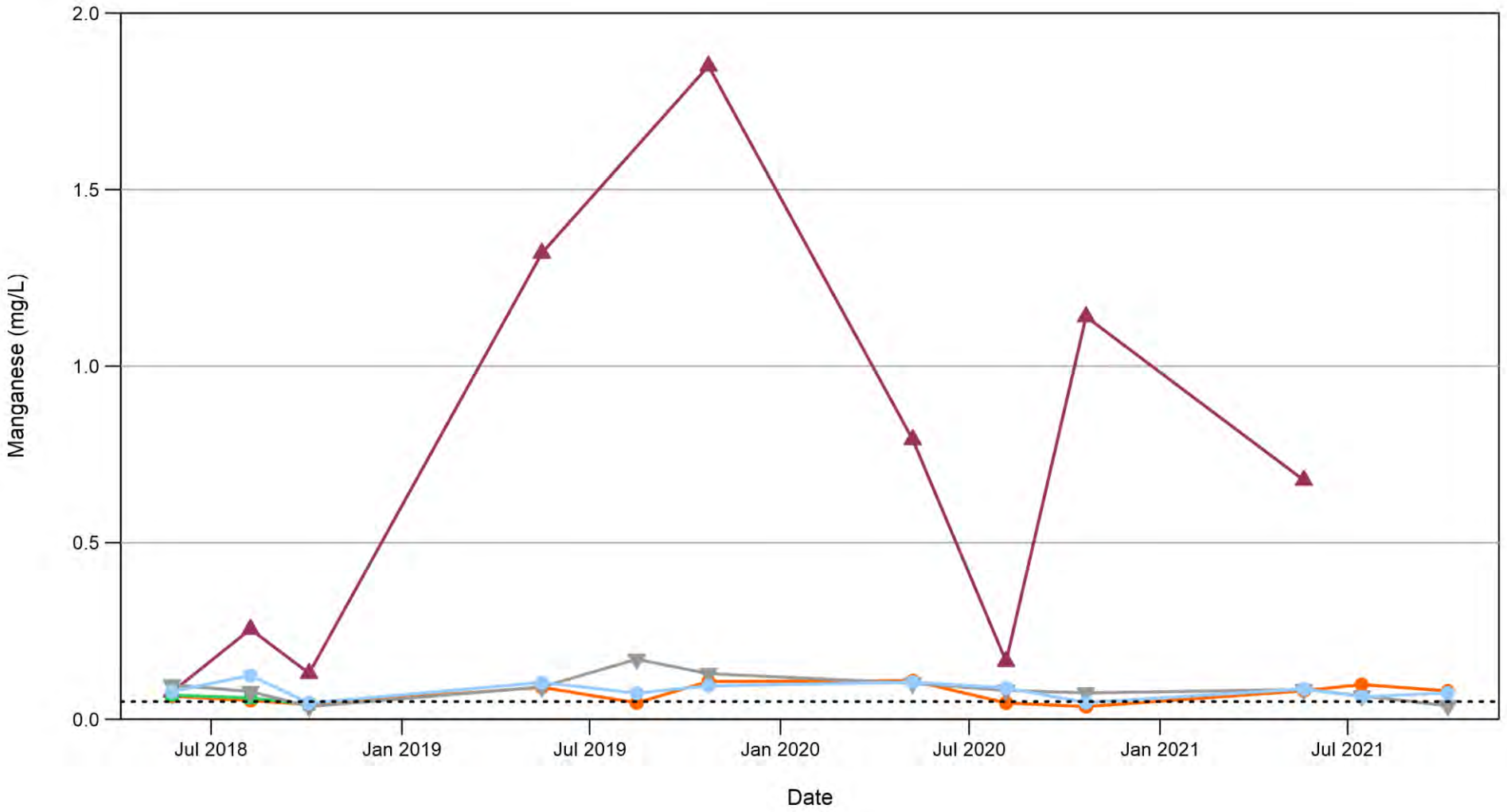
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Mann-Kendall Trend Analysis - Surface Water Iron

Date:	Project:	Submitter:	Reviewer:
23 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5x



DC-SW1
DC-SW2
DC-SW4
DC-SW5
DC-SW6
DC-SW7

B.C. Approved Water Quality Guidelines - Drinking Water (2020) = 0.05 mg/L

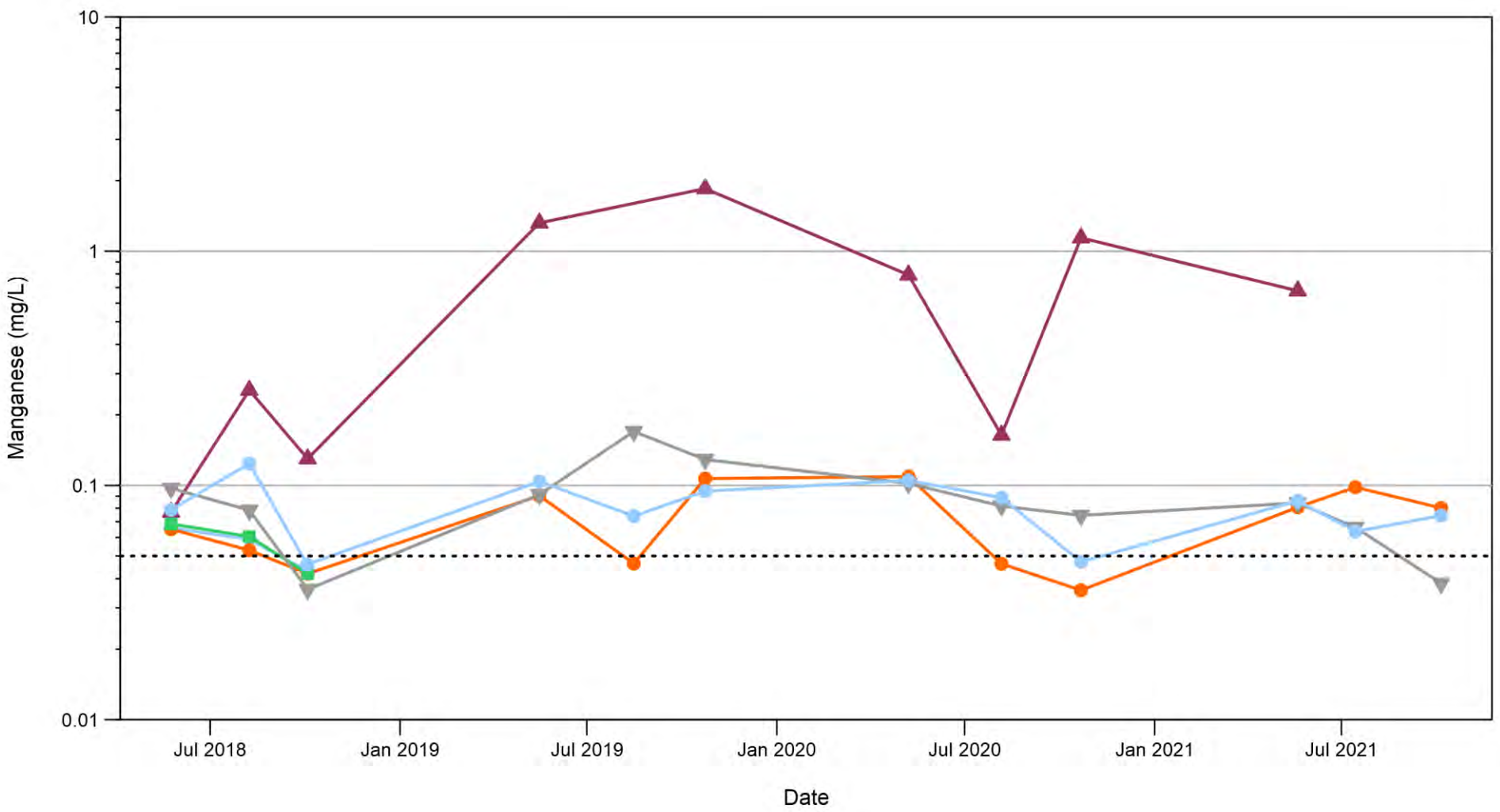
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Historical Surface Water Manganese Concentrations

Date:	Project:	Submitter:	Reviewer:
23 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5y



DC-SW1
DC-SW2
DC-SW4
DC-SW5
DC-SW6
DC-SW7

B.C. Approved Water Quality Guidelines - Drinking Water (2020) = 0.05 mg/L

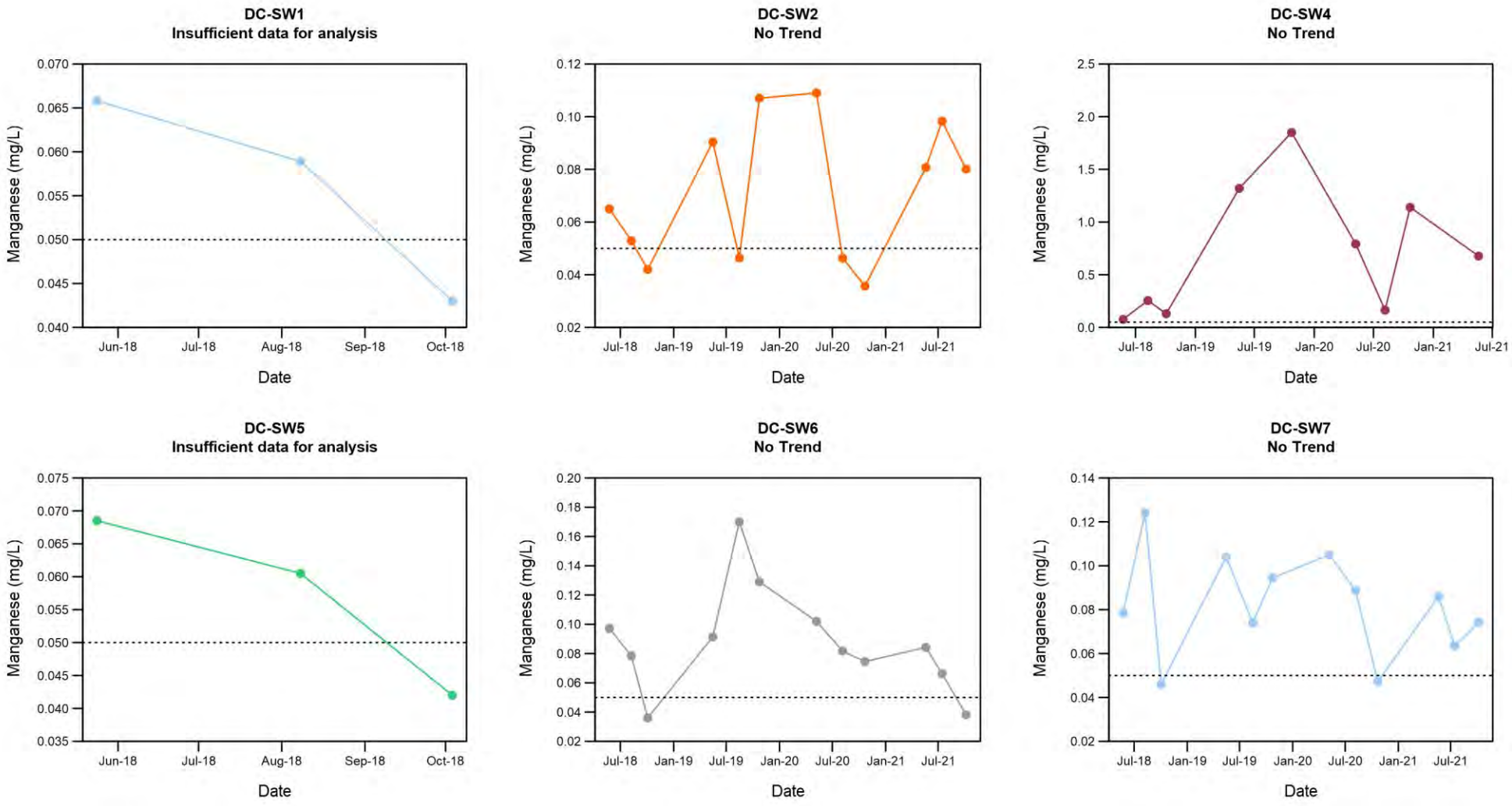
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Historical Surface Water Manganese Concentrations

Date:	Project:	Submitter:	Reviewer:
23 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5y



Manganese

B.C. Approved Water Quality Guidelines - Drinking Water (2020) = 0.05 mg/L

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Peace River Regional District
Dawson Creek Landfill

Mann-Kendall Trend Analysis - Surface Water Manganese

Date:	Project:	Submitter:	Reviewer:
23 Nov 2021	26254	C. Bromba	R. Reimer

Figure 5z

Appendix E

Water Balance Model Calculations

Water Balance Model Calculations, Area 1

Calculation of Area 1 Groundwater Influx

Inputs: Groundwater flux from upgradient (Q1)
Output: Flux into Area 2

Upgradient Influx

		Hydraulic Conductivity	
Q = K*A*dh/dl	Location	K (m/s)	Unit
K =	MW95-1	1E-07	Clay and Clay Till
	MW98-5	5E-06	Clay Till
	MW98-2	5E-07	Clay w sand
	MP99-1A	3E-08	high plastic clay
	MP99-1B	3E-09	high plastic clay
	MP99-2	3E-09	high plastic clay

Cross-section area = length (across the landfil area) * thickness of saturated aquifer
length across landfill area = 256 m
average saturated thickness = 12.0 m
Cross-sectional area = 3069 m^2

Geo mean K = 6.4E-08 m/sec
dh/dl = 0.05 m/m

$V_{Average}$ = K*dh/dl / n
8.9E-09 m/sec
0.3 m/yr

Porosity (assumed) 0.35

Groundwater flux from upgradient (Q1) 300 m3/year

Water Balance Model Calculations, Area 2

Calculation of Groundwater Flux out of landfill area

Inputs:	GW flux from Areas 1 (Q1) Leachate generation from landfill (Q2)	
Outputs:	Flux into Area 3 (Q3)	
Groundwater flux from upgradient (Q1)	300	m3/year
Leachate Generation (HELP Model - GHD, 2023 (Low Permeability) (Q2 Low)	631	m3/year
Leachate Generation (HELP Model - GHD, 2023 (Medium Permeability) (Q2 Medium)	5,197	m3/year
Evapotranspiration (HELP Model - GHD, 2023 (Low Permeability)	21,903	m3/year
Evapotranspiration (HELP Model - GHD, 2023 (Medium Permeability)	18,598	m3/year
Runoff (HELP Model - GHD, 2023 (Low Permeability)	6,369	m3/year
Runoff (HELP Model - GHD, 2023 (Medium Permeability)	5,107	m3/year
Flux out of landfill area (HELP Model - GHD, 2023 (Q3 - Low Permeability)	**931**	**m3/year**
Flux out of landfill area (HELP Model - GHD, 2023 (Q3 - Medium Permeability)	**5,497**	**m3/year**

Water Balance Model Calculations, Area 3

Calculation of Groundwater Flux out of landfill area

Inputs:	Flux from Area 2 (Q3) Infiltration of precipitation downgradient of the landfill (Q4)	
Outputs:	Discharge to Dawson Creek (Q5)	
Flux out of landfill area (HELP Model - GHD, 2023 (Low Permeability) (Q3 Low)	931	m3/year
Flux out of landfill area (HELP Model - GHD, 2023 (Medium Permeability) (Q3 High)	5,497	m3/year
Infiltration rate for Dawson Creek (CSR Protocol 2)	80	mm/year
Downgradient area	15000	m2
Flux from precipitation infiltration (Q4)	1200	m3/year
Flux out of Area 3 - Discharge into Dawson Creek (Q5 Low)	**2,131**	**m3/year**
Flux out of Area 3 - Discharge into Dawson Creek (Q5 High)	**6,697**	**m3/year**

ghd.com

The Power of Commitment

PEACE RIVER REGIONAL DISTRICT

REPORT

To: Solid Waste Committee Report Number: ENV-SWC-156

From: Gerritt Lacey, Solid Waste Manager Date: April 5, 2024

Subject: Chetwynd Landfill Replacement Project Update

RECOMMENDATION:

That the Solid Waste Committee recommend that the Regional Board share the report titled "Chetwynd Landfill Replacement Project Update ENV-SWC-156" including the attached reports titled "New Landfill Feasibility – Site Selection – Landfill Siting Memo" and "New Landfill Feasibility – Chetwynd Area Stage 1: Site Selection – Site Reconnaissance" with the following government agencies and neighbouring communities:

- District of Chetwynd,
- BC Ministry of Environment and Climate Change Strategy,
- Blueberry River First Nations,
- Doig River First Nation,
- Halfway River First Nation,
- Kwadacha Nation,
- McLeod Lake Indian Band,
- Saulteau First Nations,
- Tsay Keh Dene Band,
- West Moberly First Nations,
- Lheidli T'enneh First Nation,
- Horse Lake First Nation,
- Simpcw First Nation,
- Secwepemc LOC,
- Dene Tha First Nation,
- Prophet River First Nation,
- Ross River Dena Council,
- Kaska Dena Council,
- Liard First Nation,
- Carrier Sekani Tribal Council,
- Gitxsan Hereditary Chiefs,
- Takla Nation,
- Binche Whut'en,
- Tahltan Central Government, and
- Nak'azdli Band.

BACKGROUND/RATIONALE:

The Chetwynd Landfill manages approximately 12% (12,000 tonnes) of the waste generated in the Peace River Regional District (PRRD) annually. As per the 2022 annual report for the landfill, it is anticipated that all the available airspace will be used by the end of 2029, meaning the landfill will no longer be able to accept waste. As a result, waste that originates from Electoral Area E and Chetwynd would need to go to a new landfill located in the Chetwynd area for disposal.

In 2023 the PRRD began the process of siting a new landfill, and secured Tetra Tech Canada Inc to assist the PRRD through the process.

2023 Recap

A desktop site selection was performed which investigated 11 potential areas within a 20km radius of Chetwynd. The 2016 BC Landfill Criteria was used to evaluate the suitability of each as a potential landfill site against the regulatory requirements. These 11 potential sites were narrowed to four for further investigation which are referred to as:

- Area A - Located approximately 4km north along Don Phillips Way past the existing landfill;
- Area B - Located beside to the existing landfill;
- Area C - Located approximately 4.5km down the Lone Prairie Road; and
- Area L – Located approximately 27km down the Jackfish Lake Road.

The results of the desktop site selection process are available in the attached report titled “New Landfill Feasibility – Site Selection – Landfill Siting Memo” dated November 3, 2023.

Site visits and field reconnaissance of the four potential locations were completed by Tetra Tech and PRRD staff in the fall of 2023. The results of the site visits are captured in the report titled “New Landfill Feasibility – Chetwynd Area Stage 1: Site Selection – Site Reconnaissance” dated February 20, 2024, and attached to this report for reference.

Planned work in 2024

Based on the initial investigations in 2023, Area A and B are planned to move forward to complete the feasibility study. In 2024, this will include lidar investigation for narrowing the potential location of the landfill within each area and performing a preliminary geotechnical investigation of each site to establish subsurface site conditions. The results of the completed feasibility study will be shared through public consultation to assist the PRRD on the selection of the preferred location of the new landfill. This will then lead to proceeding with obtaining the appropriate permitting and updating the Regional Solid Waste Management Plan in the following year. As part of the works, the PRRD may need to apply for and obtain Liscense’s of Occupation for the two areas to perform the preliminary geotechnical investigations.

Public Engagement and Consultation

Public consultation for the at the Feasibility and Site Selection stage will include engagement with the District of Chetwynd, Member First Nations Communities, neighbors, and BC Ministry of Environment and Climate Change Strategy regarding the proposed location of the new landfill.

Providing this report to member municipalities, First Nations, and government agencies is the first step towards that engagement, as further communications materials are developed they will be shared with the project stakeholders.

ALTERNATIVE OPTIONS:

1. That the Solid Waste Committee provide further direction.

STRATEGIC PLAN RELEVANCE:

☒ Asset and Infrastructure Management

☒ Collaboration and Cooperation with First Nations

FINANCIAL CONSIDERATION(S):

The cost of establishing a new Landfill that is ready to accept waste is estimated to cost upwards of $5,500,000.

COMMUNICATIONS CONSIDERATION(S):

The PRRD is working on developing communications materials to be shared with the public regarding the status of the project and receiving feedback regarding the proposed locations. This includes creating materials such as:

- A Have Your Say Page which allows for posting of project updates and public to submit questions.
- Reports
- Surveys
- Posters/Pamphlets
- Workshops

OTHER CONSIDERATION(S):

None at this time.

Attachments:

1. New Landfill Feasibility – Site Selection – Landfill Siting Memo
2. New Landfill Feasibility – Chetwynd Area Stage 1: Site Selection – Site Reconnaissance

November 3, 2023

ISSUED FOR USE
FILE: 704-SWM.SWOP04805-01
Via Email: gerritt.lacey@prrd.bc.ca

Peace River Regional District
1981 Alaska Ave
Dawson Creek, BC V1G 4H8

Attention: Gerritt Lacey, Solid Waste Manager

Subject: New Landfill Feasibility – Site Selection - Landfill Siting Memo

1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) was retained by the Peace River Regional District (PRRD) to conduct a new landfill feasibility study (study) with the goal of siting a new landfill in the Chetwynd area.

The current Chetwynd Landfill (site or Landfill) received an operating permit in 1977. The 2021 Design, Operating, and Closure Plan (DOCP) indicates that the estimated closure date is 2030 while the 2021 Annual Report (Sperling Hanson 2022) indicates an estimated closure date of 2029. Based on the most conservative closure date of 2029, a new landfill cell will be required by 2028.

The scope of work for the study is divided into three stages:

- Stage 1:
  - Site Selection.
  - Feasibility Study:
    - Site Reconnaissance; and
    - Preliminary Technical Investigation.
- Stage 2:
  - Permitting; and
  - Detailed Design.
- Stage 3:
  - Construction; and
  - Commissioning.

Tetra Tech Canada Inc.
Suite 1000 – 10th Floor, 885 Dunsmuir Street
Vancouver, BC V6C 1N5 CANADA
Tel 604.685.0275 Fax 604.684.6241

This memo undertakes Stage 1: Site Selection to complete a desktop evaluation of potential areas around Chetwynd. The purpose of the work is to identify locations that, based on desktop study, have technical characteristics that appear favourable for development of a Municipal Solid Waste (MSW) Landfill in accordance with the British Columbia Ministry of Environment and Climate Change Strategy (BCMECCS) Landfill Criteria for Municipal Solid Waste (the Criteria) (2016). More specifically, this initial scope of work is intended to filter out areas that would not be favourable for landfill development based on regulatory and operational constraints. The proposed scope of work assumed that up to three (3) potentially feasible sites would be recommended for field reconnaissance in the Fall of 2023 to confirm key non-intrusive technical requirements.

For the duration of the study, the PRRD is leading and initiating public and stakeholder consultation with support from Tetra Tech. As such, the PRRD has provided current existing information on potential stakeholder concerns during this desktop evaluation. However, this study has focussed on technical constraints to siting.

2.0 SITING EXERCISE

The purpose of the work is to:

- Eliminate locations in the Chetwynd area that, based on desktop study, would not meet regulatory requirements (e.g., set-backs from water bodies); and
- Preliminary identification of locations in the Chetwynd area that, based on desktop study, have characteristics that may allow them to be considered for the development of a MSW landfill in accordance with the Criteria.

Further to the technical requirements, the siting exercise also evaluated operational considerations such as available road access and siting within a reasonable haul distance from Chetwynd.

The work undertaken for this site selection has included:

Task 1: Project Kickoff and Confirmation of Study Areas; and

Task 2: Desktop Siting Analysis.

The results for these tasks are presented in the following sections. The recommended sites to conduct the site reconnaissance portion of the feasibility study are presented in Section 4.0.

2.1 Landfill Siting – Overview

Tetra Tech met with the PRRD on June 28, 2023, to initiate work on the site selection. During the meeting, the PRRD indicated that there were no pre-determined locations and that it was a fresh slate for the evaluation process. The PRRD further indicated the following:

- The preference is for one landfill in the Chetwynd area;
- There is a previously closed landfill (Moberly Lake); and
- Believed that geology (shallow rockhead) and set-backs are not favourable to expansion of current site.

The PRRD further indicated that a previous evaluation was completed to evaluate the feasibility of transfer stations vs a new landfill and that based on the outcome of the landfill sitting, there may be a need to update the transfer station evaluation for current day. However, there would also be concern about the remaining capacity of the other landfills within the PRRD to accept the waste from the Chetwynd area.

During the meeting, it was proposed that the study area would initially be a circular zone with a radius of 50 km. For initial study purposes, the 50 km radius would be narrowed down to focus on areas within a 15 km to 20 km distance from the existing landfill location and adjacent to existing roads. The study would only extend beyond the 20 km radius if potentially feasible sites were not identified within the 20 km radius.

2.2 Siting Criteria and Constraints Applied

The siting criteria outlined in the Criteria as well as our experience in siting landfills were used to outline a series of conditions (selection criteria) that would range from unfavourable to favourable for development of a landfill in a particular location. Some selection criteria are considered 'hard constraints' (e.g., the presence of a water body within 300 m) whereas some constraints are considered 'soft constraints' (e.g., proximity of a location to an existing roadway). 'Hard constraints' as referenced from Section 3.0 "Siting Criteria" of the Criteria are listed below in Table 2-1: Selection Criteria: Hard Constraints. The 'soft constraints', as identified in Table 2-2, have been considered by Tetra Tech and/or the PRRD with rationale provided.

Tetra Tech used a GIS-based mapping system to evaluate various selection criteria for the siting of a landfill. This approach is advantageous because the procedures can be clearly documented, and the data can be stored for future use, making the analyses repeatable and enabling future refinement during future more detailed investigation or prior to regulatory application submission.

The following selection criteria were considered for this preliminary siting evaluation. The selection criteria listed below appear in hierarchical order based on potential impacts, and not in the order laid out in the Criteria.

Table 2-1: Selection Criteria: Hard Constraints

Selection Criteria	Criteria Reference	Requirement	Note/Consideration
Water Features	Section 3.9	A landfill shall not be located within 100 m of surface water.	
Water Features	Section 3.11	A landfill footprint shall not be located within 100 m of the sea level maximum high tide or seasonal high watermark of an inland lake shoreline.	
Water Wells	Section 3.5	The landfill footprint shall be a minimum of 300 m from a water supply well or water supply intake and a minimum 500 m from municipal or other high capacity water supply wells.	
Biophysical	Section 3.8	The landfill footprint must not be located within 100 m of an environmentally sensitive area such as: ▪ A national, provincial, or regional park. ▪ A wildlife management area as designated under Section 4 of the provincial Wildlife Act. ▪ A critical wildlife area or wildlife sanctuary designated under Section 5 of the provincial Wildlife Act. ▪ A land acquired and administered under Section 3 of the provincial Wildlife Act. ▪ An ecological reserve designated under the provincial Ecological Reserve Act. ▪ A bird sanctuary designated under the regulations pursuant to the federal Migratory Birds Convention Act. ▪ A wildlife area designated under the federal Wildlife Act. ▪ A marine sanctuary. ▪ A wetland. ▪ The habitat of rare, threatened, or endangered species under federal and/or provincial Species at Risk legislation.	
Land Use	Section 3.1	The landfill footprint must not be located within 500 m of an existing or planned sensitive land use. A planned sensitive land use is one that has been identified as an allowed use in a regional growth management plan, official community plan, or zoning by-law but has not yet been built/established. Sensitive land uses include, but are not limited to, schools, residences, hotels, restaurants, cemeteries, food processing facilities, churches, and municipal parks. Land uses such as heavy industry, forestry operations, aggregate extraction/mining, railways/rail yards, etc. are not considered sensitive land uses.	

Selection Criteria	Criteria Reference	Requirement	Note/Consideration
	Section 3.2	Heritage and Archeological Sites: ▪ The landfill footprint is recommended not to be located within 100 m of a heritage or archaeological site. ▪ Landfill siting is also subject to the requirements of the BC Heritage Conservation Act administered by the Archaeology Branch of the British Columbia Ministry of Forests, Lands and Natural Resource Operations. The Branch and website should be consulted for requirements	It should be noted that an evaluation of the heritage and archeology has not yet been conducted but the desktop evaluation will occur during the feasibility study of the recommended locations.
	Section 3.10	Floodplains: A landfill footprint shall not be located in a floodplain.	
Geological and Hydrogeological: ▪ Bedrock Geology ▪ Surficial Geology ▪ Presence of Aquifers ▪ Faults and Unstable Areas	Section 3.7	The landfill footprint shall not be located within 100 m of a geologically unstable area. A geologically unstable area is defined as a location where natural or man-made features pose a substantial risk to the integrity of the landfill environmental control systems or global stability of the fill. Specifically, the landfill footprint must not be located within 100 m of: ▪ A Holocene fault. ▪ A known or active or historic landslide. ▪ Areas underlain by weak or collapsible soils, karst limestone, frozen mineral soil or muskeg with an active layer, or underground mine workings. ▪ Areas prone to debris movement (landslide paths, avalanche paths, alluvial fans). ▪ A location at risk of being impacted by tsunami.”	
Airports	Section 3.3	▪ NAV CANADA must assess and approve all proposals for land use near airports and air navigation infrastructure before construction begins to ensure that air navigation system safety and efficiency are not compromised by proposed land development. NAV CANADA recommends consulting Transport Canada policies for land use in the vicinity of airports. As a rule of thumb, Transport Canada generally require that a landfill footprint be located no closer than 8 km from airports. This is due to the propensity for landfills to attract birds, thereby creating potential hazards to aircraft, especially during take-off and landing. That minimum separation distance may be reduced to 3.2 km if bird control measures acceptable to NAV CANADA are implemented at the landfill site, and the reduction in the necessary buffer is approved by the airport authority. The NAV CANADA assessment does not replace approvals or permits required by other federal, provincial or municipal authorities. Where airport zoning regulations require longer buffer zones, the provisions of those regulations shall prevail. ▪ The zoning and separation conditions included in this section refer to NAV CANADA controlled airports only, as not all airports are controlled by NAV CANADA but by local authorities or other bodies. Nonetheless, Transport Canada guidelines represent the recommended zoning and separation conditions for all other airports.	

Other sections of the Criteria that refer to Siting Criteria not referenced above will be considered in future stages of the project. For example:

- Section 3.6 – Gullies and Depressions: The landfill footprint shall not be located in a gully or depression that acts as a point of water collection during rainfall events unless acceptable diversion works are provided such as interception ditching or other diversion measures are undertaken. Diversion of water through culverts beneath the landfill footprint is not allowed.
  - During site reconnaissance at the recommended locations in this report, the potential sites can be vetted for the presence of gullies and depressions.
- Section 3.12 – Depth to Water Table: The landfill base shall be a minimum 1.5 m above "groundwater" at all times. The separation distance shall consider the hydrogeologic conditions at the site including the hydraulic capacity of the underlying soils.
  - This will be considered as part of the future design following geotechnical investigation at the site(s) chosen for advancement as a possible new landfill location.

Table 2-2: Selection Criteria: Soft Constraints

Selection Criteria	Criteria Reference	Requirement	Note/Consideration
Distance from Existing Chetwynd Landfill	N/A	Initially a 50 km travel distance was utilized.	After initial review lowered to a 20 km radius from the current Landfill.
Existing Road Access	N/A	All site locations have been chosen in part due to their proximity to existing roads.	
Municipal and First Nations District Boundaries	N/A	The potential sites were screened for proximity to First Nations and municipal boundaries.	
Private Land Ownership	N/A	Private Land Ownership was taken into account during the siting screening.	
Agricultural Land Reserves	N/A	Proximity to areas allocated as Agricultural Land Reserves has been considered.	
Development and Utilities	N/A	Locations of existing facilities, pipelines, roads, oil, and gas wells and other developments/infrastructure must be considered.	

2.3 Additional Evaluation Measures

Further to the GIS-mapping based evaluation identified in Section 2.2, Tetra Tech referenced our in-house borehole database for stratigraphic information from the region. The review of the database showed that there are no boreholes directly in the study area. Existing boreholes in the region can be utilized during the technical phase of the landfill feasibility study to assist in geological and hydrogeological assessment.

3.0 DISCUSSION OF PROSPECTIVE SITES

Based on initial evaluation of the selection criteria, Tetra Tech identified the prospective sites on Table 3-1 below and identified on Figure 1.

Table 3-1: Initially Identified Prospective Sites

Area Name	Northing (centre point)	Easting (centre point)	Comments
A	6181702.60	587980.82	This site was proposed due to good transport links, lack of water supply permits, and water wells in the vicinity. Water features are present, but not in such a great number to preclude siting.
B	6176746.71	589312.44	Area directly to the north of the existing landfill. Potential expansion may be an easier path to approval.
C1	596612.76	6162284.73	This site was proposed due to good transport links, lack of water supply permits, and water wells in the vicinity, and proximity to closed landfill.

Tetra Tech presented the prospective sites above to the PRRD during a meeting on August 8, 2023. Based on the meeting, the following selection criteria were added/confirmed:

- Reduced the radius for preferred site consideration to 15 km around Chetwynd; and
- Confirmation land adjacent to the existing Landfill would remain within consideration.

During the meeting, the PRRD also suggested the locations in Table 3-2 and Figure 1 for further evaluation.

Table 3-2: Prospective Sites Identified by the PRRD

Area Name	Northing (centre point)	Easting (centre point)	Comments
D	6174656.31	598822.33	Proposed as the site has excellent road access and is within reasonable travel distance from Chetwynd.
E / C2	6163741.02 / 6163868.13	593807.23 / 593797.64	Proposed as an option as to ensure the site is to the west of existing pipeline infrastructure. 'Area C2' was applied by Tetra Tech within the Area E provided by the PRRD.

Tetra Tech presented initial recommendations of Area A, Area B, and Area C2 to the PRRD on August 29, 2023. The PRRD indicated a limited interest to further investigate Area C2 due to potential concerns and challenges with a steep section of the road that leads to the site and proximity of residents. The PRRD requested Tetra Tech complete an additional evaluation for an additional site. Tetra Tech undertook this evaluation with the results presented in Table 3-4. These results were presented to the PRRD on September 12, 2023, at which time the PRRD requested Tetra Tech to further evaluate sites north along Jackfish Lake Road with the indication that the distance from the current Chetwynd Landfill could be increased from 15 km to 20 km or slightly further if required. The results of this evaluation are presented in Table 3-5.

3.1 Evaluation of Prospective Sites

Based on the sites discussed during the August 8, 2023 meeting, and identified above, four potential locations were further evaluated. These locations are shown on Table 3-3 and Figure 1. These sites were evaluated relative to available species at risk, borehole, water well information, and surface conditions / development from aerial imagery.

Table 3-3: Initially Evaluated Locations

Area Name	Northing (centre point)	Easting (centre point)	Approximate Study Area Size(m^2)	Comments
A	6181702.60	587980.82	4,000,000	Approximately 6.5 km to the north of the existing Chetwynd landfill.
B	6176746.71	589312.44	90,000	This would be an expansion to the north at the existing Chetwynd landfill.
C1	596612.76	6162284.73	4,000,000	Approx 10.6 km to the south of the existing Chetwynd landfill. Based on discussion with the PRRD this site is in close proximity to a former closed landfill that had been previously considered for a transfer station location; however, the closed site itself would not be a suitable location. Indicated by PRRD that there is a steep section in the road access and a location closer to the main Highway should be considered.
D	6174656.31	598822.33	4,000,000	Proposed by PRRD as a potential location. Approx 10.6 km east of the existing Chetwynd landfill. It was noted during the meeting of August 8 that there were numerous water features including watercourses, waterbodies, and groundwater wells in the Area. Other observations included the presence of numerous private landowners.
E / C2	6163741.02 / 6163868.13	593807.23 / 593797.64	8,988,484	Proposed by PRRD as a potential location due to the presence of existing pipeline infrastructure in the Lone Prairie location. Approximately 10.6 km south of existing Chetwynd landfill. It was noted that Area E overlaps Area C. The sections of Area E that lie outside of the proposed Area C boundary have numerous limitations as a siting option: multiple private landowners to the west, multiple packets of Provincial Crown land, water features that with the 100 m buffer would preclude construction in the southern section of Area E, and the western part of the study area is situated within an alluvial fan.

Figures 2a, 2b, 2c, and 2d, show water features including watercourses and waterbodies, and groundwater wells. A 100 metre buffer has been applied to water features.

- **Figure 2a** shows that Area A has watercourses present that likely preclude the possibility of siting a landfill to the west of Highway 29; however, to the east of the highway there is enough space to potentially site a landfill between two of the water bodies. No water wells are present in the study area.
- **Figure 2b** shows the location of a potential expansion to the north of the existing Chetwynd landfill, note that there is a water feature mapped that runs through the existing site. There are also three water wells present on private land to the west, east, and northeast of the existing site, the wells are sufficiently distant, and beyond the Criteria siting requirement limits.

- **Figure 2c** Within the Area C2 boundary, there is a water feature present to the south of Lone Prairie Road, and further water features on the eastern and northeastern boundary of the potential siting area. The area to the north of Lone Prairie Road is a potentially favorable location in this study area. No water wells are present in the study area. Within the Area E boundary, there are water features present in the northwest, west, south, and east sections.
- **Figure 2d** shows that there are water features, largely watercourses and wetland, present in approximately 50% of the potential siting area (Area D).

Figures 3a, 3b, 3c, and 3d show an overlay of environmental searches, land use, and surficial geology. Environmental searches considered included the presence of sensitive species, historical resources, parks, and protected areas.

- **Figure 3a** shows that there are no known habitats of sensitive species, historical resources or parks and protected areas within Area A. Surficial geology present in the study area is largely "streamlined till ridges" with an area of glaciolacustrine veneer running along the Highway 29 in a north to south alignment for much of the central part of the study area. An alluvial plain associated with a water feature is present in the northwest corner of the study area. Figure 1 shows that Moberly Lake Park is present to the northwest of Area A; however, it is approximately 4 km away from the study area.
- **Figure 3b** shows that there are no known habitats of sensitive species, historical resources or parks and protected areas within Area B. There is an agricultural land reserve approximately 350 m to the east of the current landfill site (shown in the southeast corner of Figure 3b). Surficial geology present in the study area is largely streamlined till ridges with a glaciolacustrine plain to the east, and an alluvial fan to the east-northeast. It should be noted that landfills cannot be sited within 100 m of alluvial fans; however, the potential site is greater than 250 m away from the 100 m buffer applied to the closest alluvial fan deposit.
- **Figure 3c** shows that there are no known habitats of sensitive species, historical resources, or parks and protected areas within the Area C2. Surficial geology present in the study area is largely till veneer. There is an alluvial fan present to the west of the study area that removes a portion of Area E as a potential siting option, and the 100 m buffer zone would extend into the potential siting area. However, this is largely to the south of Lone Prairie Road, and combined with the presence of the water feature mentioned above, would make this part of the study area less desirable for landfill siting.
- **Figure 3d** shows that there are no known habitats of sensitive species, historical resources, or parks and protected areas within the Area D. The Area is within an Agricultural Land Reserve and has numerous private landowners present. Surficial geology present in the study area is largely glaciolacustrine veneer in the southern portion, and glaciofluvial ridge deposits, including eskers, and streamlined till ridges in the northern portion of the study area. Figure 1 shows that the Pine River Breaks Park is present to the southeast of Area D; however, it is approximately 1 km away from the study area.

Figures 4a, 4b, 4c, and 4d show bedrock geology. In all four of the study areas the bedrock primarily belongs to the Dunvegan Formation, with the underlying Fort St John Group also present. The Dunvegan Formation, of the middle Cenomanian (lower Upper Cretaceous), is described as being composed of coarse clastic sedimentary rocks including interbedded sandstones, siltstones, and shales. In the Peace River Valley, the Dunvegan Formation dips gently to the southwest. The Fort St John Group is composed of five formations, with the Cruiser Formation (the uppermost) being present in study Area B and Area C2. The Cruiser Formation is argillaceous, composed largely of shale, with interbedded mudstone and siltstone.

In terms of landfill siting, these bedrock formations as described do not present obvious hard constraints, although it should be noted that the Dunvegan Formation description of being composed of coarse clastic sedimentary rocks that would require further investigation at the intrusive stage. Hydraulic conductivity values for the coarse grained rocks could be evaluated. This concern is somewhat negated by the presence of the shales of the Fort St John Group underlying the Dunvegan Formation, and the presence of fine-grained surficial deposits above.

Based on the information and considered constraints, the following locations were deemed less favourable due to the following limitations:

- Area D has been removed from further consideration as a potential site for a new landfill due to following reasons: the presence of water features, largely watercourses and wetland, present in approximately 50% of the potential siting area; the fact that it is within an area of Agricultural Land Reserve; the proximity of Pine River Breaks Park to the southeast; and the presence of numerous private landowners in the area.
- The sections of Area E that are outside the boundaries of proposed Area C2 have been also been removed from further consideration due to the following reasons: the western segment overlies an alluvial fan; there are numerous water features in the west, south, and eastern sections of Area E; slopes appear to be steep in the north, south, and west sections.

Following the August 29, 2023 meeting with the PRRD presenting Areas A to Area E, Tetra Tech undertook an evaluation for a further third potential siting location. The assessment of further options was carried out with the siting criteria methodology described in Section 2. As part of this, ease of access from main travel routes was considered as a key factor in evaluating potential sites, and as such the search areas are described as per the road corridors they lie along. The results of this further evaluation are presented in Table 3-4.

Table 3-4: Evaluation After August 29, 2023 Meeting

Search Area	Road Corridor	Direction from Chetwynd	Comments
F	Highway 97	East	To the southeast of town, and to the west of Area D. Limiting factors for siting in this area include being within the 8 km setback of the NAV CANADA setback from airports, a site located in this area would likely be on the landing/takeoff flight path for the airport. Acreages are present to the south of the highway and have water well licenses. Watercourses and other surface water features are present to the north and south of Highway 97 further limiting siting potential.
G	Highway 97	East	To the southeast of town, and to the east of Area D. There are many surface water features north and south of the highway. There are also various wells and water licenses associated with acreages and farms. East of Area D, the area becomes part of the Agricultural Land Zone, this would make obtaining siting approval more problematic.
H	Highway 97	West	To the southwest of town. Topography is a limiting factor in this area, north of the highway ground is very steep, development of a landfill would not be advisable. The valley floor is largely set in alluvial fan deposits which are a hard constraint for landfill siting. Water features including Pine River, and numerous water wells are present.
I	Highway 29	South	To the south of town. In this area alluvial fan deposits are present along the valley floor. To the east of the highway the topography is very steep, and therefore unsuited to landfill development. Water features including the river and water wells associated with private residences are present.
J	Highway 29	North	To the north of town, and Area A. Similar to Area A; however, topography is steeper and therefore siting would be more difficult to achieve. This area is closer to Moberly Lake First Nation. As with Area A there are some water features present, but not enough to preclude construction.
K	Jackfish Lake Road	Northeast	To the northeast of town and Area B. Topography to the north of the road is steep and therefore unfavourable for landfill construction. Numerous private and Crown land packages to southeast of the road. Numerous water features present within the area that limit potential siting locations. Note that this area would also be within the (outer) 8 km NAV CANADA setback, however, less likely to be on a direct flightpath for takeoff/landing. The surficial geology is shown to be Glaciolacustine Plain in the flat areas and Streamlined Till Ridges in the forested areas.

Area F to Area K have various limiting factors that either rule out siting completely or would render siting unfavourable. Tetra Tech recommends removing Area F to Area K from further consideration.

Based on a meeting presenting Area F to Area K on September 12, 2023, the PRRD requested that Tetra Tech further evaluate sites north along Jackfish Lake Road based on a distance from Chetwynd up to 15 km to 20 km or slightly further if required. Based on this evaluation, Area L in Table 3-5 was identified.

Table 3-5: Evaluation After September 12, 2023 Meeting

Area Name	Northing (centre point)	Easting (centre point)	Approximate Study Area Size(m^2)	Comments
L	6188388.93	597107.11	4,397,203	Approximately 18 km northeast of Chetwynd on Jackfish Lake Road. Airphoto resolution is poor, but the area appears flat with little grade. It is Crown Land but 500 m residential buffer reduces potential developable area. Relatively complex pattern of development constraints. There are no groundwater abstraction wells in proximity to the candidate area. Surficial geology is predominantly Glaciofluvial Plain and Glaciofluvial Hummocky Terrain.

4.0 RECOMMENDATIONS AND NEXT STEPS

Based on the evaluation completed, Tetra Tech recommends the preliminary field reconnaissance portion of the Feasibility Study be undertaken for the sites in Table 4-1. Based on discussion with the PRRD on September 14, 2023, it was agreed that Area A, Area B, and Area L would be investigated and, if there was time, remaining Area C2 would also be investigated noting that the original scope was for three sites.

Table 4-1: Recommended Sites for Site Reconnaissance

Area Name	Location
A	Approximately 6.5 km to the north of the existing Chetwynd landfill.
B	Expansion to the north at the existing Chetwynd landfill.
C2	Approximately 10.6 km to the south of the existing Chetwynd landfill.
L	Approximately 15.5 km to the north of the existing Chetwynd Landfill

The site reconnaissance will be completed to get an overview of the land, and to identify features such as springs, small waterbodies, the potential presence of gullies, or depressions. The field work is preliminary in nature and will be used to further recommend sites to undergo a more in-depth technical investigation. The following field work will be completed:

- Incidental wildlife sweep to identify the presence of any sensitive habitat features such as dens, or species-at risk which may require specific consideration in design, regulatory dealings, as well as prior to construction activity.
- Confirmation of wetland presence, classification, and desktop-delineated wetland and watercourse boundaries.
- Visual assessment of the site from a geotechnical/landform standpoint and overall site suitability for landfill operations.

A desktop Archeological Overview Assessment (AOA) will be completed of the candidate areas.

Tetra Tech will prepare a technical memo outlining the results of the site reconnaissance and AOA for the three or four potential sites. From these three potential locations, a recommendation on sites deemed feasible and warranting further in-depth technical investigation will be made.

It should be noted that no specific surveys for rare plants or wildlife (i.e., breeding birds) are recommended at this time and a topsoil assessment is not included. These tasks would be completed as part of further in-depth technical investigation.

4.1 Preliminary Technical Investigation

Tetra Tech recommends that once the technical memo has been reviewed, that a preliminary technical investigation be advanced. It is anticipated that the technical investigation would be undertaken in Spring 2024 and depending on the site and available information include:

- Advancement of up to eight (8) geotechnical boreholes with Standard Penetration Test (SPT) testing to a maximum depth of 10 m.
- Installation of three (3) groundwater piezometers to characterize depth to groundwater within the cell design or waste footprint area.
- Laboratory testing to determine the engineering properties of the site's soils. This allows a preliminary assessment to determine the required liner systems and identify conditions that may inhibit landfill construction.
- Interpretation of the data and preparation of a summary geotechnical report.

5.0 CLOSURE

We trust this document meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

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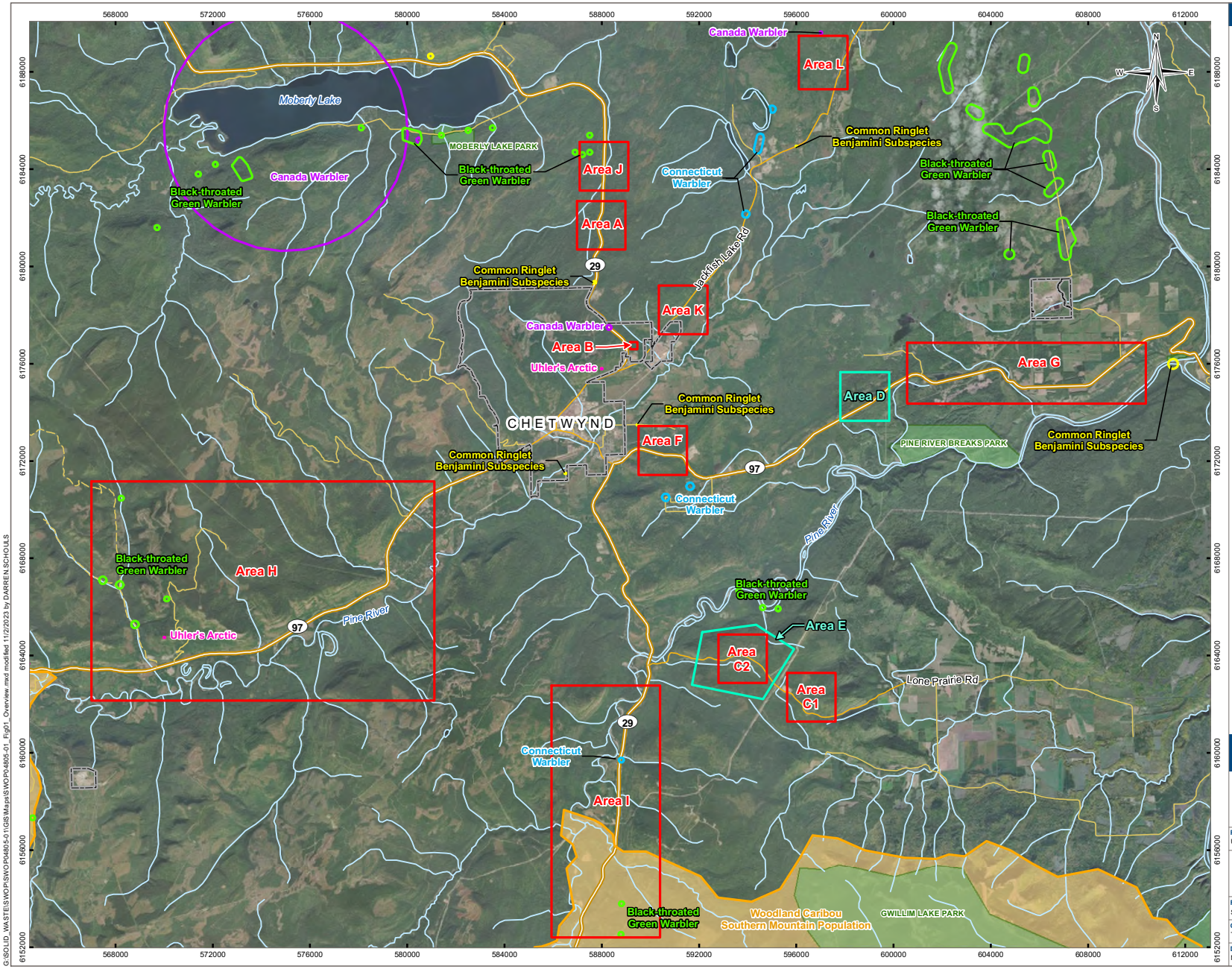
PERMIT TO PRACTICE
TETRA TECH CANADA INC.
PERMIT NUMBER: 1001972

FIGURES



LEGEND

- Potential Lanfill Site Area Identified by Tetra Tech
- Potential Lanfill Site Area Identified by PRRD

SARA Critical Habitat (Status)

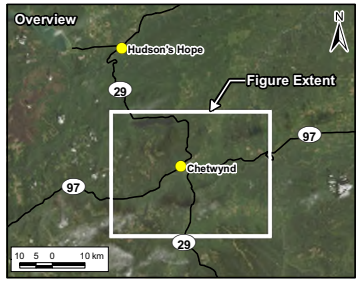
- Woodland Caribou - Southern Mountain Population (Final)

CDC Species at Risk Occurrences

- Black-throated Green Warbler (Blue-listed)
- Canada Warbler (Blue-listed)
- Caribou - Central Mountain Population (Red-listed)
- Common Ringlet - Benjamini Subspecies (Blue-listed)
- Connecticut Warbler (Blue-listed)
- Uhler's Arctic (Blue-listed)

Base Data

- Highway
- Main Road
- Local Road
- Resource/Recreational Road
- Watercourse/Waterbody
- District Of Chetwynd Municipal Boundary
- Provincial Park Boundary



NOTES
Base data source:
Imagery from ESRI; Maxar
Base data from CanVec; 1:250,000 (2019)

STATUS
ISSUED FOR USE

NEW LANDFILL FEASIBILITY STUDY - SCREENING STAGE
PEACE RIVER REGIONAL DISTRICT

Site Overview & Species at Risk Occurrences

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	Peace River Regional District

Scale: 1:150,000
3 1.5 0 3
Kilometres

TETRA TECH

FILE NO.				
SWOP04805-01_Fig01_Overview.mxd				
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Tt-VANC	DS	SL	SB	0
DATE	PROJECT NO.			
November 2, 2023	SWM.SWOP04805-01			

Figure 1

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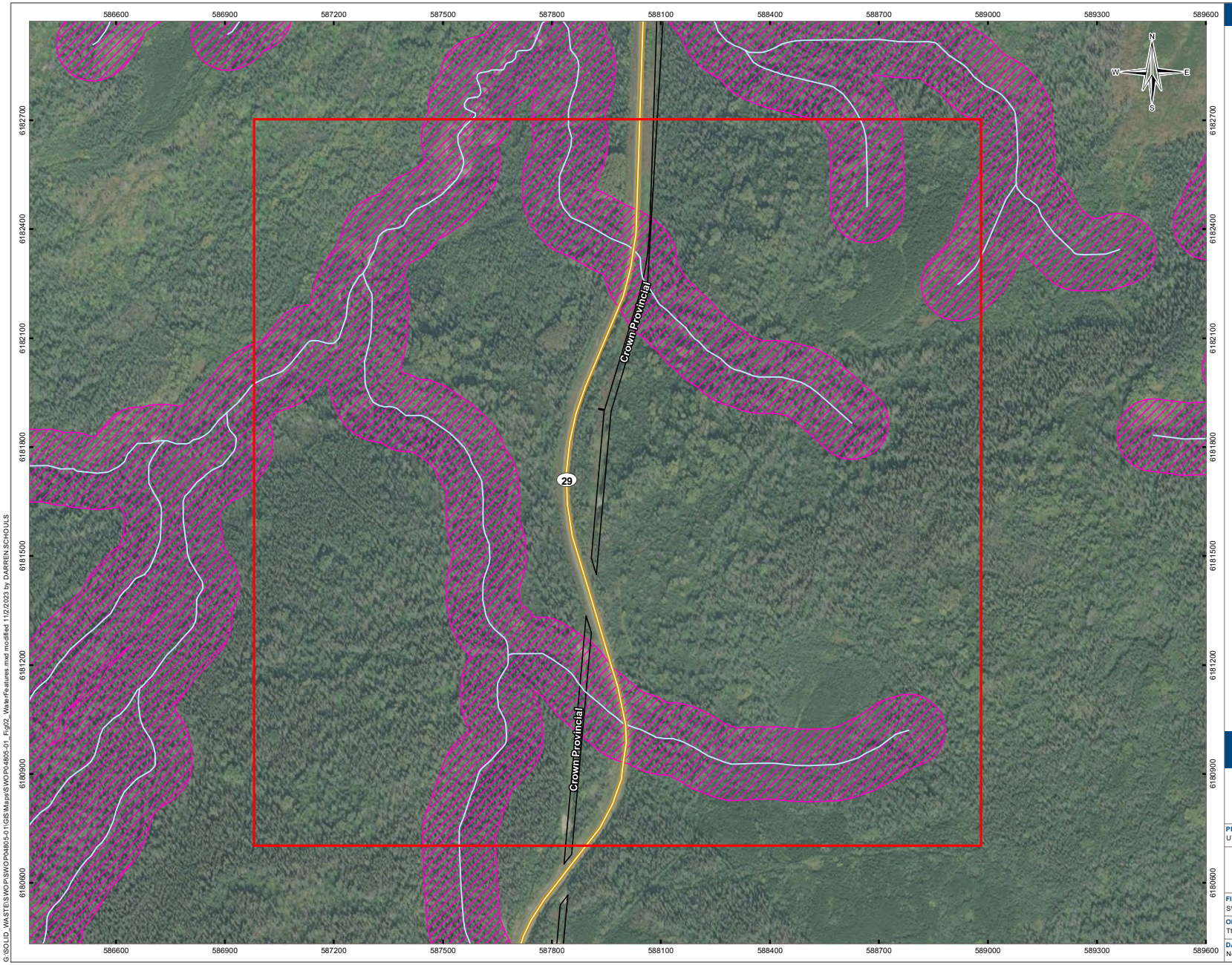
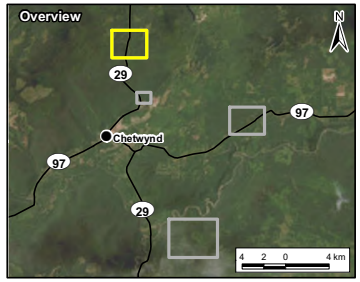


LEGEND

- Potential Lanfill Site Area Identified by Tetra Tech
- 100 m Water Feature Buffer
- Parcel Boundary

Base Data

- Highway
- Watercourse/Waterbody



NOTES
Base data source:
Water features from Fresh Water Atlas (2023)
Groundwater Wells from DataBC (2023)
Parcels from DataBC (2023)

STATUS
ISSUED FOR USE

NEW LANDFILL FEASIBILITY STUDY - SCREENING STAGE
PEACE RIVER REGIONAL DISTRICT

Area A Water Features

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	Peace River Regional District

Scale: 1:10,000
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Metres

TETRA TECH

FILE NO.
SWOP04805-01_Fig02_WaterFeatures.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	SB	0

DATE
November 2, 2023

PROJECT NO.
SWM.SWOP04805-01

Figure 2a

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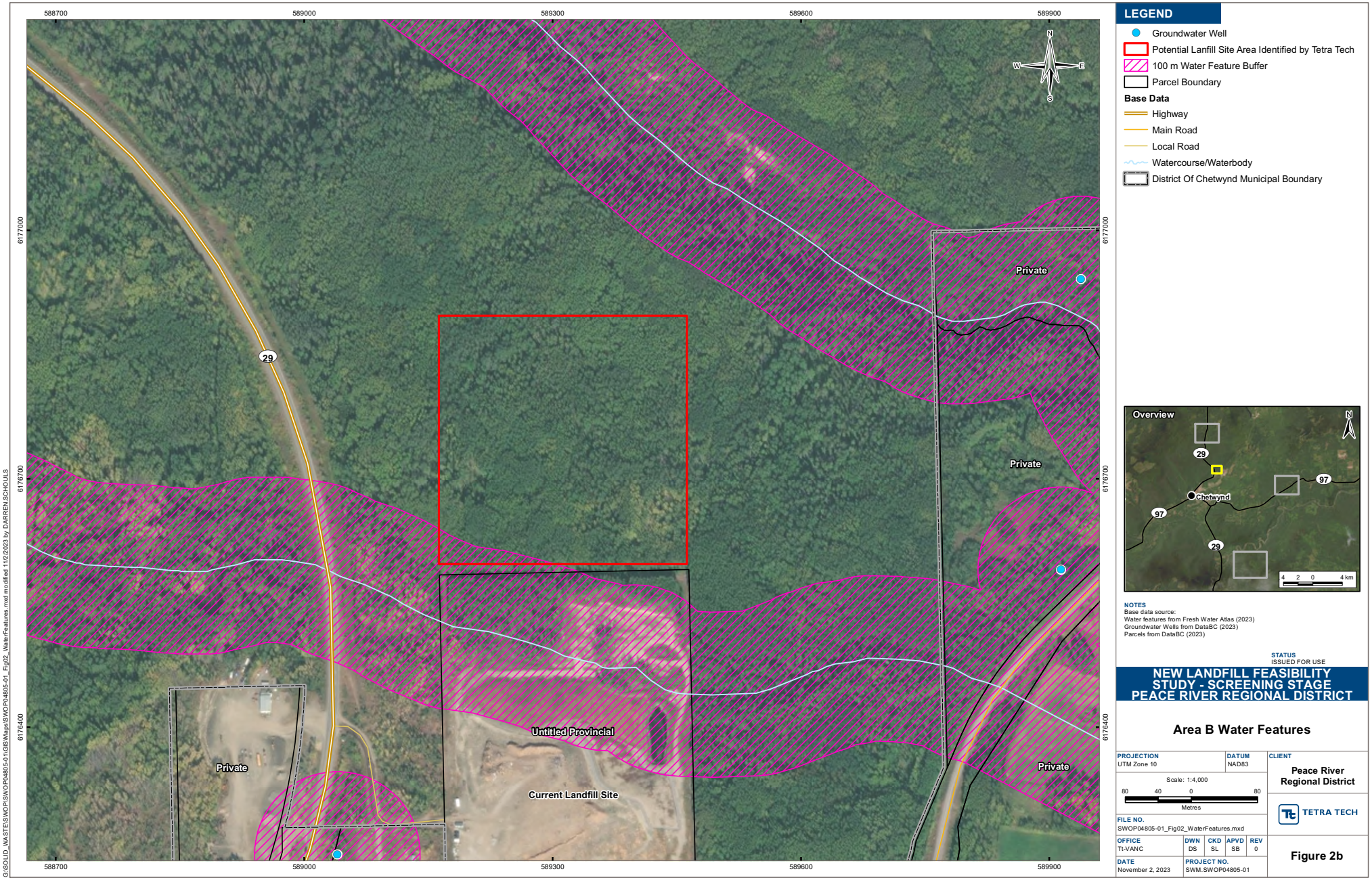
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589000
589300
589600
589900
6177000
6176700
6176400
N
W
E
S
29
Private
Private
Private
Private
Untitled Provincial
Current Landfill Site
LEGEND
Groundwater Well
Potential Lanfill Site Area Identified by Tetra Tech
100 m Water Feature Buffer
Parcel Boundary
Base Data
Highway
Main Road
Local Road
Watercourse/Waterbody
District Of Chetwynd Municipal Boundary
Overview
29
97
Chetwynd
97
29
4 2 0 4 km
NOTES
Base data source:
Water features from Fresh Water Atlas (2023)
Groundwater Wells from DataBC (2023)
Parcels from DataBC (2023)
STATUS
ISSUED FOR USE
NEW LANDFILL FEASIBILITY STUDY - SCREENING STAGE
PEACE RIVER REGIONAL DISTRICT
Area B Water Features
PROJECTION
UTM Zone 10
DATUM
NAD83
Scale: 1:4,000
80 40 0 80
Metres
CLIENT
Peace River Regional District
TETRA TECH
FILE NO.
SWOP04805-01_Fig02_WaterFeatures.mxd
OFFICE
Tt-VANC
DWN
DS
CKD
SL
APVD
SB
REV
0
DATE
November 2, 2023
PROJECT NO.
SWM.SWOP04805-01
Figure 2b
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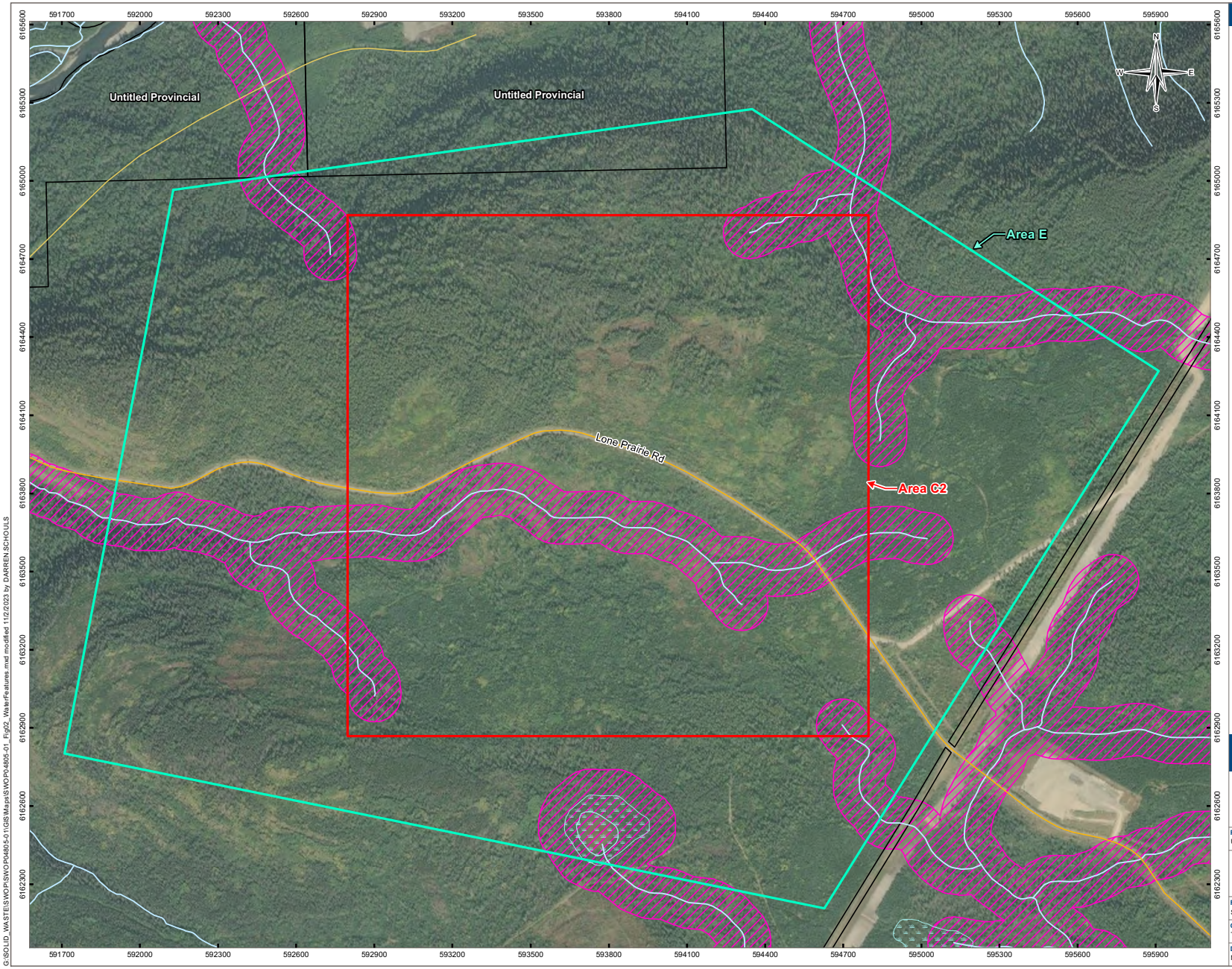
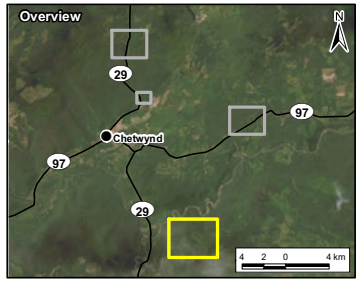


LEGEND

- Potential Lanfill Site Area Identified by Tetra Tech
- Potential Lanfill Site Area Identified by PRRD
- 100 m Water Feature Buffer
- Parcel Boundary

Base Data

- Main Road
- Local Road
- Watercourse/Waterbody
- Wetland



NOTES
Base data source:
Water features from Fresh Water Atlas (2023)
Groundwater Wells from DataBC (2023)
Parcels from DataBC (2023)

STATUS
ISSUED FOR USE

NEW LANDFILL FEASIBILITY STUDY - SCREENING STAGE
PEACE RIVER REGIONAL DISTRICT

Area C2 & E Water Features

PROJECTION: UTM Zone 10	DATUM: NAD83			CLIENT: Peace River Regional District
Scale: 1:14,000 — 80 40 0 80 Metres				TETRA TECH
FILE NO.: SWOP04805-01_Fig02_WaterFeatures.mxd				
OFFICE: Tt-VANC	DWN: DS	CKD: SL	APVD: SB	REV: 0
DATE: November 2, 2023	PROJECT NO.: SWM.SWOP04805-01			Figure 2c

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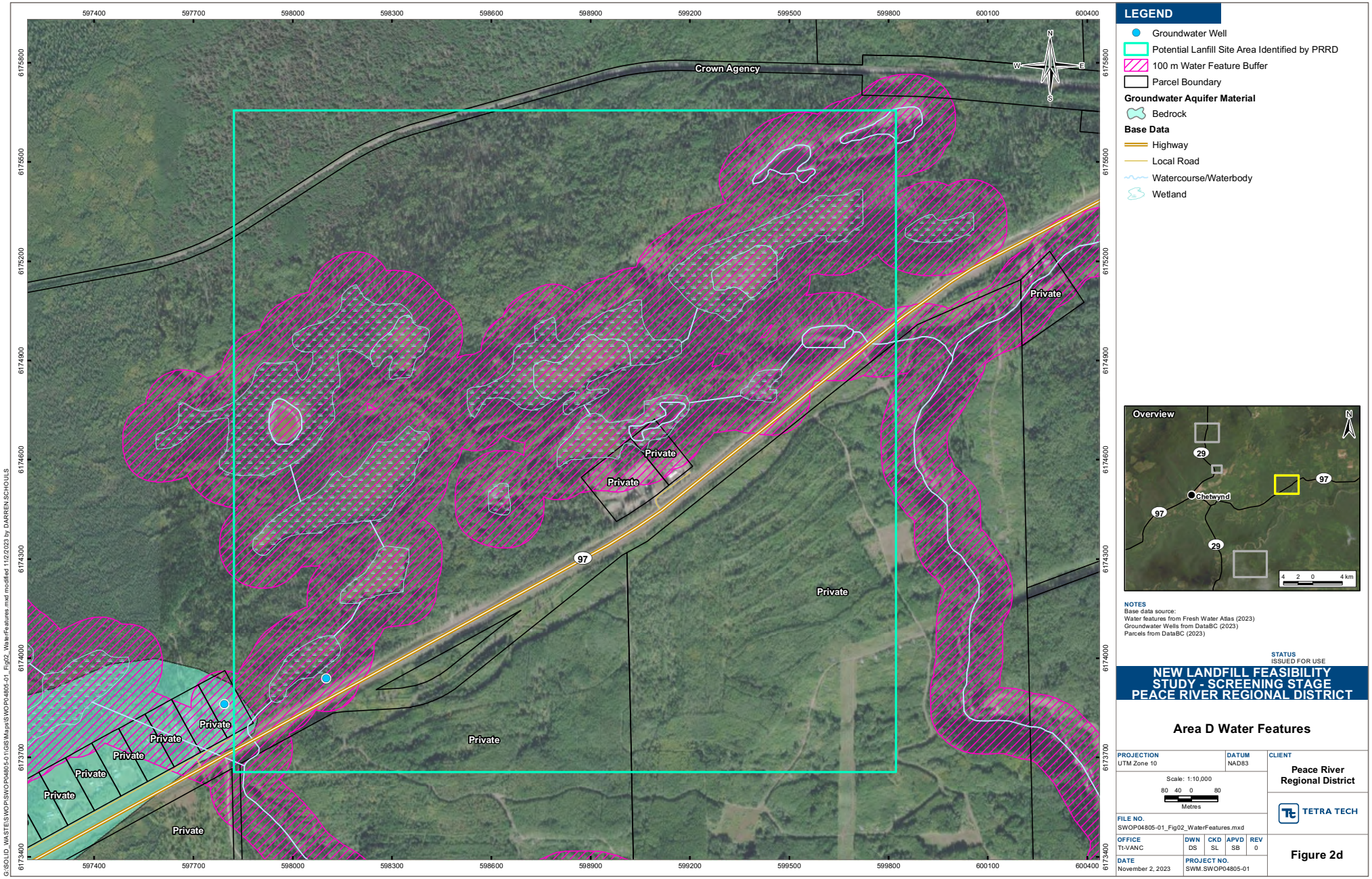

LEGEND

- Groundwater Well
- Potential Lanfill Site Area Identified by PRRD
- 100 m Water Feature Buffer
- Parcel Boundary

Groundwater Aquifer Material

- Bedrock

Base Data

- Highway
- Local Road
- Watercourse/Waterbody
- Wetland

NOTES
Base data source:
Water features from Fresh Water Atlas (2023)
Groundwater Wells from DataBC (2023)
Parcels from DataBC (2023)

STATUS
ISSUED FOR USE

NEW LANDFILL FEASIBILITY STUDY - SCREENING STAGE
PEACE RIVER REGIONAL DISTRICT

Area D Water Features

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	Peace River Regional District

Scale: 1:10,000
80 40 0 80
Metres

FILE NO.
SWOP04805-01_Fig02_WaterFeatures.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	SB	0

DATE
November 2, 2023

PROJECT NO.
SWM.SWOP04805-01

TETRA TECH

Figure 2d

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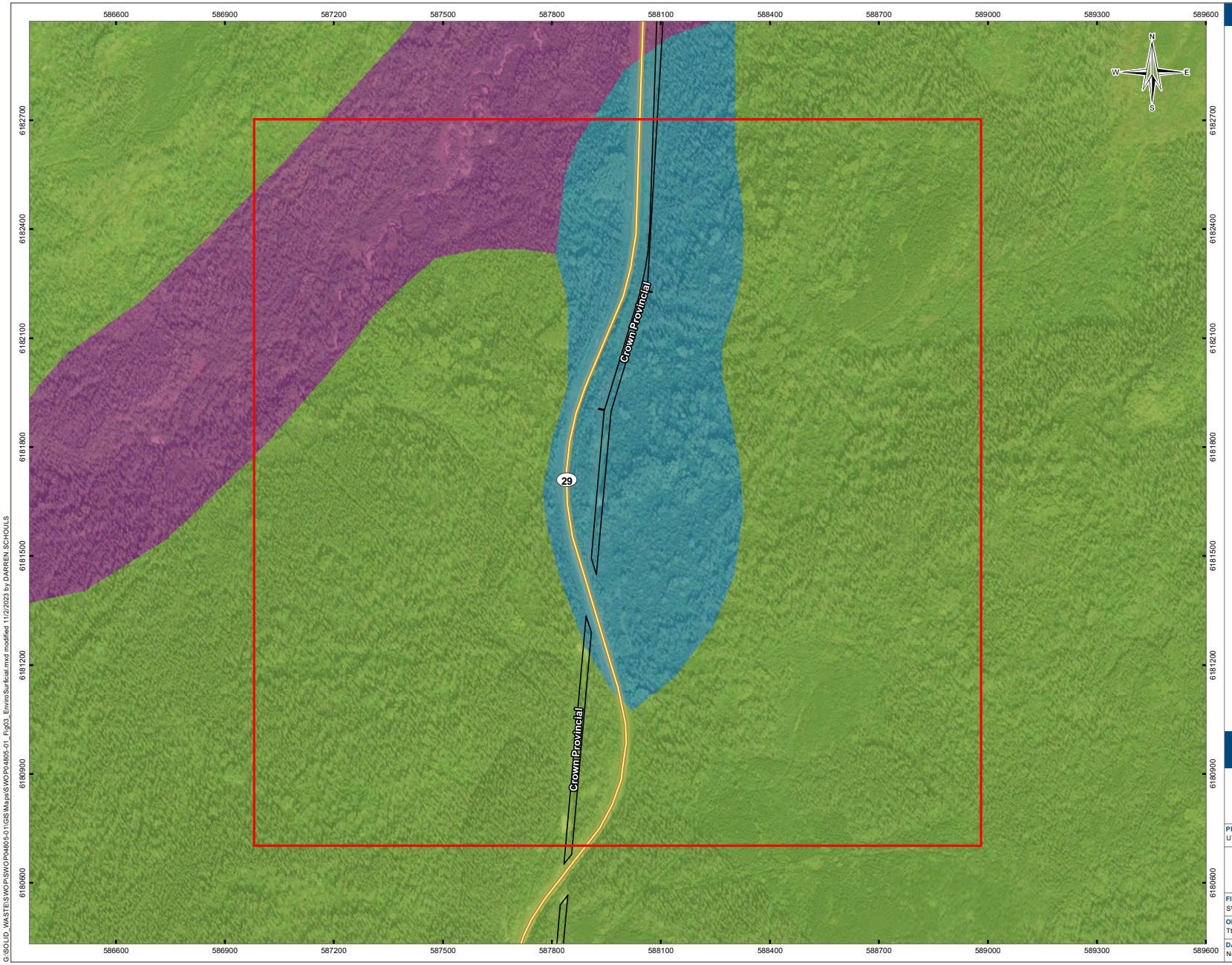


LEGEND

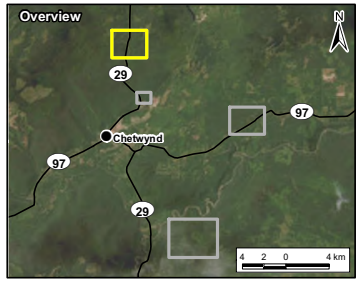
- Potential Lanfill Site Area Identified by Tetra Tech
- Parcel Boundary

Surficial Geology

- Alluvial Plain
- Glaciolacustine Veneer (thin, less than 2 m)
- Streamlined Till Ridges

Base Data

- Highway



NOTES
Base data source:
Surficial Geology from Geoscience BC (2011)
ALR, Remediation Sites, and Parcels from DataBC (2023)

STATUS
ISSUED FOR USE

NEW LANDFILL FEASIBILITY STUDY - SCREENING STAGE
PEACE RIVER REGIONAL DISTRICT

Area A Environmental Searches & Surficial Geology

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	Peace River Regional District

Scale: 1:10,000
80 40 0 80
Metres

TETRA TECH

FILE NO.				
SWOP04805-01_Fig03_EnviroSurficial.mxd				
OFFICE	**DWN**	**CKD**	**APVD**	**REV**
Tt-VANC	DS	SL	SB	0
DATE	**PROJECT NO.**			
November 2, 2023	SWM.SWOP04805-01			

Figure 3a

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LEGEND

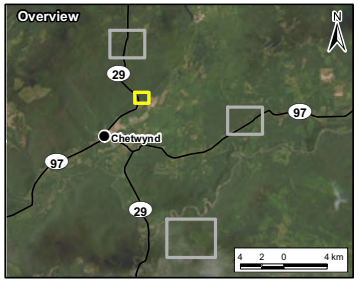
- Remediation Site
- Potential Lanfill Site Area Identified by Tetra Tech
- Agricultural Land Reserve
- Parcel Boundary

Surficial Geology

- Alluvial Fan
- Glaciolacustine Plain
- Streamlined Till Ridges
- Alluvial Fan 100 m Buffer

Base Data

- Highway
- Main Road
- Local Road
- District Of Chetwynd Municipal Boundary



NOTES
Base data source:
Surficial Geology from Geoscience BC (2011)
ALR, Remediation Sites, and Parcels from DataBC (2023)

STATUS
ISSUED FOR USE

NEW LANDFILL FEASIBILITY STUDY - SCREENING STAGE PEACE RIVER REGIONAL DISTRICT

Area B Environmental Searches & Surficial Geology

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	Peace River Regional District

Scale: 1:4,000
80 40 0 80
Metres

TETRA TECH

FILE NO.				
SWOP04805-01_Fig03_EnviroSurficial.mxd				
OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	SB	0
DATE	PROJECT NO.			
November 2, 2023	SWM.SWOP04805-01			

Figure 3b

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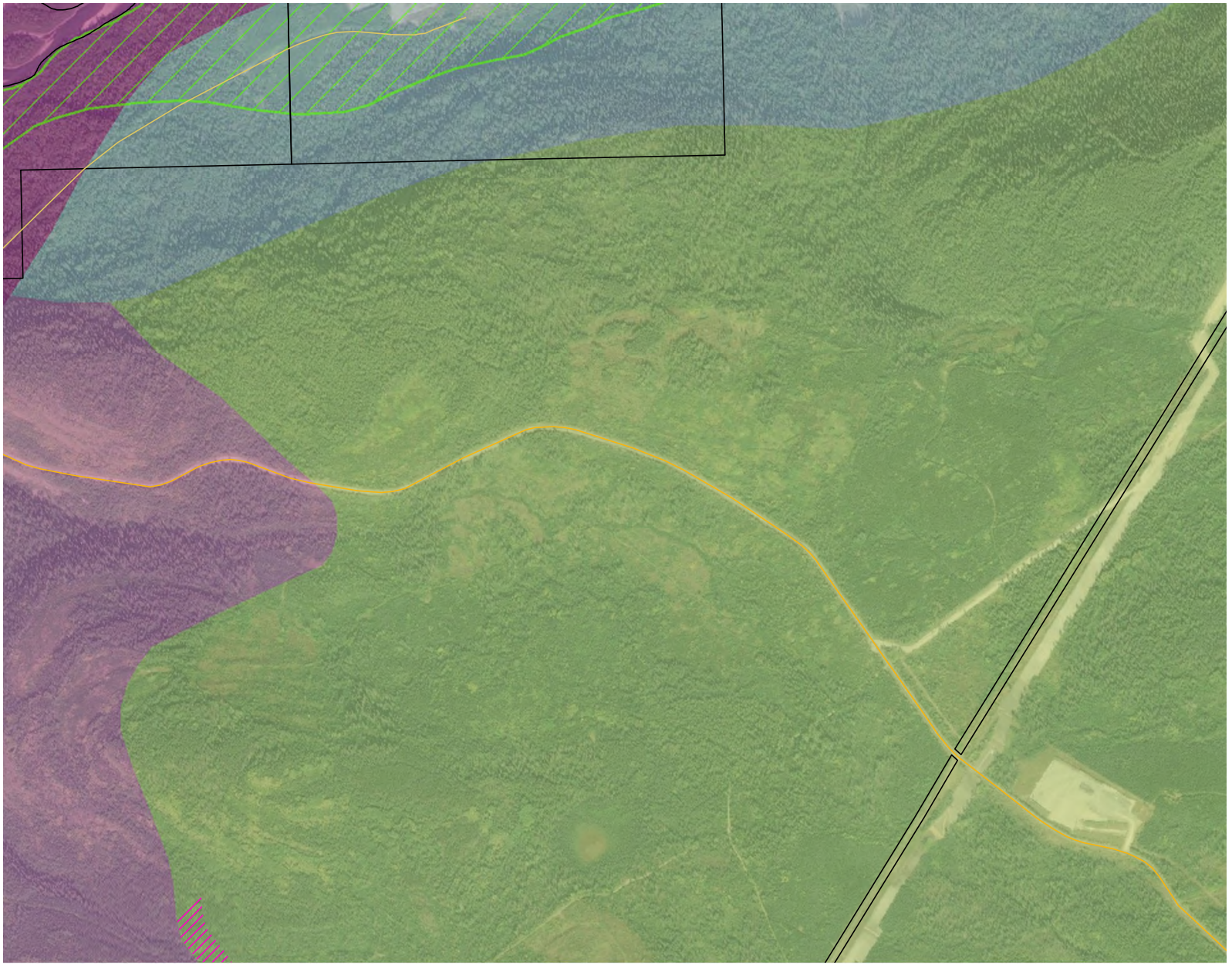

ISSUED FOR USE

PROJECTION	DATUM	CLIENT
FILE NO.		
OFFICE	DWN CKD APVD REV	Figure 3c
DATE	PROJECT NO.	

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TETRA TECH

TECHNICAL MEMO

ISSUED FOR USE

To:	Gerritt Lacey, Solid Waste Manager	**Date:**	February 20, 2024
c:		**Memo No.:**	
From:	Sarah Keith	**File:**	704-SWM.SWOP04801-01
Subject:	New Landfill Feasibility – Chetwynd Area Stage 1: Site Selection – Site Reconnaissance		

1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) was retained by the Peace River Regional District (PRRD) to conduct a new landfill feasibility study (study) with the goal of siting a new landfill in the Chetwynd area.

The current Chetwynd Landfill (site or Landfill) received an operating permit in 1977. The 2021 Design, Operating, and Closure Plan (DOCP) indicates that the estimated closure date is 2030, while the 2022 Annual Report indicates an estimated closure date of 2029[1]. Based on the most conservative closure date of 2029, a new landfill cell will be required to be approved and built by 2028.

The scope of work for the project as outlined in the Tetra Tech Proposal entitled “Request for Proposals #20-2023 New Landfill Feasibility Study” dated May 5, 2023, is divided into three stages:

- Stage 1:
  - Site Selection:
    - Desktop evaluation; and
    - Site Reconnaissance.
  - Feasibility Study:
    - Preliminary Technical Investigation.
- Stage 2:
  - Permitting; and
  - Detailed Design.
- Stage 3:
  - Construction; and
  - Commissioning.

It should be noted that the PRRD requested to move the site reconnaissance work from the feasibility phase to the site selection phase of Stage 1 which has been reflected as a change within this technical memo (memo).

The Site Selection – Desktop Evaluation phase of Stage 1 was previously completed to identify locations that, based on a desktop study, have technical characteristics that appear favourable for development of a Municipal Solid Waste (MSW) Landfill in accordance with the British Columbia Ministry of Environment and Climate Change Strategy (BCMECCS) Landfill Criteria for Municipal Solid Waste (the Criteria) (2016). This was detailed in the

[1] Tetra Tech Canada Inc. 2023. *2022 Annual Operations and Monitoring Report – Chetwynd Landfill*.

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Vancouver, BC V6C 1N5 CANADA
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Tetra Tech Report entitled “New Landfill Feasibility – Site Selection - Landfill Siting Memo” dated November 3, 2023 (Tetra Tech 2023).

This memo undertakes Stage 1: Site Selection - Site Reconnaissance which is intended to build off the Landfill Siting Memo to complete a more detailed surface review of potential landfill development based on visual attributes associated with the environmental conditions as well as geotechnical and overall suitability for landfill operations.

Through the previous desktop evaluation task, four potential sites were identified for site reconnaissance. These are identified as Areas A, B, C2, and L. The location of each area in relation to Chetwynd can be seen on Figure 1. The site reconnaissance occurred on September 18 and 19, 2023. Tetra Tech visually assessed the areas from a stability and constructability standpoint, and to assess the overall site suitability for landfill operations. The site reconnaissance also assessed environmental conditions which may impact siting requirements such as wetland presence, desktop-delineated wetland and watercourse boundaries, and other observations of habitats of sensitive species that may impact the regulatory process.

2.0 REGULATORY CONSIDERATIONS

This section summarizes the relevant regulatory standards for siting a landfill in British Columbia (BC). Relevant regulatory requirements were considered during both the desktop evaluation and site reconnaissance phases of this project.

2.1 Provincial

2.1.1 British Columbia Environmental Management Act

The BC *Environmental Management Act* (EMA)[2] was enacted in July 2004, combining the previous Waste Management Act and Environment Management Act. The EMA governs solid waste and manages the introduction of waste into the environment by providing an authorization framework and environmental management tools to protect human health and environmental quality.

- Under the *Waste Discharge Regulations* of the EMA, certain industries, trades, businesses, and operations require authorization to discharge waste into the environment. However, even if an industry, trade, business, or operation does not require an authorization, waste discharge must not cause pollution (EMA Section 6 (4)).
- The *Spill Reporting Regulations* of the EMA establishes a protocol for reporting the unauthorized release of substances into the environment as well as a schedule detailing reportable amounts for certain substances.
- The *Hazardous Waste Regulations* of the EMA ensures that the generators, carriers and receivers of hazardous waste handle, store, transport, treat and dispose of hazardous waste in a safe manner. Hazardous wastes must be disposed of properly to ensure human health and environmental protection.

Under the EMA, regional districts are required to prepare and submit a solid waste management plan. The approved solid waste management plan authorizes regional districts to manage MSW in accordance with the plan. The BCMECCS released a guidance document in 2016: the Landfill Criteria for Municipal Solid Waste (herein referred to as “the Criteria”)[3]. This guidance document outlines best practices for landfill construction, operation, and

[2] *Environmental Management Act*, SBC 2003, c. 53.
[3] BC Ministry of Environment. 2016. *Landfill Criteria for Municipal Solid Waste.* Second Edition.

monitoring. Although the Criteria are a guidance document once they are written into an Authorization or approved within a plan, they are considered to be a requirement.

2.1.2 Landfill Criteria for Municipal Solid Waste

The BCMECCS published the Criteria in 2016 to provide guidance for siting a landfill, among other things. The relevant sections of the Criteria are summarized below.

- Section 3.1 – Land Use
  - *The landfill footprint must not be located within 500 m of an existing or planned sensitive land use.*
- Section 3.2 – Heritage and Archaeological Sites
  - *The landfill footprint shall not be located within 100 m of a heritage or archaeological site.*
- Section 3.3 - Airports
  - *Transport Canada policies generally require that a landfill footprint be located no closer than 8 km from airports.*
- Section 3.4 – Buffer Zone
  - *The buffer zone between the landfill footprint and the landfill site boundary hall be a minimum of 50 m, of which the 30 m closest to the landfill site boundary shall be reserved for natural or landscaped screening (berms and/or vegetative screens). Only the 20 m buffer closest to the landfill footprint shall be used for access roads, surface water management works, leachate management, landfill gas management and monitoring works, firebeaks, and other ancillary works as required.*
- Section 3.5 – Water Supply Sources
  - *The landfill footprint shall be a minimum distance of 300 m from a water supply well or water supply intake and a minimum 500 m from municipal or other high capacity water supply wells.*
- Section 3.6 – Gullies and Depressions
  - *The landfill footprint shall not be located in a gully or depression that acts as a point of water collection during rainfall events unless acceptable diversion works are provided such as interception ditching or other diversion measures are undertaken. Diversion of water through culverts beneath the landfill footprint is not allowed.*
- Section 3.7 – Faults and Unstable Areas
  - *The landfill footprint shall not be located within 100 m of a geologically unstable area.*
- Section 3.8 – Environmentally Sensitive Areas
  - *The landfill footprint must not be located within 100 m of an environmentally sensitive area.*
- Section 3.9 – Surface Water
  - *A landfill footprint shall not be located within 100 m of surface water*.
- Section 3.10 – Floodplains
  - *A landfill footprint shall not be located in a floodplain.*
- Section 3.11 – Shorelines
  - A landfill *footprint shall not be located within 100 m of the sea level maximum high tide or seasonal high watermark of an inland lake shoreline.*

- Section 3.12 – Depth to Water Table
  - *The landfill base shall be a minimum 1.5 m above "groundwater" at all times.*

2.1.3 British Columbia Water Sustainability Act

The BC *Water Sustainability Act* (WSA) is the main provincial statute regulating water resources in BC[4]. The WSA is administered by the BC Ministry of Water, Land and Resource Stewardship (WLRS). Under the WSA, it is an offence to divert or use water, or alter a stream, without formal approval from the Province. The WSA defines "stream" as a natural watercourse or source of water supply, whether usually containing water or not, a lake, river, creek, wetland, spring, ravine, swamp, or gulch. "Stream" is used to describe any watercourse that is a fish habitat, including channelized streams, and ditches. Under the WSA, the Water Sustainability Regulation addresses the requirements to allocate both ground and surface water and identifies the requirements for using water or making changes to a stream.

Two types of approvals for in-stream works can be issued under Section 11 of the WSA. Change Approvals are written authorization required for complex works with substantial impacts. Change Approvals review timelines are influenced by project complexity, agency workload, and Indigenous review/engagement requirements, among other reasons. Notifications are typically used for low-risk works that do not include permanent water diversion, can be completed in a short period of time, and have minimal impacts. Notifications must meet the requirements of Section 39 of the *Water Sustainability Regulation* and comply with any additional conditions set out by a habitat officer. Notifications are issued following a 45-day review period.

2.1.4 BC Wildlife Act

The BC *Wildlife Act* protects most vertebrate animals from direct harm or harassment except as allowed by regulation (e.g., hunting or trapping)[5]. Section 34 of the *Wildlife Act* specifically protects the nests of Eagles, Peregrine Falcons, Gyrfalcons, Osprey, Herons, and Burrowing Owls year-round. This means that a tree or other structure containing such a nest must not be felled, even outside of the breeding season. Section 34 of the *Wildlife Act* also protects the nests of all species of birds when birds or eggs are present in the nest. If a heron or raptor nest, active wildlife den, or species at risk habitat is identified within the project footprint, mitigation and/or compensation plans will need to be developed under the direction of the BC Ministry of Forests.

Vegetated areas within the project footprint will provide habitat for breeding birds during the General Nesting Period, which extends from April 19 to August 24 for the region[6]. To avoid harm to birds and their nests, tree, and vegetation removal (including pruning activities) that may be required for the Project should be conducted outside of the General Nesting Period. If tree removal cannot be avoided during the General Nesting Period, it can only occur following a pre-clearing nest survey conducted by an Appropriately Qualified Professional (AQP). It should be noted that certain raptor species may begin nesting prior to the General Nesting Period, as early as January.

[4] *Water Sustainability Act*, SBC 2014, c. 15.
[5] *Wildlife Act*, RSBC 1996, c. 488.
[6] Environment and Climate Change Canada. 2018. *General Nesting Periods of Migratory Birds*. Available: https://www.canada.ca/en/environment-climate-change/services/avoiding-harm-migratory-birds/general-nesting-periods.html#_03.

2.2 Federal

2.2.1 Fisheries Act

The *Fisheries Act* is the main federal legislation providing protection for all fish, fish habitat, and water quality[7]. The Act is administered federally by Fisheries and Oceans Canada (DFO) and Environment Canada. This Act provides protection against the 'death of fish, other than by fishing' and the 'harmful alteration, disruption or destruction of fish habitat' (HADD), unless authorized by DFO.

Fish habitat is defined as spawning grounds and nursery, rearing, food supply, and migration areas on which fish depend directly or indirectly to carry out their life processes. This definition indicates that a watercourse (which includes but is not limited to streams, ditches, ponds, and wetlands), which provides water, food, or nutrients to a fish-bearing stream (including marine waters), is considered fish habitat even if it does not contain fish and/or if it only has temporary or seasonal flows. The definition also indicates that not only the watercourse itself but also the vegetated stream side or riparian areas which provide nutrients and shade to the stream are considered fish habitat.

DFO encourages all project proponents to avoid and mitigate the impacts of projects to fish. As part of the professional reliance model, projects near water should be evaluated by an AQP and include documentation of common measures and best practices to avoid or minimize impacts to fish and fish habitat. If a project cannot fulfill DFO's *Measures to Protect Fish and Fish Habitat* or the scope of the project is not entirely covered under DFO's *Codes of Practice,* proponents are asked to submit a Request for Review and DFO will work with the proponent to find additional ways to reduce those impacts. If the project cannot be designed to avoid a HADD, a *Fisheries Act* authorization is required.

2.2.2 Migratory Birds Convention Act

Most bird species in Canada are protected under the *Federal Migratory Birds Convention Act* (MBCA)[8]. The MBCA prohibits the disturbance or destruction of (1) a migratory bird, (2) viable eggs of a migratory bird, (3) the occupied nests of any migratory bird, and (4) provides year-round protection to the unoccupied nests of additional bird species listed in Schedule 1 of the Migratory Birds Regulations, 2022.

The MBCA also prohibits the deposit of a substance harmful to migratory birds in waters, or in a place from which the substance may enter waters, frequented by birds. These prohibitions apply wherever a migratory bird or its nest is found (i.e., federal and non-federal lands).

Under the MBCA, most unoccupied nests may be removed without a permit, unless it is a nest of a species listed in Schedule 1 of the regulation, such as Pileated Woodpecker. To destroy or disturb a nest of a bird listed in Schedule 1, the nest needs to be submitted to the online Abandoned Nest Registry, and the nest must be monitored to ensure it remains unused throughout the designated wait time set out in Schedule 1 for that species (between one to three years).

[7] *Fisheries Act*, R.S.C., 1985, c. F-14.
[8] *Migratory Birds Convention Act.* 1994, c. 22.

2.2.3 Species At Risk Act

The federal *Species at Risk Act* (SARA) protects plant and wildlife species from becoming extinct or lost from the wild, provides for the recovery of species that are at risk (Extirpated, Endangered, Threatened), and promotes the management of Special Concern species to prevent further loss on federal lands (Government of Canada 2023)[9][10].

The SARA has a list of general prohibitions that apply to all wildlife species, and their critical habitat, that are listed on Schedule 1 as Extirpated, Endangered, or Threatened (i.e., listed species). These general prohibitions make it an offence to:

- Kill, harm, capture, or take an individual of a species listed in Schedule 1 of SARA as Endangered, Threatened, or Extirpated.
- Possess, collect, buy, sell, or trade an individual of a species listed in Schedule 1 of SARA as Endangered, Threatened, or Extirpated.
- Damage or destroy the residence (e.g., nest or den) or any part of the critical habitat of one or more individuals of a species listed in Schedule 1 of SARA as Endangered, Threatened, or Extirpated (if a recovery strategy has recommended the reintroduction of that Extirpated species into the wild in Canada).

3.0 AREA A

3.1 Background

As outlined in the previous Landfill Siting Memo report (Tetra Tech 2023), Area A was identified due to its transport links, lack of water supply permits, and water wells within the vicinity. Area A has watercourses present that likely preclude the possibility of siting a landfill to the west of Highway 29. However, the area east of Highway 29 has adequate space to potentially site a landfill between two of the watercourses present.

There are no water wells, known habitats of sensitive species, historical resources or parks and protected areas within Area A. The surficial geology present within the selected area is largely “streamlined till ridges” with an area of glaciolacustrine veneer running along Highway 29 in a north to south alignment for much of the central portion of the study area. An alluvial plain associated with a water feature is present to the northwest of the study area, however, it is approximately 4 km away.

Following discussion with the PRRD on the potential sites characteristics, it was determined Area A would be included in the preliminary field reconnaissance portion of the site selection. Figure 2 shows Area A along with points of interest that were identified during the site reconnaissance.

3.2 Visual Landfill Siting and Suitability Observations

The following observations were made for Area A from a landfill suitability standpoint during the site visit:

- Area A is located approximately 11 km north of Chetwynd along BC Highway 29.

[9] *Species at Risk Act,* SC 2002, c 29.

[10] Government of Canada. 2023. *Database of wildlife species assessed by Committee on the Status of Endangered Wildlife in Canada* [COSEWIC]. Retrieved from: https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html. Accessed November 31, 2023.

- The prospective site is approximately 390 Ha and was split by the highway resulting in an eastern half and a western half of the site.
- The eastern half is generally higher in elevation than the highway while the western half was generally lower in elevation than the highway.
- The site is mostly a densely forested area with localized overgrown cut blocks from previous logging.
- Tetra Tech traversed from the highway in the middle of the site towards the northeast corner.
  - The site gains elevation quickly from the highway heading east, then transitions to a more moderately sloped area gaining elevation towards the east across the majority of this eastern half. The site seems to plateau in the middle along the east boundary then gently slopes downwards to the north and south along the east boundary.
  - Tetra Tech crossed the mapped watercourse features as identified in the Landfill Siting Memo (Tetra Tech 2023) for Area A. The watercourse features, although minor, was observed and was noted as dry and mostly vegetated at the time of the reconnaissance (Photo 1 and Photo 2).

Photo 1: P15 – Small Dry Watercourse Feature

Photo 2: P15 – Small Dry Watercourse Feature

  - From the northeast corner looking south, Tetra Tech observed the elevation increased towards the plateau noted previously. With the tree coverage it was difficult to determine the steepness of this elevation gain but based on visual observations from a distance, this may be a steep ridge. Obtaining surveyed topography (Lidar) of this site may be advantageous to better determine these slopes.
- Tetra Tech traversed from the south boundary at the highway in a northeast direction to assess the southeast quadrant of Area A.
  - This area was very densely forested.
  - The initial slope from the highway was quite steep.
  - Tetra Tech crossed an unmapped drainage feature in the southeast quadrant. This feature was situated east-west towards the highway and was very similar to the mapped drainage feature described earlier. Similarly, this feature was observed as dry at the time of the reconnaissance (Photo 3 and Photo 4).

Photo 3: P42 – Small dry unmapped drainage feature

Photo 4: P42 – Small dry unmapped drainage feature

- An isolated grassy area or potential unmapped wetland was noted within this southeast quadrant (Photo 5 and Photo 6).

Photo 5: P45-48 – Potential Unmapped Wetland

Photo 6: P45-48 – Potential Unmapped Wetland

- Tetra Tech assessed the two mapped watercourses which run through the highway. In both cases, no obvious drainage course extending outwards from the highway was noted. The highway has created parallel ditch features which is to be expected. A culvert was found at the northern feature extending under the highway. In both cases, the highway ditches and culverts were dry at the time of the reconnaissance.
- Tetra Tech assessed the west half of the area with the use of an unmanned aerial vehicle (UAV).
  - The western half generally seemed to be a lower lying area with increased downed trees as compared to the eastern half. This may represent a typically softer and wetter surface. This area can be seen in Photo 7.
  - Deadman Creek is situated through the northwest quadrant flowing northward, and was ground truthed during the site reconnaissance. A small hut was noted along this watercourse near the north boundary of Site A. This watercourse can be seen in Photo 8.
  - The mapped watercourse which extended from the southwest quadrant was less obvious with the UAV, however, a small drainage feature was noted. This feature showed signs of surface water from the aerial view and can be seen in Photo 9.

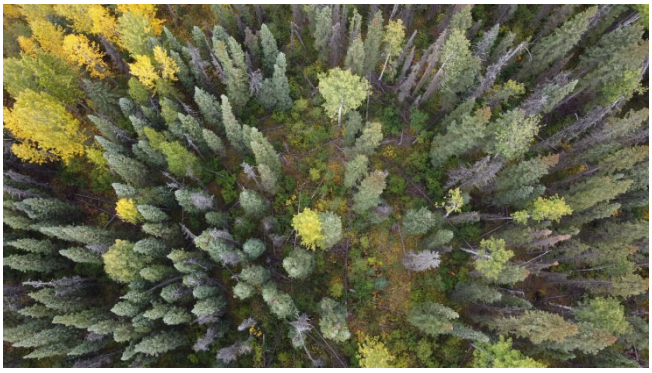

Photo 7: Western Half of Area A

Photo 8: Watercourse in the Northwest Quadrant of Area A

Photo 9: Mapped Watercourse in the Southwest Quadrant of Area A

Overall, the potential suitability for a landfill based on the site reconnaissance is limited to the east half of Area A. The presences of watercourses in the west half of the site along with higher potential for low-lying wet areas and/or shallow groundwater would limit the available footprint due to necessary setbacks, constructability, and the ability to maintain a landfill with a minimum separation of 1.5 m above the seasonally high water table.

The majority of the east half of the site, after the initial elevation gain from the highway, seems to have a more gradual slope that would be suitable for landfill development. Along with no noted permanent watercourses, it is highly probable that a portion of the area would be considered suitable from a geotechnical stability and landfill suitability standpoint. As previously indicated, obtaining detailed ground surface topography would be advantageous for determining the actual slopes or the presence of a steep ridge.

3.3 Environmental Observations

The following observations were made for Area A from an environmental standpoint during the site visit:

- Vegetation observed during the site visit along the eastern half of the area was typical of the white spruce-aspen-step moss association within the Boreal White and Black Spruce moist warm (BWBSmw) biogeoclimatic zone (Photo 10). A detailed inventory of plant species observed was not conducted but forest stands on the eastern half of the area differed from the western half. The eastern half of the area consisted of dry mixed forest dominated by mature trembling aspen (*Populus tremuloides*), balsam poplar (*Populus balsamifera*), and white spruce (*Picea glauca*), while the western half consisted of wet spruce forest dominated by white and black spruce (*Picea mariana*). Sections of forest within the eastern half of the area have been harvested and replanted with lodgepole pine (*Pinus contorta*).

- The forest stand consisted of numerous large (>40 cm diameter at breast height [DBH]) deciduous trees. There was suitable nesting habitat for Pileated Woodpecker (*Dryocopus pileatus,* [PIWO]) present.
  - An adult PIWO was observed in the northeast portion of the area.
  - There is a high risk of PIWO nest cavities being present within this area. Before clearing, a PIWO nest cavity survey should be conducted. Trees containing nest cavities (in use or abandoned) cannot be cleared until the nest is determined to be unoccupied for three years.
  - All tree and vegetation removal should be conducted outside of the General Nesting Period for breeding birds (April 19 to August 24).
- Though no nests from species listed in Section 34 were found, they may become established before clearing.
  - Before clearing, a stick nest survey should be conducted. Trees containing nests of species listed in Section 34 would require further permitting to be removed.
- Deadman Creek (watershed code 230-744800-51600) is mapped through the northwest corner of the area (Photo 8). Several small, mapped tributaries run from east to west across the area. Deadman Creek is the only watercourse in the site documented to be fish-bearing. A reference map of the watercourses noted during the site reconnaissance can be seen on Figure 2.
- Vegetation along the western half of the area changes from deciduous-dominated woodland to more dense spruce forest which indicates the presence of water. UAV imagery showed evidence of standing water through large sections of the site as seen above in Photo 9.
  - There is a higher likelihood of wetlands being present throughout the western half of the site. The encroachment of wetlands would constrain landfill location and could require permitting/compensation under the BC WSA.
  - The proximity of watercourses in the western half of the site to Deadman Creek increases the likelihood that they support fish and fish habitat under the *Fisheries Act*.
- The southeast tributary of Deadman Creek that is mapped through the east half of Area A consists of a small ephemeral channel, which was dry during the assessment (Photo 11). In addition, no culvert or signs of a watercourse were found where this tributary is mapped to cross the highway.
  - This portion of the channel is a 'stream' under the BC WSA and could indirectly support fish and fish habitat under the *Fisheries Act*.
- There were no obvious signs of a watercourse (distinguishable channel, suitable substrates, flowing water, etc.) at the mapped location of the northeast tributary of Deadman Creek. In addition, no culvert or signs of a watercourse were found where this tributary is mapped to cross the highway.
  - In the eastern half of the area, these features may not be considered 'streams' under the BC WSA and may not support fish and fish habitat as defined under the *Fisheries Act*.
- There were two unmapped ephemeral channels found north of the northeast tributary. These channels were dry at the time of observation and had poorly defined banks with minimal gravel substrate (Photo 12).
- Other mapped tributaries in the northeast corner of the site were not accessible for the assessment and based on the observations recorded at the other tributaries, these are likely ephemeral and poorly defined within the site boundaries.
- A more detailed watercourse assessment is recommended to identify suitable setback distances, if applicable.

Photo 10: Typical Tree Community Within Area A

Photo 11: P42 - Southeast Tributary of Deadman Creek

Photo 12: P30 - Ephemeral Channel Near the Northeast Tributary of Deadman Creek

From an environmental risk and permitting perspective, the eastern half of Site A appears to have fewer constraints than the western portion for a landfill based on the limited site reconnaissance. The eastern half has fewer aquatic areas and avoids Deadman Creek. The tributaries of Deadman Creek that run through the eastern half of the site were dry during the site reconnaissance and it's likely that only the southeast tributary would be subject to permitting and/or setback distances. A more detailed watercourse assessment is recommended but permitting under the BC WSA and Fisheries Act is expected to be minor. The biggest environmental challenge is the large, forested areas of the eastern half of the site that provide suitable habitat for PIWO nest cavities. While the western part of the site was not visited in detail, it is expected to also provide suitable habitat for PIWO nest cavities. As a result, there is a risk that one or more nest cavities could be found, creating permitting uncertainty. The presence of watercourses and other wet areas throughout the western half of the site would require more extensive permitting and necessary setbacks from the watercourses make this western half of the site a less desirable landfill location.

4.0 AREA B

4.1 Background

Area B is located directly north of the existing landfill. This Area was initially chosen as a landfill expansion may potentially be an easier path to approval.

There is a water feature that runs through the existing landfill and this area. There are also three water wells within private land to the west, east, and northeast of the area. However, the wells are at a distance greater than the Criteria siting requirement limits. There is also an agricultural land reserve approximately 250 m to the east of the area. There are no known habitats of sensitive species, historical resources, or parks and protected areas within Area B.

Surficial geology present in the area is largely streamlined till ridges with a glaciolacustrine plain to the east, and an alluvial fan to the east-northeast however, this alluvial fan is further than the required 100 m distance from the potential site.

The sites characteristics were discussed with the PRRD and it was determined Area B would be included in the initial site investigation. Figure 3 shows Area B along with points of interest that were identified during the site reconnaissance.

4.2 Visual Landfill Siting and Suitability Observations

The following observations were made for Area B from a landfill suitability standpoint during the site visit:

- Area B is located directly north of the existing Chetwynd Landfill approximately 5 km northeast of Chetwynd on the east side of BC Highway 29.
- The prospective site is approximately 10 Ha.
- The area is forested with moderate undergrowth and brush beneath the canopy.
- Area B is located east of the highway and is situated on a downward slope extending eastwards away from the highway.
- Tetra Tech accessed the area from the existing landfill and traversed from the southwest corner towards the middle of the area, then to the southeast corner.
  - The topography west of the area appeared to have a relatively steep slope down from the highway extending to inside the western boundary. The topography leveled out inside the western boundary and the majority of the site seemed to be a gently sloped undulating topography, and likely quite suitable for landfill development. Photo 15 shows an aerial photo (looking north) of the site providing a sense of the general topography and location compared to highway. Photo 16 is taken from the same location looking south towards the active landfill.
  - The topography drops off at some point to the east. Based on visual observations through the tree coverage, this seems to be beyond the eastern boundary (similar to the active Landfill), however, it was not obvious how far beyond the east boundary this occurs. As shown in Photo 16, the steeper drop off can be seen as a valley further east of the site. Similar to Area A, it would be advantageous to obtain detailed ground surface topography for the potential site and the immediate area around it to confirm no unobserved slopes would reduce the suitability for landfill construction.
  - No watercourses or water bodies were observed, nor were any mapped that needed to be ground truthed.

- The area within the active Landfill just north of the filling area has a mapped drainage feature. Although no obvious watercourse was observed, there were two discrete low-lying areas likely classified as wetlands (or similar), and a very deep cut drainage or erosion feature was noted east of one of the on-site retention ponds. Large pieces of excavated bedrock were noted to be placed in this drainage feature adjacent to the active landfill.
- Shallow bedrock is likely due to the presence of an outcropping bedrock layer noted along the western boundary of the active site.

Photo 15: Site B Looking North (Highway to the West)

Photo 16: Site B Looking South (Active Landfill in background)

Overall, this site seems to be a suitable choice for landfill development. From the site reconnaissance there were no discernable features that would limit the development and seemed to have a more suitable topography than the existing Chetwynd Landfill to the south.

The key benefits of this site include the ability to 'laterally expand' the existing landfill to optimize airspace, and likely would result in a more straightforward public consultation process. A few elements that should be considered or further investigated include:

- Review of the detailed ground surface topography to confirm no abrupt changes in the topography.
- Assuming similar geology to the existing Chetwynd landfill, there is a high probability of shallow bedrock which can limit the available overburden materials for use during construction activities.

4.3 Environmental Observations

The following observations were made for Area B from an environmental standpoint during the site visit:

- Area B consisted of an open deciduous forest typical of the white spruce-aspen-step moss association within the BWBSmw biogeoclimatic zone. Young trembling aspen (*Populus tremuloides*) was the dominant tree species and nootka rose (*Rosa nutkana*) was the dominant shrub species observed.
- The forest stand consists of young (<40 cm DBH) deciduous trees. Suitable nesting habitat for PIWO is limited. The typical forest stand within the area can be seen in Photo 17.
  - Before clearing, a PIWO nest cavity survey should be conducted. Trees containing nest cavities (used and abandoned) cannot be cleared until it is determined to be unoccupied for three years.
  - All tree and vegetation removal should be conducted outside of the General Nesting Period for breeding birds (April 19 to August 24).
- Though no nests of species listed in Section 34 were found, they may become established before clearing.
  - Before clearing, a stick nest survey needs to be conducted. Trees containing nests of species listed in Section 34 would require further permitting to be removed.

- No aquatic features were observed during the site reconnaissance within the site boundaries, but a wetland and watercourse were identified in the desktop search and are located immediately west of the site boundaries.
- A watercourse and adjacent marsh wetland (Photo 18) are found between Area B and the existing Chetwynd landfill. This area would likely be disturbed if Area B was chosen as a future landfill location.

From an environmental risk and permitting perspective, Area B appears to have few constraints for the development of a new landfill based on the limited site reconnaissance. There are no aquatic features (watercourses, wetlands, lakes, etc.) within the site boundaries, with only a small portion of the site overlaps with the 100 m buffer around the watercourse to the south of the site boundary. The forest within the area is too young to support PIWO nest cavities.

Photo 17: P33 - Typical Forest Stand Within Area B

Photo 18: Marsh Wetland South of Area B

5.0 AREA C2

5.1 Background

Area C2 is within an area (Area E) and was noted by the PRRD due to the presence of a closed landfill and industry in the area. It is approximately 10.6 km south of the existing landfill. The overall area was reduced to Area C2 as there were numerous limitations due to siting issues outside of the reduced area, including private landowners, Provincial Crown land, water features, and an alluvial fan.

Following the reduction of Area E to C2, it was determined there were no known habitats of sensitive species, historical resources, or parks and protected areas within Area C2. Surficial geology in the study area is largely till veneer. As previously mentioned, there is an alluvial fan, however, Area C2 is further than 100 m from it.

After discussion with PRRD, it was determined Area C2 would be included in the site reconnaissance if there was adequate time following the investigation of Areas A, B, and L. This site was included in the site reconnaissance field work. Figure 4 shows Area C2 along with points of interest that were identified during the site reconnaissance.

5.2 Visual Landfill Siting and Suitability Observations

The following observations were made for Area C2 from a landfill suitability standpoint during the site visit:

- Area C2 is located approximately 16 km southeast of Chetwynd along the Lone Prairie Road.
- The prospective site is approximately 400 ha.

- The area is split into a northern half and a southern half by the Lone Prairie Road.
- Access to the area is from the intersection of Lone Prairie Road and BC Highway 29. This road can be seen in Photo 19. The site is approximately 4 km east from this intersection along the Lone Prairie Road, which is a steep gravel road. Tetra Tech assessed the grade of this gravel road at three locations. The road grades were measured at approximately:
  - At kilometer 1 from Highway 29, 11%;
  - At kilometer 1.5 from Highway 29, 13%; and
  - At kilometer 2.3 from Highway 29, 12%.
- The prospective site is densely forested. An area in both the north and south half were noted as having been previously logged; however, were overgrown with brush and undergrowth at the time of the reconnaissance.
- Tetra Tech accessed the site from the Lone Prairie Road; however, due to the dense forest, access was limited.
- The north half of the area is dominated by a steep slope gaining elevation towards the northwest. This steep slope was visually assessed to not be suitable for landfill development. The grade was not determined; however, it is likely greater than 10% on average which is generally not recommended for landfill development due to higher risk of slope instability. The northern boundary of the site was noted to drop off at an even steeper grade towards Pine River situated approximately 1 km north and northwest of the site. These abrupt changes in elevation near the northern boundary created a narrow plateau at the high point of the site. This area can be seen in Photo 20 along with the drop off towards Pine River northwest of the site (Photo 21).

Photo 19: Lone Prairie Road to Access the Area

Photo 20: Steep Slopes in Area C2

Photo 21: Looking Northwest - Drop off to Pine River

- The south half of the area is dominated by a valley that paralleled the Lone Prairie Road approximately 150 m away from this road. An old logging road was noted along the opposite (southern) side of this valley. From this feature, the topography seemed to continue to gain in elevation towards the southern boundary of the site. Although the grade seems to be less steep than the grades north of the Lone Prairie Road, they are still considered steep for landfill development. The valley was well defined and looked to be the widest at the western boundary of the area, south of Lone Prairie Road.
- A mapped watercourse was ground truthed by Tetra Tech but was noted as dry at the time of the reconnaissance. Tetra Tech traversed across the valley and noted at the lowest point in the valley a fairly steep and well-defined drainage feature with a scoured bottom. It seems this mapped watercourse follows the valley feature described above.
- While traversing towards this mapped watercourse, a small wet area approximately 35 m south of Lone Prairie Road was noted, which contained standing water. The origin of this watercourse appeared to be from a groundwater spring further uphill near the adjacent road.

Overall, this site is not considered suitable for landfill development based on the steep slopes noted across the narrow plateau in the north half and the valley in the south half. The noted small watercourse also points to potential shallow groundwater.

5.3 Environmental Observations

The following observations were made for Area C2 from an environmental standpoint during the site visit:

- Area C2 is covered with a matrix of mixed boreal forest of various age classes (Photo 22). Large areas of the site have been logged, with the area naturally regenerating a mix of lodgepole pine, white spruce, and aspen. Large veteran trees remain sparsely scattered throughout harvested areas, and unharvested areas contain mature spruce and aspen forest.
- The southern half of the site contains several wildlife trees that were retained during previous logging. These wildlife trees are large (>40 cm DBH) deciduous trees in varying stages of decay that provide suitable PWIO nesting habitat.
  - A possible PIWO nest cavity was found in one of these trees as seen in Photo 23.
  - Before clearing a PIWO Nest Cavity survey must be conducted. Trees containing nest cavities (used and abandoned) cannot be cleared until it is determined to be unoccupied for three years.
  - All tree and vegetation removal should be conducted outside of the General Nesting Period for breeding birds (April 19 to August 24).
- Though no nests of species listed in Section 34 (raptors) were found, they may become established before clearing. The wildlife trees that are found throughout the southern half of the site would provide good nesting locations for Section 34 species.
  - Before clearing, a stick nest survey would need to be conducted. Trees containing nests of species listed in Section 34, would require further permitting to be removed.
- The only documented waterbody within the site is a mapped but unnamed watercourse (watershed code 234-440600-86600). This watercourse is mapped through the southern half of the site, draining from east to west. This unnamed watercourse is not documented as fish-bearing but is a tributary of the Pine River, which is fish-bearing.
- The unnamed watercourse contained isolated pockets of water during the site reconnaissance. It also had well-defined channel banks and contained cobble substrate, indicative of a stream.
  - This watercourse is a ‘stream’ under the BC WSA and at least indirectly supports fish and fish habitat as defined under the *Fisheries Act*.

- Portions of smaller mapped watercourses (and/or their 100m setbacks) overlap with the site boundary.
- Areas directly adjacent to the unnamed watercourse had the vegetative community change to support more hydrophilic species, indicating wetland presence (Photo 24). This vegetative community change was observed near an area of standing water approximately 35 m south of Lone Prairie Road.
  - To support a WSA permit application, a more detailed wetland assessment would be required.

Photo 22: Example of Trees Found in the Northern Half of Area C2

Photo 23: Potential PIWO Nest Cavity found in Area C2

Photo 24: View of Vegetative Change Indicating Wetland Presence in Area C2

From an environmental risk and permitting perspective, Area C2 is not a preferable location for construction of a new landfill. The southern half of the site has a well-defined watercourse and areas adjacent to the watercourse could be classified as wetland. In addition, the southern half of the site has several large wildlife trees that provide highly suitable habitat for PIWO nest cavities, with one potential nest cavity observed during the site reconnaissance visit. As a result, the risk that a suitable PIWO nest cavity is found within the site is high. These attributes present several regulatory challenges that will limit the area where a future landfill could be located. The northern half of the site would need to be investigated more sufficiently, but the older forest present provides suitable habitat for PWIO nest cavities which is a regulatory risk.

6.0 AREA L

6.1 Background

Area L was identified by PRRD as a potential site. It is located along Jackfish Lake Road. Air photo resolution is poor; however, the area appears to be flat with little grade. The Area is Crown Land but a 500 m residential buffer reduces potential developable area.

There is a relatively complex pattern of development constraints, such as private residences in the area and rail line running through the site, and there are no groundwater abstraction wells in proximity to this area. Surficial geology is predominantly Glaciofluvial Plain and Glacioifluvial Hummocky Terrain.

This Area was included in the Site Reconnaissance at the request of PRRD. Figure 5 shows Area L along with points of interest that were identified during the site reconnaissance.

6.2 Visual Landfill Siting and Suitability Observations

The following observations were made for Area L from a landfill suitability standpoint during the site visit:

- Area L is located approximately 20 km northeast of Chetwynd along Jackfish Lake Road. The majority of the area is located on the west side of the road. Only this section of the area would be suitable due to the presence of private property on the east side of the road.
- The prospective site is approximately 440 Ha including the area located on the east side of the road.
- A rail line is situated near the eastern boundary of the site that parallels the Jackfish Lake Road. The rail line is located on the west side of the road and can be seen in Photo 25.
- Tetra Tech accessed the site at a rail crossing where it was clear that this crossing is used for cattle access and grazing within the site. Photo 26 displays one of the many cattle trails throughout the site. A fenced area and gate were noted west of the rail line adjacent to the crossing.
- The area is mostly forested, however, has been used as a cattle pasture which has removed most of the undergrowth through much of the eastern half of the site. The western half is less disturbed and was noted to have moderate undergrowth.
- Tetra Tech traversed the area from the rail crossing and completed a loop that covered the majority of the potential site.
  - The area was generally flat with undulating topography with no discernible high point or low point. Based on Google mapping, the northeast corner is believed to be the low point and the southwest corner is believed to be the high point of the area. This is counterintuitive based on the presence of a large mapped wetland approximately 300 m northwest of the northwest corner, as well as Halfmoon Lake and Jackfish Lake located approximately 1.3 km southwest of the southwest corner.
  - The undulating topography was evident due to isolated low-lying wet areas most of which either contained water at the time of the reconnaissance or were marshy and muddy. It was clear that cattle use these areas as a water source. Based on visual observations, these areas did not seem to drain nor were they connected overland to one another. Some of these areas were mapped as wetlands while others were not.
  - A mapped watercourse orientated east to west was ground truthed as not present at various locations across the site. No discernable drainage feature or watercourse (either wet or dry) were noted through the site. This mapped feature included a small waterbody which was ground truthed as one of the mapped

wetlands. Photos 27, 28, and 30 show this mapped wetland and no observable watercourse associated with these features.

Photo 25: Rail Crossing in Area L

Photo 26: Overview of Area L and a Cattle Trail

Photo 27: Open Water Wetland

Photo 28: No Observable Mapped Location of Water Course

Overall, there is little concern regarding the suitability of this site for development of a landfill. There are no limitations because of slopes, permanent watercourses, and from a general geotechnical stability standpoint. A few key elements that should be considered or further investigated include:

- The proximity to private properties to the east.
- The current use of this property is for cattle pasture.

6.3 Environmental Observations

The following observations were made for Area L from an environmental standpoint during the site visit:

- The vegetation observed within Area L was typical of open rangeland in the BWBSmw zone. A detailed inventory of plant species observed was not conducted but the boreal forest stand was dominated by trembling aspen (Photo 29). Due to the heavily grazed nature of the site, shrubs were sparse.
- A Canada Warbler (*Cardellina canadensis*) occurrence was documented approximately 280 m north of the site boundary.

- Area L is not located on federal land but provides suitable nesting habitat. All tree and vegetation removal should be conducted outside of the General Nesting Period for breeding birds.
- The forest stand consisted of smaller deciduous trees that could provide nest habitat for various birds. Some deciduous trees are large enough to support suitable PIWO nesting habitat (>40 cm DBH).
  - There is a possibility of PIWO nest cavities being present within this area. Before clearing, a PIWO Nest Cavity survey must be conducted. Trees containing nest cavities (in use or abandoned) cannot be cleared until it is determined to be unoccupied for three years.
- Though no nests of species listed in Section 34 were found, they may become established before clearing.
  - All tree and vegetation removal should be conducted outside of the General Nesting Period for breeding birds (April 19 to August 24).
- Six wetlands were found within the site boundaries. There was no observed overland flow and we determined that the wetlands are not directly connected. The approximate locations of each wetland can be seen on Figure 5.
- The six wetlands observed with aerial imagery were ground truthed within the site boundaries. The desktop delineation of each wetland was confirmed to be accurate. Each of these wetlands were degraded by cattle grazing. An example of an open water wetland and marsh wetland found in the area can be seen in Photo 30 and Photo 31 respectively.
  - Encroachment and or loss of wetlands could require permitting and compensation under the BC WSA. A more detailed wetland assessment could be required.
- The advanced degradation made it challenging to identify the vegetation community surrounding the wetland. The eastern two wetlands are likely classified as marsh and the remaining four as shallow open-water wetland.
- The watercourse mapped from east to west along the centre of the site was not found. There were no signs of a watercourse (distinguishable channel, flowing water, etc.) at the mapped location.
  - No location constraints or permitting is expected for this mapped feature.

Photo 29: Typical Forest within Area L

Photo 30: Example of the Open Water Wetlands found in Area L

Photo 31: Example of the Marsh Wetlands found in Area L

From an environmental risk and permitting perspective, Area L provides a less favourable option for a landfill based on the limited site reconnaissance. The largest concern is the presence and distribution of wetlands throughout the site which restrict the area available for landfill placement. Further, a more detailed wetland assessment to support permitting and compensation under the BC WSA will be required if the landfill encroaches into the setbacks. The forested areas of the area are young, mainly consisting of smaller deciduous trees, which provide limited PIWO nesting habitat. Nonetheless, a few larger veteran trees were observed, therefore a PIWO nest cavity survey would be required, but the risk that a nest cavity is found within the site is low. The area is already disturbed by heavy cattle grazing throughout the site, so it provides less habitat value for surrounding wildlife.

7.0 RECOMMENDATIONS AND NEXT STEPS

Tetra Tech recommends the following for each of the Areas discussed:

- Area A – The western half of the area has multiple watercourses that would limit the development of a landfill and is therefore, not recommended. The eastern portion, however, has no apparent permanent watercourses, and appears suitable from a geotechnical stability standpoint. There is risk that one or more nest cavities are within the area which create permitting uncertainty. A detailed ground surface survey is recommended to evaluate the slopes within the eastern portion of the area to better evaluate the surface topography.
- Area B – This area has no apparent limitations for constructing a landfill and has the potential to allow a lateral expansion of the site which may simplify the approval and public consultation process. There is one portion of the area that would be within a 100 m buffer zone from the nearest watercourse, however, this would not significantly limit the available space for the landfill. A detailed ground surface survey is recommended to evaluate the slopes along the western boundary of the area.
- Area C2 – This area is likely not suitable for a landfill due to the steep slopes, potential shallow groundwater, well-defined watercourse running through the area, and the presence of large wildlife trees. No further action is recommended.
- Area L – From a landfill suitability perspective, this area is likely suitable for development. There are no limitations due to steep slopes and the geology appears favourable. However, the presence of wetlands on site would limit the area available for the landfill. If this area is further pursued, a ground surface survey and a detailed wetland assessment are recommended to determine where landfill development is possible.

7.1 Archeological Overview Assessment

It should be noted that given the site reconnaissance was moved to the site selection phase and based on the number of sites chosen for site reconnaissance the archeological overview assessments (AOA) were not completed at this stage. A desktop AOA should be conducted for each site chosen to advance to Site Feasibility.

7.2 Preliminary Technical Investigation

Tetra Tech recommends that once the memo has been reviewed and a decision made on which sites to advance to Site Feasibility, that a preliminary technical investigation be advanced. It is anticipated that the technical investigation would be undertaken in Spring 2024 and depending on the site and available information include:

- Advancement of up to eight (8) geotechnical boreholes with Standard Penetration Test (SPT) testing to a maximum depth of 10 m.
- Installation of three (3) groundwater piezometers to characterize depth to groundwater within the cell design or waste footprint area.
- Laboratory testing to determine the engineering properties of the site's soils. This allows a preliminary assessment to determine the required liner systems and identify conditions that may inhibit landfill construction.
- Interpretation of the data and preparation of a summary geotechnical report.

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9.0 CLOSURE

We trust this technical memo meets your present requirements. If you have any questions or comments, please contact the undersigned.

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Enclosure: Limitations on the Use of this Document
Figure 1 Site Overview & Species at Risk Occurrences
Figure 2 Area A Site Reconnaissance
Figure 3 Area B Site Reconnaissance
Figure 4 Area C2 Site Reconnaissance
Figure 5 Area L Site Reconnaissance

LIMITATIONS ON USE OF THIS DOCUMENT

GEOENVIRONMENTAL

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In certain instances, the discovery of hazardous substances or conditions and materials may require that regulatory agencies and other persons be informed and the client agrees that notification to such bodies or persons as required may be done by TETRA TECH in its reasonably exercised discretion.

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584000 588000 592000 596000 600000 604000

6188000 6184000 6180000 6176000 6172000 6168000 6164000

N W E S

Moberly Lake

MOBERLY LAKE PARK

Black-throated Green Warbler

Black-throated Green Warbler

Black-throated Green Warbler

Black-throated Green Warbler

Canada Warbler

Area L

Connecticut Warbler

Connecticut Warbler

Connecticut Warbler

Aphrodite Fritillary Manitoba Subspecies

Common Ringlet Benjamini Subspecies

29

Area A

Jackfish Lake Rd

Common Ringlet Benjamini Subspecies

Canada Warbler

Area B

Uhler's Arctic

CHETWYND

Common Ringlet Benjamini Subspecies

97

PINE RIVER BREAKS PARK

97

Common Ringlet Benjamini Subspecies

Connecticut Warbler

Pine River

29

Black-throated Green Warbler

Area C2

Yellow-banded Bumble Bee

Lone Prairie Rd

Overview

Hudson's Hope

29

Figure Extent

97

Chetwynd

97

29

15 7.5 0 15km

584000 588000 592000 596000 600000 604000

LEGEND

- Potential Landfill Site Area

CDC Species at Risk Occurrences

- Aphrodite Fritillary - Manitoba Subspecies (Blue-listed)
- Black-throated Green Warbler (Blue-listed)
- Canada Warbler (Blue-listed)
- Common Ringlet - Benjamini Subspecies (Blue-listed)
- Connecticut Warbler (Blue-listed)
- Uhler's Arctic (Blue-listed)
- Yellow-banded Bumble Bee (Blue-listed)

Base Data

- Highway
- Main Road
- Local Road
- Watercourse/Waterbody
- Provincial Park Boundary
- District Of Chetwynd Municipal Boundary

NOTES
Base data source:
Imagery from ESRI; Maxar
Base data from CanVec; 1:250,000 (2019)
CDC data from DataBC (February 5, 2024)

NEW LANDFILL FEASIBILITY CHETWYND AREA STAGE 1 SITE SELECTION – SITE RECONNAISSANCE

Site Overview & Species at Risk Occurrences

PROJECTION UTM Zone 10			**DATUM** NAD83	**CLIENT** Peace River Regional District
Scale: 1:90,000 — 1.5 0.75 0 1.5 — Kilometres				TETRA TECH
FILE NO. SWOP04805-01_Fig01_Overview.mxd				
OFFICE Tt-VANC	**DWN** DS	**CKD** SL	**APVD** ED	**REV** 0
DATE February 8, 2024	**PROJECT NO.** SWM.SWOP04805-01			**Figure 1**

STATUS ISSUED FOR USE

586600 586900 587200 587500 587800 588100 588400 588700 589000 589300 589600

6182700 6182400 6182100 6181800 6181500 6181200 6180900 6180600

Deadman Creek

Crown Provincial

Northeast Tributary

Slimy Sculpin

Pileated Woodpecker

29

Crown Provincial

Southeast Tributary

N W E S

LEGEND

- FIsh Occurrence
- Potential Landfill Site Area
- 100 m Water Feature Buffer
- Parcel Boundary

Field Observations

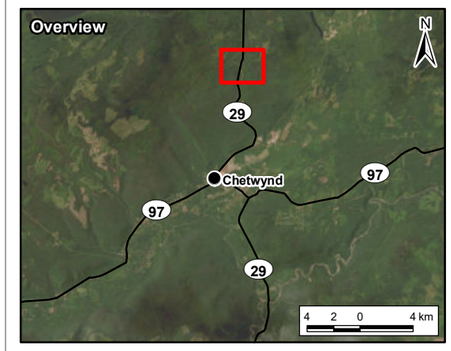
- Pileated Woodpecker Observation
- Approximate Unmapped Ephemeral Channel

Surficial Geology

- Alluvial Plain
- Glaciolacustine Veneer (thin, less than 2 m)
- Streamlined Till Ridges

Base Data

- Highway
- Watercourse/Waterbody



NOTES
Base data source:
Water features from Fresh Water Atlas (2023)
Fish data from DataBC (February 5, 2024)
Parcels from DataBC (2023)
Surficial Geology from Geoscience BC, Energy Open File 2011-2 (2011)

STATUS
ISSUED FOR USE

NEW LANDFILL FEASIBILITY CHETWYND AREA STAGE 1 SITE SELECTION – SITE RECONNAISSANCE

Area A Site Reconnaissance

PROJECTION UTM Zone 10		**DATUM** NAD83			**CLIENT** Peace River Regional District
Scale: 1:10,000 200 100 0 200 Metres					TETRA TECH
FILE NO. SWOP04805-01_Fig02_AreaA.mxd					
OFFICE Tt-VANC	**DWN** DS	**CKD** SL	**APVD** SB	**REV** 0	**Figure 2**
DATE February 8, 2024	**PROJECT NO.** SWM.SWOP04805-01				

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588700 589000 589300 589600 589900

6177000 6176700 6176400

N W E S

29

Private

Private

Marsh Extent

Untitled Provincial

Current Landfill Site

Private

Private

588700 589000 589300 589600 589900

LEGEND

- Groundwater Well
- Potential Landfill Site Area
- Alluvial Fan and Water Feature 100 m Buffer
- Parcel Boundary

Field Observations

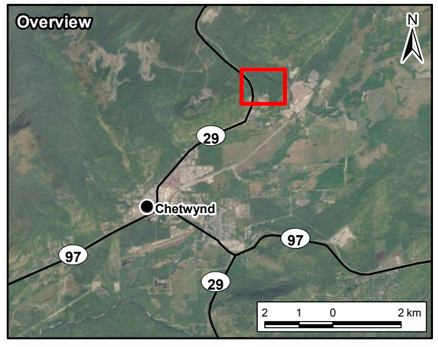
- Approximate Marsh Extent

Surficial Geology

- Alluvial Fan
- Glaciolacustine Plain
- Streamlined Till Ridges

Base Data

- Highway
- Main Road
- Local Road
- Watercourse/Waterbody
- District Of Chetwynd Municipal Boundary



NOTES
Base data source:
Water features from Fresh Water Atlas (2023)
Groundwater Wells from DataBC (February 5, 2024)
Parcels from DataBC (2023)
Surficial Geology from Geoscience BC, Energy Open File 2011-2 (2011)

STATUS
ISSUED FOR USE

NEW LANDFILL FEASIBILITY CHETWYND AREA STAGE 1 SITE SELECTION – SITE RECONNAISSANCE

Area B Site Reconnaissance

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	Peace River Regional District

Scale: 1:4,000
80 40 0 80
Metres

TETRA TECH

FILE NO.				
SWOP04805-01_Fig03_AreaB.mxd				
OFFICE	**DWN**	**CKD**	**APVD**	**REV**
Tt-VANC	DS	SL	SB	0
DATE	**PROJECT NO.**			
February 8, 2024	SWM.SWOP04805-01			

Figure 3

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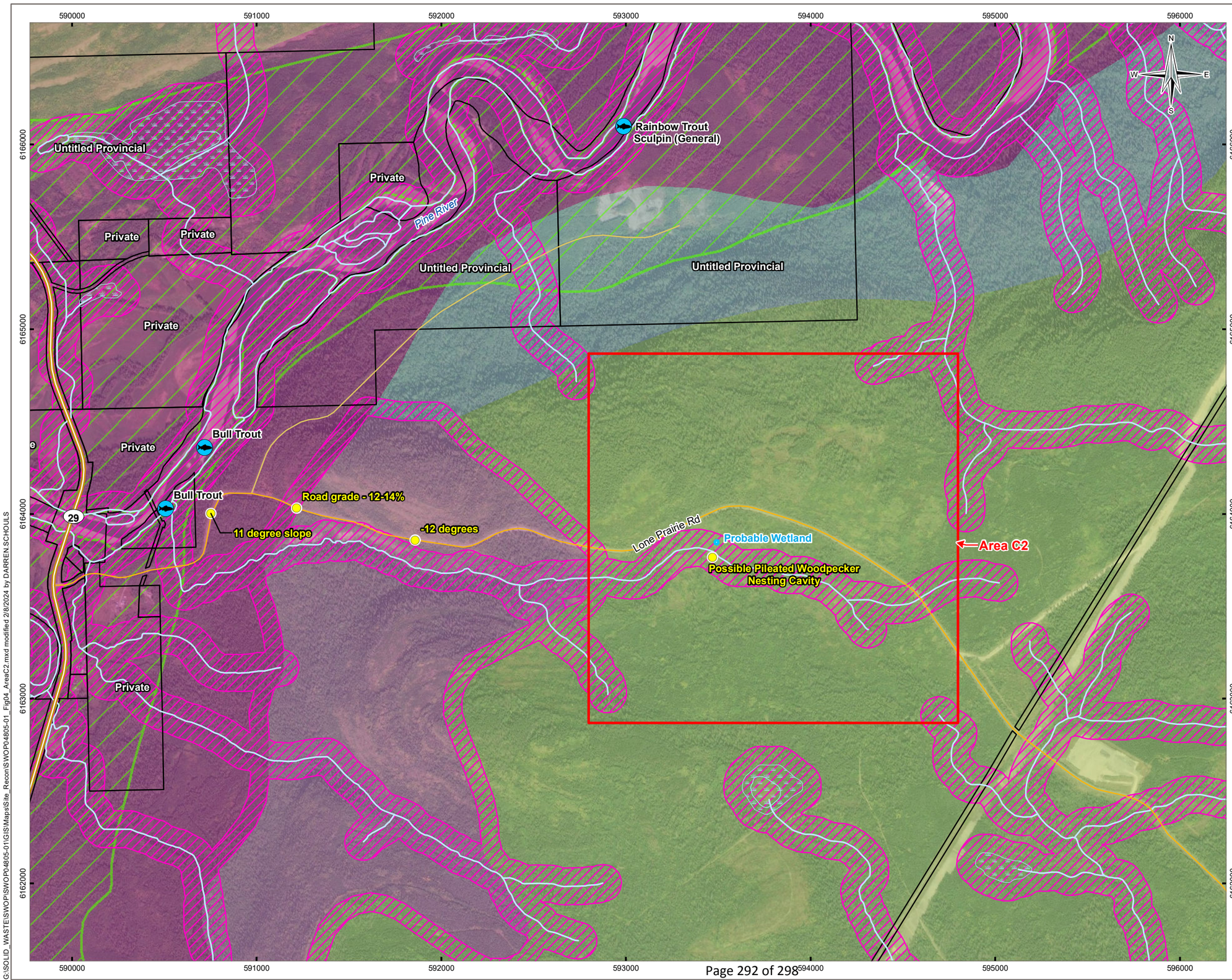


LEGEND

- Fish Occurrence
- Potential Landfill Site Area
- Alluvial Fan and Water Feature 100 m Buffer
- Agricultural Land Reserve
- Parcel Boundary

Field Observations

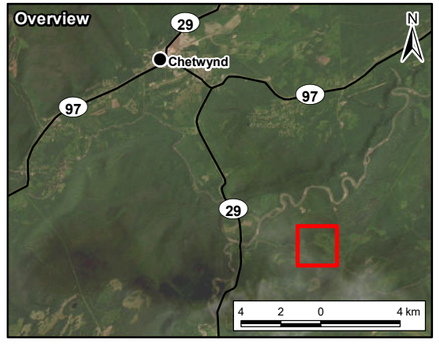
- Observation Location
- Probable Wetland

Surficial Geology

- Alluvial Fan
- Alluvial Plain
- Colluvial Veneer (thin, less than 2 m)
- Glaciolacustine Plain
- Till Veneer (thin, less than 2 m)

Base Data

- Highway
- Main Road
- Local Road
- Watercourse/Waterbody
- Wetland



NOTES
Base data source:
Water features from Fresh Water Atlas (2023)
Fish from DataBC (February 5, 2024)
ALR and Parcels from DataBC (2023)
Surficial Geology from Geoscience BC, Energy Open File 2011-2 (2011)

STATUS
ISSUED FOR USE

NEW LANDFILL FEASIBILITY CHETWYND AREA STAGE 1 SITE SELECTION – SITE RECONNAISSANCE

Area C2
Site Reconnaissance

PROJECTION UTM Zone 10	**DATUM** NAD83		**CLIENT** Peace River Regional District
Scale: 1:20,000 400 200 0 400 Metres			TETRA TECH
FILE NO. SWOP04805-01_Fig04_AreaC2.mxd			
OFFICE Tt-VANC	**DWN** DS / **CKD** SL / **APVD** SB / **REV** 0		**Figure 4**
DATE February 8, 2024	**PROJECT NO.** SWM.SWOP04805-01		

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596000
597000
598000
599000
6190000
6189000
6188000
6187000

Untitled Provincial
Private
CN Railway
Crown Agency
Black Bear Observation
Jackfish Lake Rd

N
W
E
S

LEGEND

- Potential Landfill Site Area
- Alluvial Fan and Water Feature 100 m Buffer
- Parcel Boundary

Field Observations

- Observation Location
- Approximate Marsh Extent
- Approximate Shallow Open Water Extent

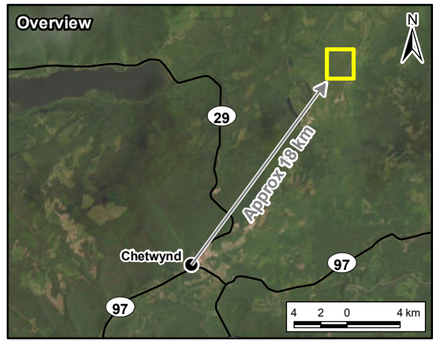
Surficial Geology

- Alluvial Fan
- Alluvial Plain
- Glaciofluvial Hummocky Terrain
- Glaciofluvial Plain
- Till Plain
- Streamlined Till Ridges

Base Data

- Main Road
- Local Road
- Railway
- WatercourseWaterbody
- Wetland

Overview



NOTES
Base data source:
Water features from Fresh Water Atlas (2023)
Parcels from DataBC (2023)
Surficial Geology from Geoscience BC, Energy Open File 2011-2 (2011)

STATUS
ISSUED FOR USE

NEW LANDFILL FEASIBILITY CHETWYND AREA STAGE 1 SITE SELECTION – SITE RECONNAISSANCE

Area L
Site Reconnaissance

PROJECTION UTM Zone 10			**DATUM** NAD83	**CLIENT** Peace River Regional District
Scale: 1:13,000 — 250 125 0 250 Metres				TETRA TECH
FILE NO. SWOP04805-01_Fig05_AreaL.mxd				
OFFICE Tt-VANC	**DWN** DS	**CKD** SL	**APVD** SB	**REV** 0
DATE February 8, 2024	**PROJECT NO.** SWM.SWOP04805-01			**Figure 5**

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PEACE RIVER REGIONAL DISTRICT

REPORT

To: Solid Waste Committee Report Number: ENV-SWC-157

From: Gerritt Lacey, Solid Waste Manager Date: April 5, 2024

Subject: RFP Award 23-2024 Hudson's Hope Transfer Station Operations

RECOMMENDATION:

That the Solid Waste Committee recommend that the Regional Board award Request for Proposal 23-2024 "Hudson's Hope Transfer Station Operations" to Secure Energy for a 41-month term ending October 31, 2027 at a total cost of $917,760 (excluding taxes); further that the Chair and Chief Administrative Office be authorized to sign the agreement on behalf of the Peace River Regional District.

BACKGROUND/RATIONALE:

The Peace River Regional District (PRRD) has a network of 16 manned Transfer Stations (TS). These 16 sites are staffed by 4 contracts/agreements:

1. Waste Transfer Station Operation and Haulage Contract (13 sites)
2. Tumbler Ridge Transfer Site Agreement (1 site)
3. Hudson's Hope Transfer Station Attendant Contract (1 site)
4. Mile 62.5 Transfer Station Site Attendant Contract (1 site)

Between the years 2000 and 2002, the Hudson's Hope Landfill was closed and replaced by the Hudson's Hope Transfer Station. The site is considered a Transtor site, however, it accepts *most* of the same materials as a Tier 1 site and is operated as a joint venture between the District of Hudson's Hope (the District) and the PRRD. The PRRD is responsible for collection and transportation of household bagged waste and used oil, while the District is responsible for all other waste streams collected on the site such as, share shed materials, metal, white goods, tires, and sorted wood.

The Hudson's Hope Transfer Station is kept operational through the PRRD with the use of two contracts:

1. Hudson's Hope Attendant Contract
2. Transtor Collection Haulage Contract

The current contract for the Hudson's Hope attendant services expires on May 31, 2024.

Through the public procurement process, one Request for Proposal (RFP) submission was received from Secure Energy. The proponent was evaluated on Experience and Qualifications, Methodology, and Budget. The chart that follows summarizes the ranking of each of the three rated criteria.

	Secure Energy
Mandatory Requirements	
Submission Form (Appendix B)	✓
Pricing (Appendix C)	✓
Scoring Matrix Results	
Experience and Qualifications (30%)	20.25
Methodology (30%)	20.67
Project Budget (40%)	40.00
Total Score	**80.92**

The submission met the mandatory requirements of the RFP.

The term of the contract is for a period of 41 months starting June 1, 2024, and ending October 31, 2027. This aligns the closing date of the contract with the closing date of the Waste Transfer Station Operation and Haulage Contract. In order to increase efficiencies and reduce contract management requirements, the operations of the Hudson's Hope Transfer Station will be included into the Waste Transfer Station Operation and Haulage Contract in 2027.

As part of this RFP, waste hauling and site maintenance services have been included to reflect the PRRDs responsibilities for the Transfer Station upon completion of the Tier 1 Upgrade Project. Previously these costs were borne by the District for the management of materials such as bulky waste, wood, metal, appliances, and tires.

ALTERNATIVE OPTIONS:

1. That the Solid Waste Committee provide further direction.

STRATEGIC PLAN RELEVANCE:

☒ Asset and Infrastructure Management

FINANCIAL CONSIDERATION(S):

Table 1 below shows the anticipated costs for the next 41-months:

Table 1: Annual Contract Rate

2024 Proposed	2025 Proposed	2026 Proposed	2027 Proposed
$256,080	**$263,057**	**$270,257**	**$128,366**

The total contract value of $917,760 represents an increase of 25% compared to the previous contract when comparing attendant services. Additional annual costs are attributed to the inclusion of a 20% contingency, bin rentals and waste hauling of bulky, wood, and metal wastes as a result of the PRRD becoming solely responsible for all material management upon completion of the Tier 1 Upgrade Project.

COMMUNICATIONS CONSIDERATION(S):

PRRD Staff will communicate the change of the Transfer Station Operations contractor with the District of Hudson's Hope staff and provide contact information upon the start of the contract.

OTHER CONSIDERATION(S):

In 2024, the PRRD initiated the Tier 1 Upgrade Project for the transfer station, this includes building tipping rails for collection of wood, metal, and bulky waste items in roll off bins, as well as building a new recycling station and share shed. This project will bring the transfer station in alignment with other Tier 1 transfer stations operated by the PRRD, and once construction is complete, the PRRD will be solely responsible for the management of all materials collected on the site.

PEACE RIVER REGIONAL DISTRICT

Solid Waste Committee
Terms of Reference

1. Background:

1.1 The Peace River Regional District (PRRD) developed a Regional Solid Waste Management Plan that was approved in 2022. The current Plan addresses five key areas:

a. Strategies to Encourage Reduction, Reuse and Recycling
b. Strategies to Increase Organics Diversion
c. Strategies to Increase Energy Recovery
d. Strategies to Improve Residual Waste Management
e. Strategies for Solid Waste Management Funding

2. Role of the Committee:

2.1 The general purpose of the Solid Waste Committee of the Peace River Regional District (SWC) is to act as the conduit between the Public Technical Stakeholder Committee (PTSC) and the Peace River Regional District Board regarding matters relating to Solid Waste in the region. The SWC will ensure the following actions are followed:

a. To ensure regulatory provisions are appropriate to program delivery and recommend amendments to the Board and staff;
b. Adhere to, and amend as appropriate, the Regional Solid Waste Management Plan; and,
c. Approve the annual draft Solid Waste budget.

3. Structure of the Solid Waste Committee:

3.1 Members: The SWC will consist of six (6) Board members as appointed by the Chair and will consist of:

i. Director from the City of Dawson Creek, or their alternate ;
ii. Director from the City of Fort St. John, or their alternate;
iii. Director or alternate director from one additional municipality in the South Peace (District of Chetwynd, or Village of Pouce Coupe or District of Tumbler Ridge);
iv. Director or alternate director from one additional municipality in the North Peace (District of Hudson's Hope or District of Taylor);
v. Director or alternate director from the North Peace (Electoral Area 'B' or 'C');
vi. Director or alternate director from South Peace (Electoral Area 'D' or 'E');
vii. PRRD Board Chair, as ex-officio member;
viii. Appropriate Regional District staff person – non-voting.

3.2 The meetings will be chaired by a Committee member elected by the Committee participants on an annual basis.

3.3 In the absence of the Chair, a member elected Vice-Chair by the Committee on an annual basis will chair the meetings.

4. Meetings:

4.1 The Committee shall meet as approved in conjunction with the Board meeting schedule each year;
4.2 Meetings will be open to the public;
4.3 Items for the regular agenda must be provided to Administration one (1) week prior to the scheduled meeting;
4.4 The PRRD Board Chair will be given a copy of all Committee meeting agendas;
4.5 The Committee has the authority to add or reschedule its meetings as necessary.
4.6 The Committee has the authority to call special committee meetings as necessary.

5. Procedures:

5.1 Quorum – at least one-half of the members of the Committee;

5.2 Voting – all options and recommendations shall be determined by majority vote, with recommendations and options being forwarded to the Regional Board for consideration and action.

Date Committee Established	March 10, 2016	Board Resolution #	RD/16/03/31
Date TOR Approved by Board	May 26, 2016	Board Resolution #	RD/16/05/20 (26)
Amendment Date	January 14, 2021	Board Resolution #	RD/21/01/14
Amendment Date	November 24, 2022	Board Resolution #	RD/22/11/12 (24)
Amendment Date		Board Resolution #	