REGIONAL DISTRICT
of Fraser-Fort George

MACKENZIE REGIONAL LANDFILL
2024 ANNUAL REPORT
PRINCE GEORGE, BRITISH COLUMBIA

Prepared by:

THE REGIONAL DISTRICT OF FRASER-FORT GEORGE
155 George Street
Prince George, British Columbia
V2L 1P8

[redacted]

Laura Zapotichny
General Manager of Environmental Services

March 3, 2026

Attention: British Columbia Ministry of Environment and Parks

Subject: Qualified Professional Annual Report Review
Mackenzie Regional Landfill 2024 Annual Report

The Regional District of Fraser-Fort George has retained Tetra Tech Canada Inc. (Tetra Tech) as a Qualified Professional (QP) to review the Mackenzie Regional Landfill (the Site) 2024 Annual Report (Annual Report).

Relevant third-party information, which has been relied upon, has been used in, and/or is appended to this report. Tetra Tech has reviewed the Annual Report and based on the information provided and knowledge of the Site, Tetra Tech is in general agreement with the information provided. Tetra Tech has reviewed the information presented in the Annual Report and is not responsible for the information that is included, or that may have been omitted.

Respectfully submitted,
Tetra Tech Canada Inc.

[redacted]

M.E. LEFEBVRE
#26071
BRITISH COLUMBIA
ENGINEER

Reviewed by:
Michel Lefebvre, M.Sc., P.Eng.
Senior Project Engineer
Solid Waste Management Practice
Direct Line: 587.460.3549
Michel.Lefebvre@tetratech.com

PERMIT TO PRACTICE
TETRA TECH CANADA INC.
PERMIT NUMBER: 1001972

/js

Enclosure: Declaration of Competency
Conflict of Interest Disclosure Statement

Tetra Tech Canada Inc.
14940 - 123 Avenue
Edmonton, AB T5V 1B4 CANADA
Tel 780.451.2121 Fax 780.454.5688

BRITISH COLUMBIA | Ministry of Environment and Climate Change Strategy

Declaration of Competency

The Ministry of Environment and Climate Change Strategy relies on the work, advice, recommendations and in some cases decision making of qualified professionals[1], under government's professional reliance regime. With this comes an assumption that professionals who undertake work in relation to ministry legislation, regulations and codes of practice have the knowledge, experience and objectivity necessary to fulfill this role.

1. Name of Qualified Professional: Michel Lefebvre, M.Sc., P.Eng.

   Title: Senior Project Engineer

2. Are you a registered member of a professional association in B.C.? ☒ Yes ☐ No

   Name of Association: Engineers & Geoscientists BC Registration # 26071

3. Brief description of professional services:

Qualified Professional Review of Landfill Annual Reports 2024 for the Regional District of Fraser-Fort George.

This declaration of competency is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Declaration

I am a qualified professional with the knowledge, skills and experience to provide expert information, advice and/or recommendations in relation to the specific work described above.

Signature: [redacted]

X _____

Print Name: Michel Lefebvre

Witnessed by [redacted]

X _____

Print Name: Lauren Quan

Date signed: March 3, 2026

[1] *Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

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

b) *through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

BRITISH COLUMBIA | Ministry of Environment and Climate Change Strategy

Conflict of Interest Disclosure Statement

A qualified professional [1] providing services to either the Ministry of Environment and Climate Change Strategy ("ministry"), or to a regulated person for the purpose of obtaining an authorization from the ministry, or pursuant to a requirement imposed under the *Environmental Management Act,* the *Integrated Pest Management Act* or the *Park Act* has a real or perceived conflict of interest when the qualified professional, or their relatives, close associates or personal friends have a financial or other interest in the outcome of the work being performed.

A real or perceived conflict of interest occurs when a qualified professional has

a) an ownership interest in the regulated person's business;

b) an opportunity to influence a decision that leads to financial benefits from the regulated person or their business other than a standard fee for service (e.g. bonuses, stock options, other profit sharing arrangements);

c) a personal or professional interest in a specific outcome;

d) the promise of a long term or ongoing business relationship with the regulated person, that is contingent upon a specific outcome of work;

e) a spouse or other family member who will benefit from a specific outcome; or

f) any other interest that could be perceived as a threat to the independence or objectivity of the qualified professional in performing a duty or function.

Qualified professionals who work under ministry legislation must take care in the conduct of their work that potential conflicts of interest within their control are avoided or mitigated. Precise rules in conflict of interest are not possible and professionals must rely on guidance of their professional associations, their common sense, conscience and sense of personal integrity.

Declaration

I Michel Lefebvre, as a member of Engineers & Geoscientists BC declare

Select one of the following:

☑ Absence from conflict of interest

Other than the standard fee I will receive for my professional services, I have no financial or other interest in the outcome of this work involving annual report reviews. I further declare that should a conflict of interest arise in the future during the course of this work, I will fully disclose the circumstances in writing and without delay to Leonard Cook, erring on the side of caution.

☐ Real or perceived conflict of interest

Description and nature of conflict(s):

I will maintain my objectivity, conducting my work in accordance with my Code of Ethics and standards of practice.

In addition, I will take the following steps to mitigate the real or perceived conflict(s) I have disclosed, to ensure the public interest remains paramount:

Further, I acknowledge that this disclosure may be interpreted as a threat to my independence and will be considered by the statutory decision maker accordingly.

This conflict of interest disclosure statement is collected under section 26(c) of the *Freedom of Information and Protection of Privacy Act* for the purposes of increasing government transparency and ensuring professional ethics and accountability. By signing and submitting this statement you consent to its publication and its disclosure outside of Canada. This consent is valid from the date submitted and cannot be revoked. If you have any questions about the collection, use or disclosure of your personal information please contact the Ministry of Environment and Climate Change Strategy Headquarters Office at 1-800-663-7867.

Signatu [redacted]

X _____

Print name: Michel Lefebvre

Date: March 3, 2026

Witnessed by [redacted]

X _____

Print name: Lauren Quan

[1]*Qualified Professional, in relation to a duty or function under ministry legislation, means an individual who*

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

b) *through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.*

EXECUTIVE SUMMARY

This 2024 Annual Operations Report has been prepared by the Regional District of Fraser-Fort George for the Mackenzie Regional Landfill located approximately 3 kilometres south of Mackenzie, British Columbia.

The objective of the 2024 Annual Operations Report is to summarize the development of the Site for the period of January 1, 2024, to December 31, 2024. The results of the Environmental Monitoring Program were submitted to the British Columbia Ministry of Environment and Parks (BC MOEP) in the report entitled, "2024 Annual Groundwater Monitoring Report Mackenzie Regional Landfill" generated by Tetra Tech Canada.

The Site began to accept waste in 1974. It currently operates under Operational Certificate (OC) 100206 issued March 4, 2009, by the British Columbia Ministry of Environment under the provisions of the *Environmental Management Act* and in accordance with the Regional District of Fraser-Fort George (RDFFG) Solid Waste Management Plan. The site is operating as a natural attenuation landfill.

The Site has a total permitted area of approximately 8.2 hectares.

In 2019 the municipal solid waste landfill was converted into a Transfer Station operation and Select Landfill for demolition, land clearing and construction (DLC) waste. With the completion of the transfer station facility to the west of the landfill property, municipal solid waste (MSW) is now hauled to the Foothills Boulevard Regional Landfill. As of January 1, 2020, only DLC materials are landfilled at the Site.

According to RDFFG records, the total amount of DLC landfilled at the active face is estimated at approximately 765 tonnes, during the Reporting Period.

Approximately 1,697 tonnes (per Section 3.6 and Table 2) of commercial and residential MSW were transported to Foothills Boulevard Regional Landfill during the Reporting Period.

TABLE OF CONTENTS

1. INTRODUCTION

The objective of the 2024 Annual Operations Report is to summarize the development of the Site for the period of January 1, 2024 to December 31, 2024 (Reporting Period).

This report fulfils the annual operational reporting requirements outlined in Condition 8.2 of Operational Certificate 100206 (OC), issued by the British Columbia Ministry of Environment and Parks (BC MOEP).

2. SITE AND REGULATORY SETTING

2.1 Site Description

The Site is located approximately 3 kilometres south of the District of Mackenzie, British Columbia on leased Crown land previously used as a gravel pit. The Site comprises an area of approximately 8.2 hectares. A site location map is provided as Figure 1.

The Site opened in 1974 and accepts waste from the District of Mackenzie and surrounding area.

Currently, the Site provides services for receiving Demolition, Land Clearing and Construction (DLC) waste for burial. Municipal Solid Waste (MSW), used oil, oil filters and containers, antifreeze, lead acid batteries, and rechargeable household batteries are received at the Transfer Station. A swap shed, marshalling site for appliances, scrap metal, and multi-material recycling (MMR) are present at the Transfer Station.

Large quantities of source separated yard and garden waste can be dropped off at the Site at no charge. Yard waste is chipped periodically and stored for future use on-site.

The existing site conditions are shown on Figure 3.

2.2 Site History

The Site began to accept waste in 1974 from the District of Mackenzie and surrounding area. The Site is operated as a "natural attenuation landfill."

On December 1, 2019, the Transfer Station was fully operational, accepting all MSW and recyclables. The landfill site transitioned to only accept DLC waste.

The old weigh scale was replaced with a new weigh scale in 2019. The weigh scale and scale house are located at the Transfer Station entrance of the Site.

2.3 Regulatory Setting

The OC for the Site (Appendix A) was issued on March 4, 2009 by the BC MOEP under the provisions of the *Environmental Management Act* and in accordance with the Regional District of Fraser-Fort George Solid Waste Management Plan (2015). The annual operations reporting requirements for the Site, are outlined in Condition 8.2 of the OC, including the following:

- An executive summary;
- The type and tonnage of waste received, recycled, and landfilled for the year;
- A current topographic map detailing airspace consumption, on-site borrow pit changes, and future developments (Figure 2);

- Updated estimates for the remaining capacity, closure date for the current phase, and closure date for the current landfill footprint;
- Any new information or proposed changes relating to the facilities and Design and Operating Plan;
- Composting operation activity including amount of material received for composting, material composted, material sold and number of composting cycles;
- Occurrences or observations of wildlife (medium and large carnivores) at the facility;
- A statement regarding the facility's progress in reducing the regional solid waste stream, in accordance with the hierarchy of reduce, reuse, and recycle principles; and
- The results of monitoring programs as specified in the OC will be submitted by the RDFFG under separate cover and are not included in this report.

3. LANDFILL OPERATION AND MANAGEMENT

3.1 Site Operations

Since December 1, 2019, and the completion of the Transfer Station, the active face at the Site accepts only DLC waste from the District of Mackenzie and surrounding areas.

Other waste items accepted at the Transfer Station include the following:

- MSW;
- Scrap metal;
- Yard and Garden Waste; and
- Clean Cover.

According to Condition 6.1 of the OC, hazardous waste, as defined by the Hazardous Waste Regulation pursuant to the Environmental Management Act is prohibited from disposal unless expressly authorized by the Hazardous Waste Regulation, approved by the Director or as specified in the OC.

Condition 6.2 of the OC authorizes the disposal of waste asbestos at the Site, subject to compliance with the requirements of Section 40 of the Hazardous Waste Regulation. The Site did not accept asbestos for disposal in 2024. The Site now prohibits the disposal of asbestos.

Materials that are prohibited for disposal at the Site include: cattle carcasses; fencing wire; hazardous waste; industrial chemical waste; lubricants; radioactive waste; refuse (on fire or smouldering); special waste (except as permitted controlled waste); steel/plastic drums (if not cut, crushed, or perforated); tires on rims; explosives; fuels; ignitable waste; liquids; paints/solvents; reactive waste; and slurry/sewage sludge.

Equipment used at the Site for landfilling related activities, includes the following:

- D6M Crawler Tractor or equivalent;
- Hydraulic excavator;
- All-wheel drive dump truck; and
- Articulating rock truck.

The landfill hours of operation are as follows:

- Monday to Friday: 9am – 5pm
- Saturday and Sunday: 9am – 3pm
- Holidays: 9am – 4pm on Easter Monday, Victoria Day, Labour Day and Thanksgiving Day. Closed on all other Holidays. (Came into effect, September 01, 2024).

Currently, the active face area of the landfill is machine compacted and covered three to four times during Spring and Summer. The active face area of the landfill is covered with soil.

3.2 Site Facilities

The limit of waste of the landfill and Transfer Station is secured with an electric fence. Access to the Site is controlled by a gate located at the main entrance. The gate is locked outside of normal operating hours to prevent unauthorized access and uncontrolled disposal. The weigh scale facility includes a 12-metre long weigh scale and an adjacent scale house. When residents and commercial haulers arrive at the Site, they are instructed to report to the scale house where load inspections and discharge direction is provided.

All weigh scale records are maintained on a computer attached to the weigh scale. The software program used to collect weigh scale data at the Site is the same software used at the Foothills Boulevard Regional Landfill (FBRL). This harmonizes the data input between the Site and FBRL.

In addition to the scale house, the following facilities are maintained at the Site:

- Swap Shed;
- Used Oil Storage sea can, which consists of a double walled storage tank with a capacity of 2,200 litres and a built in catch basin within the sea can;

3.3 Open Burn Activity

No open burning activities occurred on the Site during the Reporting Period.

3.4 Wildlife Observations

Medium carnivores (coyotes) were observed on Site during the Reporting Period, a total of thirty three times, the total number of animals observed was 49 during the Reporting Period.

3.5 Waste Diversion Activities

The RDFFG encourages the reduction of solid waste generated and subsequently landfilled by the following means (Appendix B):

- Swap shed – waste exchange areas where reusable items can be either dropped off or picked up free of charge;
- Grinding of yard and garden waste;
- Recycle BC:
  - printed paper, paper packaging, corrugated cardboard, cartons and paper cups
  - plastic containers, metal containers
  - white and colour foam packaging
  - plastic bags and overwrap, other flexible plastic packaging
  - glass bottles and jars

- Automotive lead acid battery collection;
- Single use battery collection;
- Sea can for collection of used oil and antifreeze, oil filters and used oil containers;
- Marshalling area for scrap metal; and
- Marshalling area for white goods, including Ozone Depleting Substances (ODS) containing appliances.

The Regional District of Fraser-Fort George partnered with Recycle BC to open a principal Recycle BC deport at the site on September 15, 2024. By partnering with Recycle BC, the RDFFG can accept more material categories under their program for waste diversion.

3.6 Waste Disposal

Residential and Commercial MSW are no longer received at the Landfill Site for burial since the Transfer Station started operations on December 1, 2019. All MSW received is transported to the FBRL.

Only DLC waste is accepted for disposal at the Select Landfill area. According to RDFFG records, the total amount of DLC landfilled at the active face is estimated at approximately 765 tonnes during the Reporting Period, with 695 tonnes scaled in.

According to RDFFG records, the total MSW transported to FBRL is 1,697 tonnes during the Reporting Period. This total was comprised of approximately 1,398 tonnes of MSW collected through the District of Mackenzie's curbside garbage collection and approximately 299 tonnes brought by commercial haulers and residential self haul (see Table 2).

Prior to 2020, the amount of waste received at the site was approximated using the scale software data and average provincial per capita disposal rates. Since that time, most of the waste is accounted for in two ways.

The municipal solid waste collected at the Mackenzie Regional Transfer station is transported to the FBRL and weighed in.

Most demolition, land clearing, and construction waste was scaled in at the Site, however the RDFFG applied a factor of 10% to account for the small loads of DLC waste that were not scaled in at the Site for a total of 765 tonnes of DLC waste buried at the site in 2024.

3.7 Landfill Volume Consumed

As indicated in Section 3.6, the total amount of DLC waste received was estimated to be approximately 765 tonnes during the Reporting Period.

The apparent waste density is estimated from the calculated landfill airspace consumption and the annual tonnage landfilled. The apparent waste density is not a true density, but is a relationship that represents the mass of waste that can be

disposed in each cubic metre of landfill air space. The apparent waste density is a more accurate measure of the efficiency of landfilling since soil (used for daily and interim cover) is excluded from the ratio. The apparent waste density is based on the comparison of the tonnage landfilled versus the air space consumed. Soil used as daily cover is excluded from consideration since an increase in soil usage can increase the true density and provide a skewed representation of landfilling efficiency.

Efficient landfill compaction techniques employed at well-operated landfill sites can typically attain an apparent waste density of 0.5 to 1.0 tonnes of waste per cubic metre of air space consumed dependant upon the type of material landfilled and the size of the landfill. A landfill similar to the Site would be anticipated to achieve an apparent waste density of 0.5 tonnes per cubic metre.

The apparent waste density was calculated by comparing the waste tonnage and air space consumed between the survey period on May 10, 2024, and May 1, 2025. Using the topographic contour plan generated during the Reporting Period, shown as Figure 3, an airspace consumption of approximately 3113 cubic metres was estimated (Tetra Tech Canada., 2025) and 695 tonnes were received on Site during this period giving an apparent waste density of 0.22 tonnes per cubic meter, (Tetra Tech Canada., 2025), (Appendix C).

3.8 Approved Design Volume

An approved design volume has been defined for the Site. An updated DOCP was for the site was completed by Morrison Hershfield starting in 2023 and the findings and results of that undertaking have been included in the 2024 Annual Report.

3.9 Remaining Capacity and Site Life

The remaining Site life as per the 2024 Design, Operations and Closure Plan is approximately 59 years with a contingency area of a further 21 years of airspace. (Morrison Hershfield 2024).

The current landfill was converted into a Select Landfill, where DLC is the only waste accepted for burial. The Transfer Station portion opened on December 1, 2019.

The Site will continue to accept residential, commercial, and light industrial waste from the District of Mackenzie and surrounding areas directed to the Transfer Station. Other waste items listed in Section 3.1 will continue to be accepted at the Site.

To enhance cardboard diversion, a cardboard compactor unit was installed in October 2021 to maximize the collection of corrugated cardboard. Multi-material recycling is scheduled to be consolidated at the Site and will coincide with the removal of the recycling bins at the Fire Hall location.

Future consideration will be given to implementing the DLC waste diversion program at the Mackenzie Regional Landfill.

3.10 Summary of Environmental Monitoring Data

The results of the Environmental Monitoring Program were submitted to the British Columbia Ministry of Environment and Parks (MOEP) in the report entitled, "2024 Annual Groundwater Monitoring Report Mackenzie Regional Landfill" generated by Tetra Tech Canada, (June 2024).

4. SUMMARY AND CLOSURE

The 2024 Annual Report was prepared to summarize the development and operations of the Mackenzie Regional Landfill, for the January 1, 2024, to December 31, 2024 Reporting Period.

According to RDFFG records, approximately 765 metric tonnes of waste was received at the Site during the 2024 Reporting Period. In 2023/2024 an update to the sites Design, Operation and Closure Plan was undertaken that determined the lifespan of the current footprint in the 2024 Annual Report.

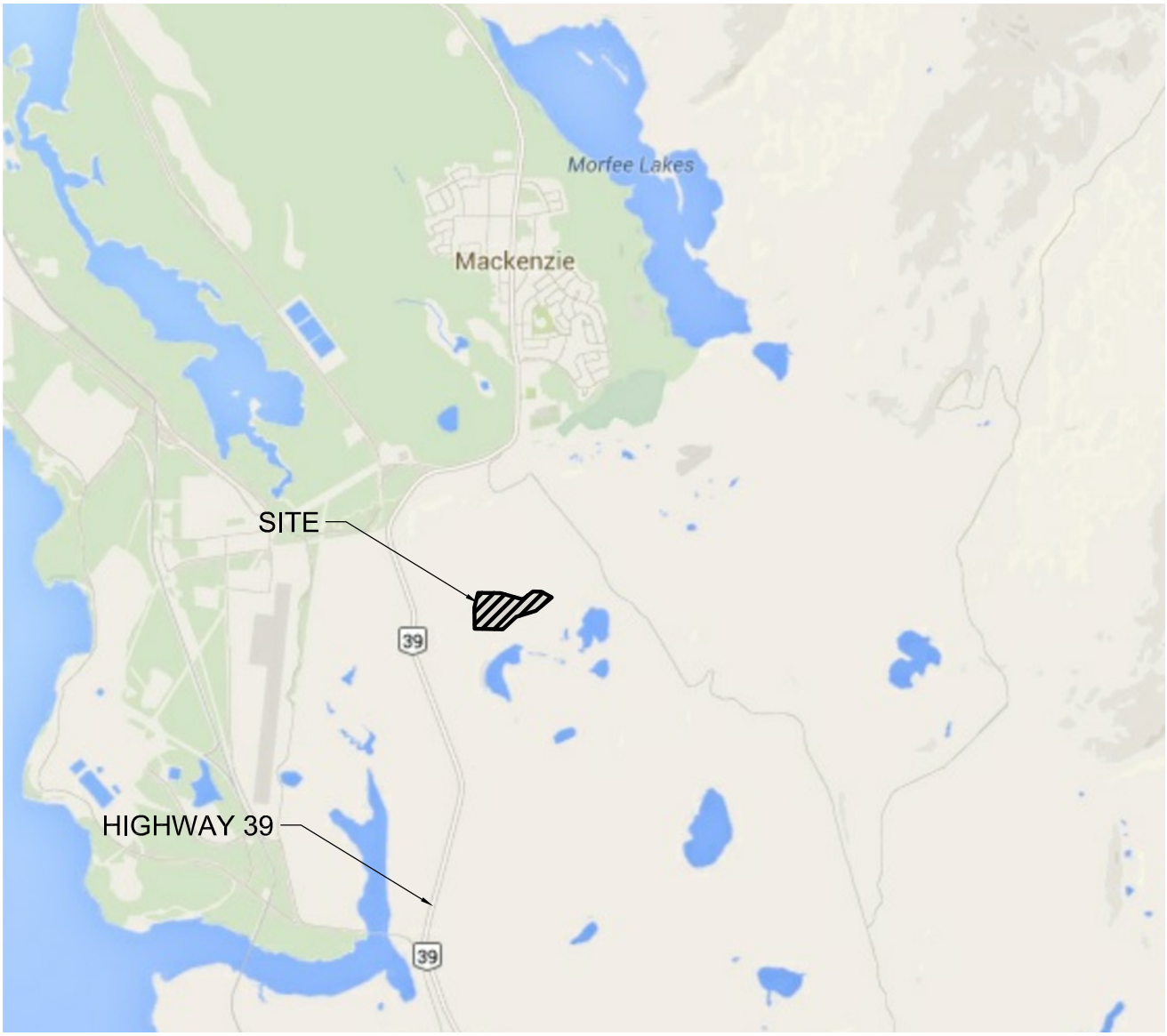
The updated Design, Operation and Closure Plan is attached in Appendix D.

5. REFERENCES

1. Aero Geometrics Ltd., 2023. “Air Survey.”
2. Dillon Consulting Inc., “2024 Volume Assessment - Mackenzie Regional Landfill.”
3. British Columbia Ministry of Environment, Second Edition, June 2016. “Landfill Criteria for Municipal Solid Waste.”
4. Environmental Management Act, 2009. “Hazardous Waste Regulation.”
5. British Columbia Ministry of Environment 2006, "Guidelines to Environmental Monitoring at Municipal Solid Waste Landfills."
6. British Columbia Ministry of Environment 2020. "Environmental Management Act."
7. Ministry of Environment 2020. "Landfill Gas Management Regulation".

FIGURES

FIGURE 1
SITE LOCATION MAP



NOT TO SCALE

SITE LOCATION MAP

2013 ANNUAL OPERATIONS REPORT
MACKENZIE REGIONAL LANDFILL
REGIONAL DISTRICT OF FRASER-FORT GEORGE

XCG CONSULTANTS LTD.

DATE	JOB NO.	FIGURE NO.
AUGUST 2014	4-2428-03-03	1

(file: R424280303001FIG1.dwg)

FIGURE 2
SITE PLAN

REGIONAL DISTRICT
of Fraser-Fort George

MACKENZIE REGIONAL LANDFILL
SITE PLAN
MAY 2025

LEGEND:

—— x —— - FENCE

● TH4 - MONITORING WELL

NOTE: EXISTING CONDITIONS AS OF MAY 2025

0 20 40 m

1: 750

FIGURE 3
AERIAL SURVEY

REGIONAL DISTRICT
of Fraser-Fort George

POLLUTION CONTROL INFRASTRUCTURE AT MACKENZIE REGIONAL LANDFILL MAY 2025

LEGEND:
- x - FENCE
- TH4 - MONITORING WELL
- SURFACE WATER DITCHING

MAIN ACCESS ROAD
GATE
GATE
NEW WEIGHT SCALE AND SCALE HOUSE
MULTI-MATERIAL RECYCLING BINS
TRANSFER STATION
YARD AND GARDEN MARSHALLING AREA
BATTERY, PROPANE TANKS, AND OIL MARSHALLING AREA
WHITE GOOD AND METAL MARSHALLING AREA
HISTORIC LANDFILL AREA
ACTIVE LANDFILL AREA
BORROW PIT
TH2
TH3
TH4
TH5
TH6

NOTE: EXISTING CONDITIONS AS OF MAY 2025

0 20 40 m
1: 750

TABLES

TABLE 1 WASTE DIVERSION

Material	**Units**
Waste Oil	2,584 litres
Oil Filters (drums)	1 drum
Antifreeze	205 litres
Batteries	229 units
Scrap Metal	5.7 tonnes

TABLE 2 SOLID WASTE DISPOSAL SUMMARY

Materials Received Mackenzie Regional Landfill 2024		
	Materials Received and Buried at Active Face	
	Construction and Demolition (tonnes)	**Asbestos (tonnes)**
Scale Data	695.2	0
Estimate	70	0
Total	**765.2**	**0**
MSW Materials Diverted Off-Site 2023		
	Residential Curbside (tonnes)	**Residential & Commercial Self-Haul (tonnes)*includes calculated estimate.**
Scale Data	1398.1	298.9
Total	**1,697 tonnes**	

APPENDIX A
OPERATIONAL CERTIFICATE 100206

PROVINCE OF
BRITISH COLUMBIA

MINISTRY OF ENVIRONMENT

OPERATIONAL CERTIFICATE
100206

Under the Provisions of the Environmental Management Act
and In accordance with the
Regional District of Fraser-Fort George
Solid Waste Management Plan

Regional District of Fraser-Fort George

155 George Street

Prince George, British Columbia

V2L 1P8

is authorised to manage recyclable material and municipal solid waste at a sanitary landfill located 4.2 km south of Mackenzie, British Columbia, subject to the conditions listed below. Contravention of any of these conditions is a violation of the *Environmental Management Act* and may result in prosecution.

1. LOCATION OF AUTHORISED FACILITY

The location of the facility for the management of recyclable material and municipal solid wastes to which this Operational Certificate is applicable is the **Mackenzie Regional Landfill**, covering all unsurveyed Crown Land in the vicinity of District Lot 3458, Cariboo District, containing 16.73 hectares, more or less. The Crown Licence of Occupation for the site is #705356.

2. ENTRANCE FACILITIES

The authorised facility includes recyclable material and municipal solid waste drop-off facilities, weigh scales and related appurtenances approximately as shown on attached Site Plan A.

3. MANAGEMENT OF MUNICIPAL SOLID WASTE

3.1. Sanitary Landfill

3.1.1. The authorised facilities are a sanitary landfill area, recyclable material storage areas and related appurtenances approximately as shown on the attached Site Plan. The site reference number for the discharge is E211576.

[redacted]

Del Reinheimer, P.Eng.
for Director, Environmental Management Act

Date Issued: MAR 0 4 2009

3.1.2. The characteristics of the discharge must be municipal solid waste as defined under the *Environmental Management Act* and other wastes as approved in writing by the Director.

3.1.3. Waste may be discharged to the areas specified in the Regional District's Design and Operation Plan, approximately located as shown on attached Site Plan A.

4. GENERAL REQUIREMENTS

4.1. Qualified Professionals

All facilities and information, including works, plans, assessments, investigations, surveys, programs and reports, must be certified by qualified professionals.

4.2. Plans

4.2.1. The Regional District shall prepare a Design and Operation Plan that will include considerations for site operation, development and closure, leachate and landfill gas management, composting operations, monitoring programs and environmental impact mitigation management.

The Design and Operation Plan must be submitted to the Director by May 15, 2009.

4.2.2. The Design and Operation Plan must address, but not be limited to, each of the subsections in the *Landfill Criteria for Municipal Solid Waste* including performance, siting, design, operational and closure and post-closure criteria.

4.2.3. The facilities must be developed and operated in accordance with the Design and Operation Plan.

4.2.4. Any updates to the plan shall be immediately submitted to the Director.

4.3. Additional Facilities or Works

The Director may require investigations, surveys, and the construction of additional facilities or works. The Director may also amend information requirements of this Operational Certificate including plans, programs, assessments and reports.

[redacted]

Date Issued: MAR 0 4 2009

Del Reinheimer, P.Eng.
for Director, Environmental Management Act

5. OPERATIONAL REQUIREMENTS

5.1. Non-Compliance Reporting

The Regional District shall immediately notify the Regional Manager, Environmental Protection, or designate by facsimile (250-565-6629) of any non-compliance with the requirements of this Operational Certificate and take appropriate remedial action.

Written confirmation of all non-compliance events, including available test results, is required by facsimile within 24 hours of the original notification unless otherwise directed by the Regional Manager, Environmental Protection.

5.2. Operator Training and Development

At a minimum, the Regional District will ensure that operating personnel are trained to industry standards and current in a SWANA recognized landfill operator course or equivalent.

5.3. Electric Fencing

Areas where putrescible materials are stored or discharged shall be surrounded by an electric fence.

5.3.1. Design, Construction and Maintenance

The electric fencing shall be designed, constructed, and maintained such that bears are prevented from penetrating the fence. The Director shall be advised of any modifications to the fence.

5.3.2. Operating Period

The electric fence shall be fully operational during the period of April 15 to November 15 inclusive each year. If snow is present during this period, any electrified strands above snow line shall be isolated from the remainder of the system and energised. The Director may vary the operating period with prior written authorisation.

5.3.3. Record Keeping and Reporting

The Regional District is required to monitor wildlife (medium and large camivores) activity at the facility and keep records of occurrences and observations of wildlife (medium and large carnivores).

[redacted]

Del Reinheimer, P.Eng.
for Director, Environmental Management Act

Date Issued: MAR 0 4 2009

5.4. Compost

Composting facilities shall be operated and maintained in accordance with the *Organic Matter Recycling Regulation.*

5.5. Landfill Gas

Landfill gas shall be managed in accordance with the *Landfill Gas Management Regulation.*

5.6. Leachate

The characteristics of the surface water and groundwater at the property boundary must not exceed concentrations set in the *British Columbia Approved Water Quality Guidelines (Criteria)* and *A Compendium of Working Water Quality Guidelines for British Columbia.* Where natural background water quality concentrations exceed the aforementioned guidelines, characteristics of the surface water and groundwater at the property boundary must not exceed background concentrations.

6. HAZARDOUS WASTE MANAGEMENT

6.1. Hazardous Waste

"Hazardous Wastes" as defined by the *Hazardous Waste Regulation* pursuant to the *Environmental Management Act* are prohibited from disposal unless expressly authorised by the *Hazardous Waste Regulation*, approved by the Director or as specified in the Operational Certificate.

6.2. Waste Asbestos

Waste asbestos is authorized for disposal subject to compliance with the requirements of section 40 of the *Hazardous Waste Regulation* and the following conditions:

6.2.1. The asbestos waste may not be mixed with any other hazardous waste.

6.2.2. The Regional District must approve the disposal before disposal takes place.

6.2.3. All other applicable requirements of the *Hazardous Waste Regulation*, including but limited to manifesting and waste record keeping, must also be complied with.

[redacted]

Date Issued: MAR 0 4 2009

Del Reinheimer, P.Eng.
for Director, Environmental Management Act

6.3. Handling of Impacted Soil

The *Environmental Management Act*, the *Contaminated Sites Regulation* and the *Hazardous Waste Regulation* are applicable for the disposal of impacted (contaminated) soil at the facility.

6.4. Hazardous Wastes from Accidental Spills or Abandonment

Hazardous wastes resulting from accidental spills or abandonment of dangerous goods may be accepted at the facility only under the authority of Section 52(1) of the *Hazardous Waste Regulation*.

7. MONITORING

7.1. Monitoring Program

7.1.1. A monitoring program shall be developed by a qualified professional to identify potential impacts to the environment and public health from the facility.

7.1.2. The monitoring program shall be submitted as part of the Design and Operation Plan.

7.1.3. The monitoring program must address, but not be limited to, subsections 4.1, 4.2 and 7.15 of the *Landfill Criteria for Municipal Solid Waste* and the *Guidelines for Environmental Monitoring at Municipal Solid Landfills*.

7.1.4. Monitoring must be conducted in accordance with the monitoring program.

8. REPORTING

All reports and drawings shall be submitted in electronic format unless otherwise requested by the Director.

8.1. Drawings

All drawings shall be certified correct and sealed by a qualified professional. Drawings shall be submitted to the Director within 30 days of completion or as otherwise specified by the Director.

8.2. Annual Report

The Regional District shall submit an Annual Report to the Director on or before June 30 each year for the previous calendar year.

[redacted]

Del Reinheimer, P.Eng.
for Director, Environmental Management Act

Date Issued: MAR 04 2009

The report shall contain, but not be limited to the following information:

i.) an executive summary;

ii.) the type and tonnage of waste received, recycled and landfilled for the year;

iii.) a current topographic map detailing airspace consumption, on-site borrow pit changes and future developments;

iv.) updated estimates for the remaining capacity, closure date for the current phase and closure date for the current landfill footprint;

v.) any new information or proposed changes relating to the facilities and Design and Operation Plan;

vi.) composting operation activity including amount of material received for composting, material composted, material sold and number of composting cycles;

vii.) occurrences or observations of wildlife (medium and large carnivores) at the facility;

viii.) a statement regarding the facility's progress in reducing the regional solid waste stream, in accordance with the hierarchy of reduce, reuse and recycle principles; and,

ix.) the results of all monitoring programs as specified in this Operational Certificate. Data interpretation and comparison to the performance criteria in the *Landfill Criteria for Municipal Solid Waste* and the *Guidelines for Environmental Monitoring and Municipal Solid Waste Landfills*. Trend analysis, as well as an evaluation of the impacts of the discharges on the receiving environment in the previous year shall be carried out by a qualified professional.

9. CLOSURE PLAN

At least one year in advance of decommissioning the landfill, or as otherwise specified by the Director, a Closure Plan shall be submitted which includes at least the following information:

i) a topographic plan showing the final elevations contours of the landfill and surface water diversion and drainage controls;

ii) specifications for the final cap and proposed end use of the site; and,

[redacted]

Date Issued: MAR 0 4 2009

[redacted] Del Reinheimer, P.Eng.
for Director, Environmental Management Act

iii) provisions for a minimum 25 year post-closure care period at the facility which, at a minimum, considers the following: groundwater monitoring, surface water monitoring, landfill gas management, erosion and settlement monitoring and management.

10. CLOSURE AND POST-CLOSURE FUND

The Regional District will conform to the Public Sector Accounting and Auditing Board's requirements (PS 3270) to recognize solid waste landfill closure and post-closure liability. The Regional District will develop a plan to ensure that sufficient funds are available for closure and post-closure care work.

[redacted]

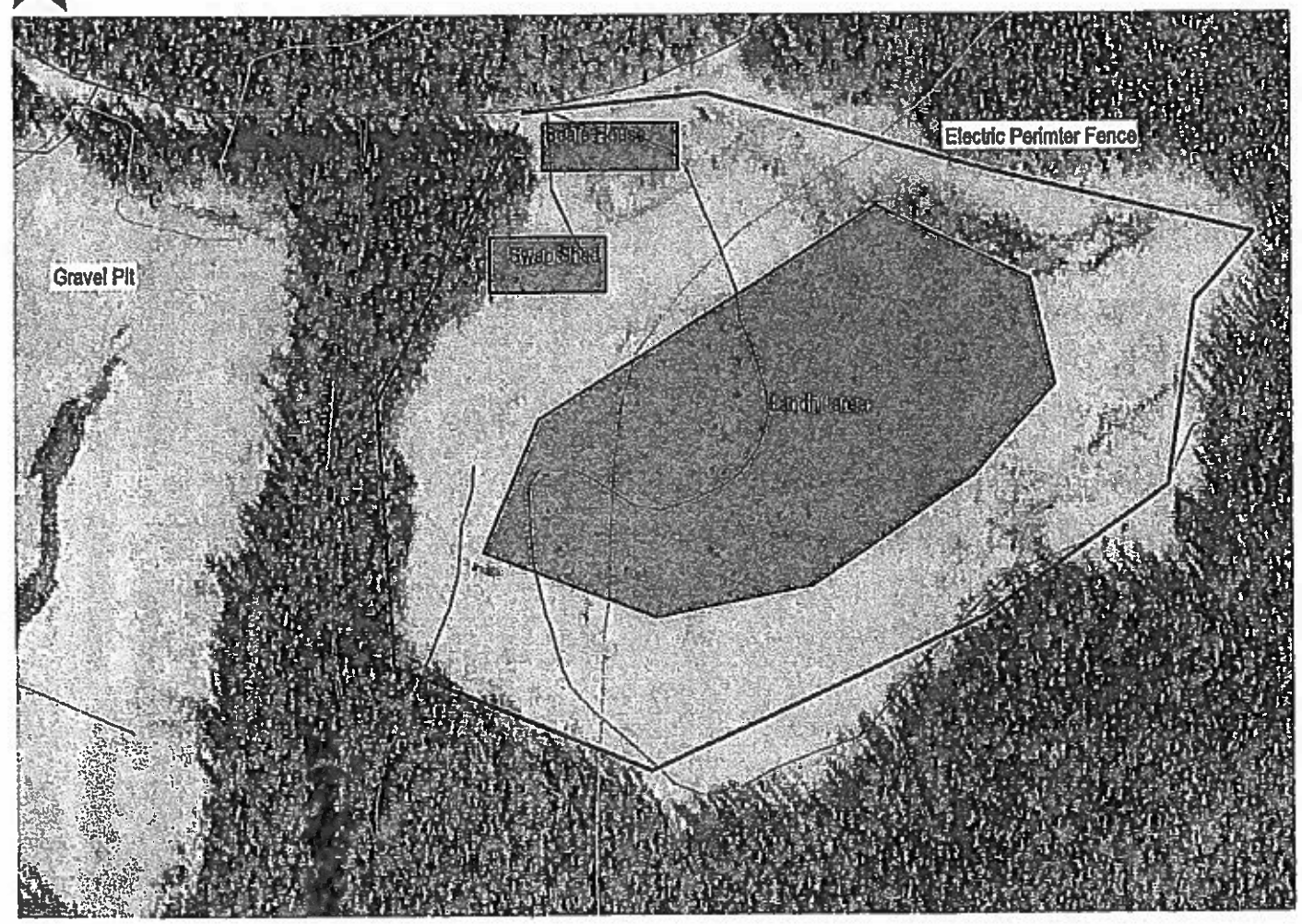
Date Issued: MAR 0 4 2009

Del Rehnheimer, P.Eng.
for Director, Environmental Management Act

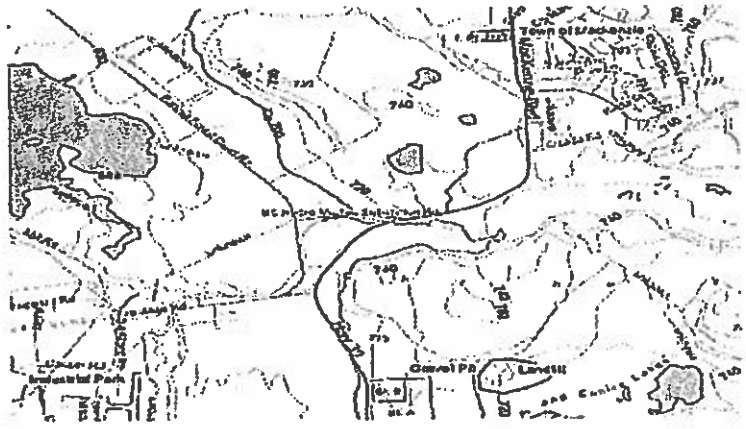
PROVINCE OF
BRITISH COLUMBIA

Environmental Protection

SITE PLAN A



Location Map



Not to Scale

Operational Certificate 100206

Date: MAR 0 4 2009

[redacted]

Del Reinheimer, P.Eng.
for Director, *Environmental Management Act*
Omineca and Peace Regions

APPENDIX B
SITE BROCHURE

RECYCLE BC

This site will accept:

- printed paper, paper packaging, corrugated cardboard, cartons and paper cups
- plastic containers, metal containers
- white and colour foam packaging
- plastic bags and overwrap, other flexible plastic packaging
- glass bottles and jars

The Recycle BC website has more information on the What Can I Recycle? page about these different categories and a "Waste Wizard" look up tool to find out if a specific item can be recycled.

If you have more questions on what can be recycled under the new Recycle BC program, contact the Regional District's Recycling Information Line at 250-960-4433 or ask for a handout at the site.

For a detailed list of accepted materials, please visit our website or www.sortsmart.ca.

USED OIL AND ANTIFREEZE

Used oil, oil filters and containers, and used antifreeze and containers are accepted for recycling.

APPLIANCES CONTAINING REFRIGERANT

Fridges, freezers, air conditioners, dehumidifiers and water coolers are accepted **free of charge** for recycling. (https://www.marrbc.ca)

SCRAP METAL RECYCLING

Metal materials accepted at the Mackenzie Regional Transfer Station for recycling include:

- Appliances and parts such as stoves, dishwashers, hot water tanks, washers, dryers and any other **non-refrigeration** type appliance, many of which are part of MARR;
- Bicycle frames and barbeque hulks;
- Metal roofing and siding;
- Lawnmower bodies, snowmobile and motor bike frames (fuel, lubricants and tires must be removed);
- Steel containers (drums and tanks) must be crushed or perforated to ensure that they contain no liquid or hazardous material. Pressurized containers cannot be recycled.

HOURS OF OPERATION

Mackenzie
Demolition and Construction Landfill
Hours of Operation

Operating Hours – Year Round

Monday to Friday	9 am – 5 pm
Saturday & Sunday	9 am – 3 pm

Holiday Operating Hours are from 9 am to 4 pm. (Easter Monday, Victoria Day, Labour Day and Thanksgiving Day ONLY).

This facility is **CLOSED** on all Holidays:

New Years' Day	National Day of Truth and Reconciliation
Family Day	Remembrance Day
Good Friday	Christmas Day
Canada Day	Boxing Day
BC Day	

When delivering waste to Regional District facilities, ensure that loads are covered and secured so that material does not blow out onto the roads.

LOCATION MAP

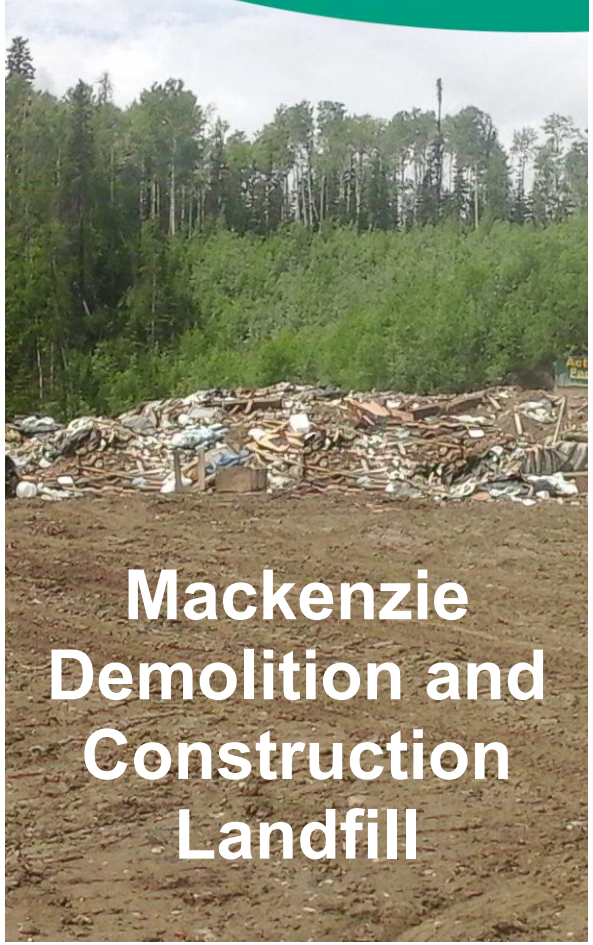
REGIONAL DISTRICT
of Fraser-Fort George

155 George Street, Prince George, BC V2L 1P8
Tel: 250-960-4400 • Toll Free: 1-800-667-1959
Fax: 250-563-7520 • Email: environment@rdffg.bc.ca

www.rdffg.ca

REGIONAL DISTRICT
of Fraser-Fort George

Environmental Services



Mackenzie Demolition and Construction Landfill

LANDFILL SERVICES

As of December 1, 2019, the site operates as a transfer station and a demolition and construction waste landfill.

SITE OPERATION

The Mackenzie Demolition and Construction Waste Landfill is a select waste landfill operated by the Regional District of Fraser-Fort George. Materials accepted for disposal include demolition and construction waste and land clearing debris.

SOLID WASTE DISPOSAL BYLAW

Regional District of Fraser-Fort George Bylaw No. 3166, 2020, Amendment Bylaw No. 3330, 2023 establishes:

- Tipping Fee rates
- Definition of terms
- Site regulations, and
- Permit and approval requirements for Controlled Waste

QUICK REFERENCE DEFINITIONS

Demolition, Land Clearing & Construction Waste

- may include waste such as PVC pipe, asphalt, lumber, stumps, roofing materials, masonry and wire, and shall not contain Prohibited Waste, Controlled Waste, Recyclable Materials or Hazardous Waste.

Contaminated Soil

- means soil, sediment and/or fill material containing substances in quantities or concentrations as defined by the Contaminated Sites Regulation but is not hazardous waste under the Hazardous Waste Regulation. Requires pre-approval as well as laboratory analysis and an application for the acceptance of controlled waste.

Concrete

- means a hardened mixture of cement with sand, gravel and/or rebar. Rebar protruding from cement shall not exceed 1 ft. in length.

Creosote Treated Wood

- means wood that is treated with creosote, which may include railway ties, telephone poles and dock pilings. Requires pre-approval.

TIPPING FEES AND SITE REGULATIONS

A tipping fee is a charge levied for disposal of waste and is based on weight and type of material. Tipping fees apply to “controlled waste”, and demolition, land clearing and construction waste (DLC).

PAYMENT

Payment may be made by Mastercard, VISA, AMEX, Discovery or debit card. Commercial customers may apply to the Regional District for credit accounts. Application forms are available from the Mackenzie Regional Transfer Station during operating hours or Financial Services at 155 George Street, Prince George, BC, between 8:45 am – 12:00 pm and 1:00 pm – 5:00 pm, Monday to Friday (excluding holidays).

FEES

The fee to dispose of DLC waste is $98 per tonne or a $6 minimum charge per load. Load weights are measured on scales provided at the landfill.

PROHIBITED MATERIALS

The following materials are not accepted for disposal at the Mackenzie Regional Landfill. For disposal options, please consult with the attendant or call the Regional District Service Centre at 1-800-667-1959.

Asbestos
Cattle Carcasses
Chemical Waste
Explosives
Fencing Wire
Fuels
Hazardous Waste
Ignitable Waste
Liquids
Lubricants
Paints/Solvents
Pesticides
Radioactive Waste
Reactive Waste
Refuse (on fire or smoldering)
Restaurant grease
Slurry/Sewage Sludge
Steel/Plastic Drums (if not cut, crushed, or perforated)
Tires (as of March 31, 2022)

SWAP SHED

The Mackenzie Demolition and Construction Landfill has a waste exchange area where reusable items can be either dropped off or picked up free of charge. Accepted items include clothing, books, toys, sporting goods, and furniture.

SALVAGING

Salvaging of materials from dumping areas, marshalling areas, or recycling bins is not permitted.

CENTRALIZED COMPOSTING

Large quantities of source separated yard and garden waste can be dropped off at the Mackenzie Regional Transfer Station at no charge for inclusion into the centralized compost operation. Please consult the attendant for further information on acceptable materials.

CONTROLLED WASTE

Controlled wastes are materials that require special handling and disposal techniques to avoid creating health hazards, nuisances or environmental pollution. Controlled wastes **require pre-approval** and a Regional District permit prior to delivery. Check with landfill staff concerning permits and delivery times.

CONTROLLED WASTE	RATE PER TONNE OF WEIGHT	Minimum Charge
Bulky Waste	$116.00	$6.00
Concrete	$228.00	$6.00
Contaminated Soil	$116.00	$6.00
Creosote treated wood	$178.00	$6.00
Waste sludge from municipal sewage treatment plants and screening stations	$0	$0

**In all cases, Bylaw No. 3166, Amendment Bylaw No. 3330, 2023, should be consulted for conditions and definitions of terms.*

Permits for Disposal of Controlled Waste

A permit issued by the Regional District is required to deposit a controlled waste at the Mackenzie Demolition and Construction Landfill. Permit application forms are available from the Mackenzie Demolition and Construction Landfill during regular operating hours, or on the Regional District website.

Revised: September 1, 2024

APPENDIX C
2024 MACKENZIE VOLUME ASSESSMENT

June 25, 2024

Regional District of Fraser-Fort George
155 George Street
Prince George, British Columbia
V2L 1P8

Attention: Mr. Darwin Paton
Environmental Services Technician

2024 Volume Assessment – Mackenzie Regional Landfill

Dear Mr. Paton:

Dillon Consulting Limited (Dillon) is pleased to provide the 2024 volume assessment for the Mackenzie Regional Landfill (Site) located in the Regional District of Fraser-Fort George (RDFFG).

Aerial photographic mapping was completed over the Site on May 10, 2024 by Aero Geometrics Ltd. Information obtained from the aerial photographic mapping was used to generate the 2024 elevation contours which were then compared against the May 11, 2023 elevation contours to determine the approximate airspace consumed at the Site between the two time periods. A comparison of May 2023 and May 2024 elevation contours (Figure 1) shows negligible change in airspace in the identified waste filling area.

In discussion with the RDFFG, it was understood that excess intermediate cover soil was excavated out of the area prior to in-filling with waste. These activities occurred between the two survey dates and as such were not captured in the contour comparisons. The area in which soil was excavated was measured to be approximately 730 square metres. Assuming an approximate soil thickness of 0.5 m, the approximate volume removed was 365 cubic metres.

Weigh scale records indicate that 212.62 tonnes of waste were landfilled at the Site between May 11, 2023 and May 10, 2024, as provided by the RDFFG. Using the total tonnage of waste landfilled at the Site and calculated volume, the apparent density for the landfill was calculated to be approximately 0.58 tonnes per cubic metre (212.62 tonnes / 365 cubic metres). The apparent density is not a true density but is a relationship that represents the mass of waste disposed in each cubic metre of landfill airspace, excluding soils used as cover. Additionally, this is an estimation based on the total volume of excess soil excavated.

DILLON CONSULTING

3820 Cessna Drive
Suite 510
Richmond
British Columbia
Canada
V7B 0A2
Telephone
604.278.7847
Fax
604.278.7894

Dillon Consulting Limited

Dillon appreciates the opportunity to support the RDFFG with this volume assessment. Should you have any questions or require additional information, please do not hesitate to contact us.

Sincerely,

DILLON CONSULTING LIMITED

[redacted]

Elise Duma, P.Eng.
Project Manager
AT: tjs

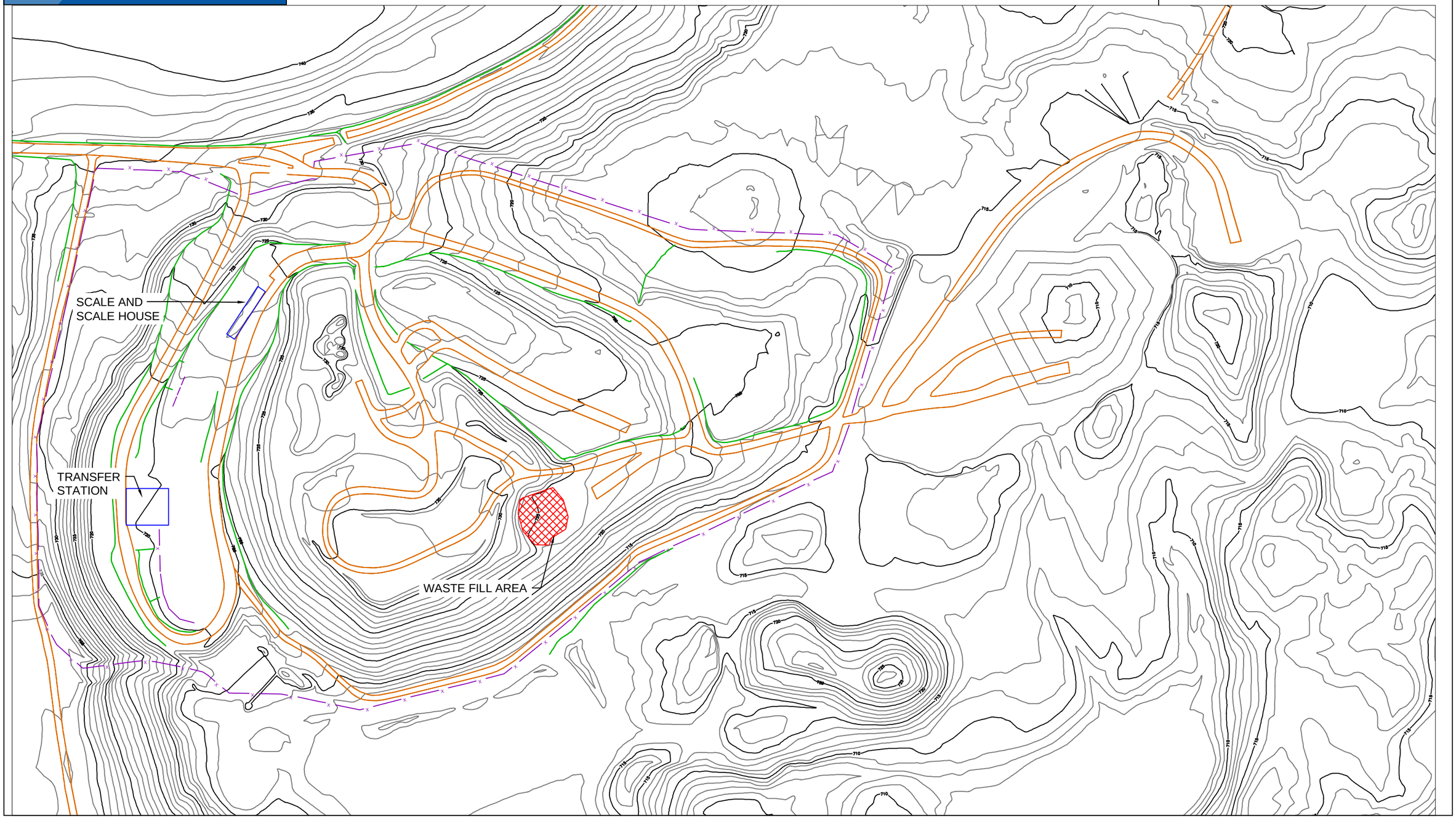
Phillip Auclair, P.Eng.
Senior Waste Engineer

REGIONAL DISTRICT of Fraser-Fort George

MACKENZIE REGIONAL LANDFILL AND TRANSFER STATION SITE TOPOGRAPHY

LEGEND

- CONTOURS
- GRAVEL ROAD
- DITCH
- FENCE



NOTE: EXISTING CONDITIONS AS OF MAY 2024.

20 0 20
SCALE 1:1,000 METRES

APPENDIX D

DESIGN, OPERATIONS AND CLOSURE PLAN

MORRISON HERSHFIELD

Mackenzie Regional Landfill
Design, Operations and Closure Plan

Presented to:

Darwin Paton
Environmental Services Technologist

Regional District of Fraser-Fort George
155 George St
Prince George, BC

Project No. 230259800
April 3, 2024

TABLE OF CONTENTS

Page

TABLE OF CONTENTS

TABLE OF CONTENTS

APPENDICES

TABLE OF CONTENTS

Page

FIGURES

1. INTRODUCTION

1.1 Background

Morrison Hershfield (MH) was retained by the Regional District of Fraser-Fort George (RDFFG) to complete a Landfill Design, Operations and Closure Plan (DOCP) for their Mackenzie Regional Landfill (the Landfill) located approximately 2 kilometers south of Mackenzie, BC, from Highway 39. MH submitted a proposal to the Regional District of Fraser-Fort George in May 2023 and the project startup meeting occurred in July 2023. A site inspection was completed by MH in August 2023.

1.2 Scope of Work

This DOCP was developed to address the requirements of the current Operational Certificate 100206 (issued March 4, 2009) and with consideration to the applicable regulations summarized in Section 1.3.

The purpose of the DOCP is to specify how the landfill site will be developed and closed, including the operational requirements and environmental controls that will be in place to support site development.

1.3 Regulatory Setting

The site is currently authorised to manage recyclable material and municipal solid waste (MSW) as a sanitary landfill under Operational Certificate 100206. A copy of the current Operational Certificate is included in APPENDIX A.

The following regulatory documents and License of Occupation documents are applicable, as they relate to facility construction, operation, closure and monitoring:

- Environmental Management Act, Chapter 53 (March 29, 2023)
- Landfill Criteria for Municipal Solid Waste, Second Edition (June 2016)
- License of Occupation No. 705356, Mackenzie Landfill (November 2, 2005)
- License of Occupation No. 706803, Mackenzie Clay Borrow Pit (January 11, 2019)
- License of Occupation No. 706803, Management Plan (March 18, 2019)

The landfill is located on Crown land under Crown License of Occupation No. 705356.

2. SITE DESCRIPTION

2.1 Location and Historic Use

The Site is located approximately 2 kilometres south of the District of Mackenzie, British Columbia on leased Crown land previously used as a gravel pit. The Mackenzie Regional Landfill site is located on unsurveyed Crown Land covering an area of approximately 16.73 hectares. The facility boundary is defined under License of Occupation No. 705356. A site location plan is provided as Figure 1.

The landfill footprint comprises an area of approximately 8.2 hectares. The Site opened in 1974 and accepts waste from the District of Mackenzie and surrounding area. The Site is operated as a natural attenuation landfill.

On December 1, 2019, the landfill site transitioned to only accept construction and demolition (C&D) waste and a newly constructed transfer station became fully operational, accepting all MSW and recyclables. The old weigh scale was replaced with a new weigh scale in 2019. The weigh scale and scale house are located at the transfer station entrance of the Site.

Figure 2 shows the current site plan of the facility, showing both the transfer station and the landfill.

2.2 Access and Layout

Access to the site is along Highway 39, approximately 2 km south of the District of Mackenzie. An access road, called Dump Road, leads to the Mackenzie Regional Transfer Station and Landfill.

Currently, the Site provides services for receiving construction and demolition (C&D) waste for disposal. MSW is received at the transfer building and hauled to the Foothills Boulevard Regional Landfill for disposal. Materials that are collected at the Transfer Station as part of recycling programs include used oil, oil filters and containers, antifreeze, lead acid batteries, and rechargeable household batteries. A swap shed, marshalling site for appliances, scrap metal, and multi-material recycling (MMR) are present at the Transfer Station.

Large quantities of source separated yard and garden (Y&G) waste are accepted at the Site at no charge. Y&G waste is chipped periodically and stockpiled on-site.

2.3 Service Population

The Mackenzie Regional Landfill facility services the northern portion of the Regional District. Only the District of Mackenzie is serviced by this landfill. The District of Mackenzie, according to the 2021 Census of Population, has a population of 3,281. The population dropped from 3,714 in 2016, which accounts for a 11.7% population decrease from 2016 to 2021.

Regional District Of Fraser-Fort George

Mackenzie Regional Landfill
Site Location Plan

REGIONAL DISTRICT of Fraser-Fort George

MORRISON HERSHFIELD

Project No. 230259800

Date February 1, 2024

Figure No. Figure 1

X:\Proj\2023\230259800-RDFFG Mackenzie Regional Landfill\09. CAD\07 Sheets\Figure 1 Site Location Plan.dwg Plotted: by Warren Pare

Site Entrance Road
Gate
Gate
TH6
Borrow Pit
TH4
Scale House
Scale
Swap Shed
Recycling Bays For HHW
Plastic Recycling Bin
Staff Storage Shed
Transfer Station
TH5
Cardboard Compactor
Scrap Metal Recycling Bay
White Goods Recycling Bay
Compost Piles
Internal Landfill Access Roads
Gate
TH3
Active Face (May 2023)
TH2
5:1
6:1
4:1
2:1
3:1
0 20 60 100m
1:2000

Legend:

- License Of Occupation Boundary
- Edge Of Existing Access Road
- Existing Fence Line
- Existing Ditch
- Existing Tree / Bush Line
- Existing Retaining Wall
- Existing Culvert Inlet / Outlet
- Existing Groundwater Monitoring Well

Notes:

Contours Represent Ground Surface As Surveyed By Aero Geomatics Ltd. On May 11, 2023.

Regional District Of Fraser-Fort George

Mackenzie Regional Landfill
Existing Site Plan

REGIONAL DISTRICT of Fraser-Fort George

MORRISON HERSHFIELD

Project No. 230259800

Date February 1, 2024

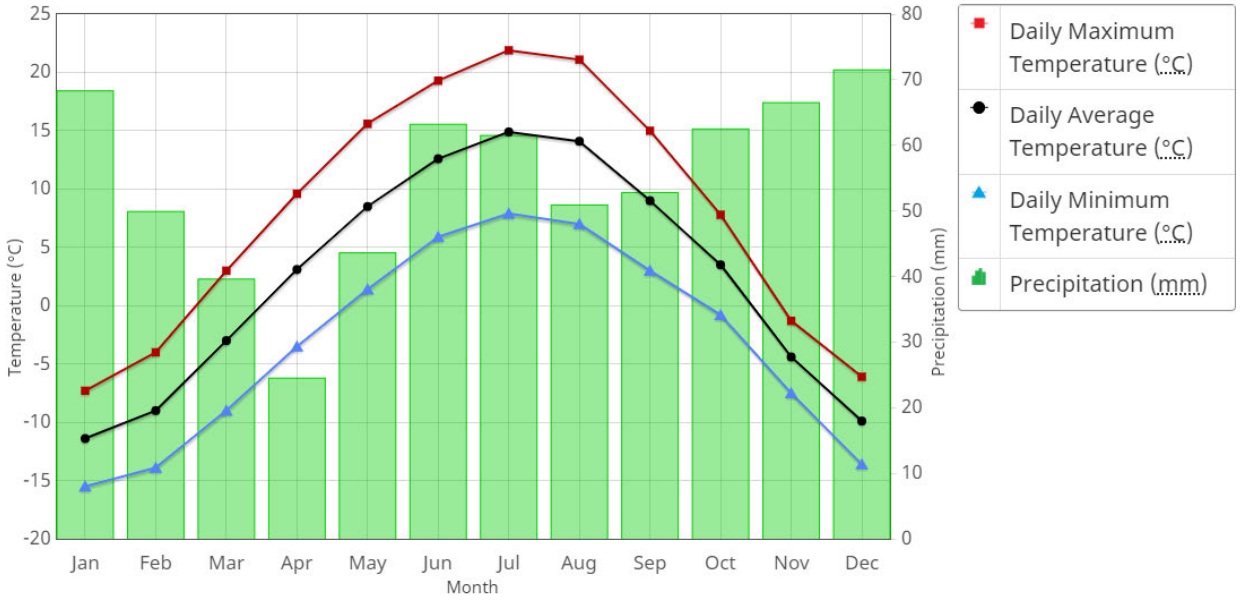
Figure No. Figure 2

X:\Proj\2023\230259800-RDFFG Mackenzie Regional Landfill\09. CAD\07 Sheets\Figure 2 Existing Site Plan.dwg Plotted: by Warren Pare

2.4 Climate

Mackenzie experiences a subarctic climate that is tempered by influences from the Pacific Ocean, leading to milder winters, given its northern latitude when compared to other areas in Canada. The town has warm summer days, with cooler nights when mean temperatures exceed 10 °C. While winters can occasionally be extremely cold, their duration is relatively brief for a subarctic climate, with January holding the record for the coldest month, reaching an average temperature of −9.2 °C.

Canadian Climate Normals data from 1971 to 2000 published by Environment and Climate Change Canada for Station "*MACKENZIE A*" (ECCC, 2023) is shown in the figure below.



Average annual precipitation based on the 1971 to 2000 Climate Normals data is approximately 655 mm, with about 358 mm as rainfall and the rest as snowfall. Mackenzie averages just over 3 m of snowfall each year. The highest months of snowfall are between November to February, with the majority of rainfall between May to October.

Climate change considerations are discussed in Section 8.

2.5 Topography and Drainage

The Mackenzie Regional Landfill and Transfer Station is located within the northern section of Rocky Mountain trench at an elevation of approximately 700 m above sea level (ASL). The Parsnip Reach of Williston Lake is approximately 4 km west of the Site, at an elevation of approximately 680 m ASL. The landfill footprint is located on a gentle southwest slope and is relatively flat with surrounding areas to the north and west sloping inward to the landfill. Regional topography is generally sloped to the south or southwest and surface water drainage leaving the Site flows south toward a swampy area consisting of Tom and Eunice Lakes located approximately 220 m south of the Site. There are networks of small tributaries that connects the lakes and the swampy area into the Parsnip Reach of Williston Lake.

There are currently drainage ditches along the toe of the landfill and around the transfer station that eventually drain to the south.

2.6 Surficial and Bedrock Geology

As per information accessed online from the BC Ministry of Environment (MOE) Ground Water Resources of British Columbia, the site is situated along the northwestern perimeter of the Rocky Mountain Trench. This trench is characterized by folded volcanic formations and some sedimentary Mesozoic rock layers. The trench's floor is mainly made up of substantial deposits from glacial lakes and glacial rivers, with only a few instances of exposed bedrock.

Based on a review of BC's online bedrock geology map, MapPlace 2, the mapping shows NW-SE trending faults, of unspecified orientation, 3 km west of the Site and a second fault 3 km east of the Site. Generally the Mackenzie area lies within the northern Rocky Mountain Trench which is a product of geological faulting.

Previously, the site was utilized as a gravel pit until around 1974, and sections of its western border are still utilized for gravel extraction. Data from borehole logs from three groundwater monitoring wells in the vicinity as well as the results of a geotechnical investigation completed in December 2018 indicate that the soils beneath the area consist mainly of fluvial deposits, primarily composed of sands and gravels interspersed with occasional silt deposits. These deposits overlay glacial till, a heterogeneous amalgamation of materials ranging in size from silt, clay, and sands to gravels and boulders.

2.7 Site Investigation

2.7.1 Geotechnical Assessment (2018) for Transfer Station Development

A geotechnical assessment titled "*Geotechnical Assessment for the Proposed Mackenzie Transfer Station*" was completed for the proposed Transfer Station construction (McElhanney, 2018). The geotechnical assessment included a desktop review of publicly available data (surficial geology, bedrock, water resources), a site visit assessment, performing a field assessment by drilling 13 boreholes, and lab testing on select soil samples.

The soils observed in all test locations were generally classified as compact to dense, well graded sand and gravel. Poor recovery in the split spoons, combined with refusal at some locations suggests that there are occasional cobbles and/or boulders in the soil. Groundwater was not encountered in any of the boreholes. Based on the findings of the drilling program and historical data from geological history and surficial geology, the Site is classified as Site Class D "Stiff Soil" for seismic design purposes.

The Geotechnical memo report can be found in APPENDIX B.

3. WASTE DISPOSAL AND DIVERSION

3.1 Waste in Place

The first permit for operations at the Mackenzie landfill is dated for 1974, and MH has assumed that this was the first year the landfill began accepting waste. The landfill did not use a scale until one was installed in 1995. The annual quantity of waste disposed at the site between 1974 and 2019 was estimated to be approximately 5,000 tonnes per year based on a population of 6,000 people and a landfill disposal rate of 0.76 tonnes per capita per year. These tonnages include all material crossing the scales which includes MSW from curbside collection programs. With the installation of the Transfer Station in 2020, the waste disposal tonnages significantly decreased to around 1,000 tonnes per year due to the landfill only accepting construction and demolition waste.

Based on the above estimates of annual waste disposal from various reports, the total waste in place as of 2023 is estimated to be roughly 251,000 tonnes. A summary of the assumed disposal quantities over the landfill lifespan to date is provided as Appendix C.

3.2 Waste Transfer and Disposal

The Landfill no longer receives residential and commercial MSW since operations of a transfer site began in December of 2019. All MSW is transported to the Foothills Boulevard Regional Landfill for disposal.

Only Construction and Demolition (C&D) waste is accepted at the Landfill site. According to RDFFG records, the total amount of C&D waste landfilled at the active face was estimated at approximately 1,429 tonnes during the 2021 reporting period (January 1, 2021 to December 31, 2021).

Approximately 1,900 tonnes of commercial and residential MSW were received at the Mackenzie Transfer Station transported to the Foothills Boulevard Regional Landfill during the same reporting period.

In total, approximately 3,329 tonnes of waste was managed at the Mackenzie Regional Transfer Station and Landfill in 2021.

A summary of the MSW received and transferred and the C&D waste received and landfilled in 2021 is provided in Table 1 below (RDFFG, 2021).

Table 1: MSW transferred and C&D waste landfill in 2021

Material received in 2021	Quantity (tonnes)

MSW (received and transferred)	• 1,900 tonnes
	  ○ 1,333 residential curbside
	  ○ 567 self-haul

C&D (received and landfill)	• 1,429 tonnes
	  ○ 1,189 crossing scales
	  ○ 240 additional estimate*

***Data as reported in "*2021 Annual Operations Report – Mackenzie Regional Landfill*" prepared by RDFFG (RDFFG, 2021)**

The total waste tonnages received at the facility (MSW and C&D waste) during the reporting period in 2021 corresponds to an estimated waste generation rate of 2.78 kg/capita/day or 1,015 kg/capita/year in 2021, based on a population of 3,281. This includes all C&D waste material disposed in the landfill and MSW collected and transferred at the transfer station.

3.3 Waste Diversion

The following waste diversion services are offered at the Mackenzie Regional Transfer Station:

- Swap shed – waste exchange areas where reusable items can be either dropped off or picked up free of charge
- Grinding and stockpiling yard and garden waste for beneficial use on-site
- Multi-material recycling including:
  - Residential corrugated cardboard and mixed paper;
  - Plastic cartons and containers, metal food cans;
- Automotive lead acid battery collection;
- Single use battery collection;
- Sea-can for collection of used oil and antifreeze, oil filters and used oil containers through Interchange Recycling;
- Marshalling area for scrap metal;
- Marshalling area for white goods, including ODS containing appliance;
- Large appliances through the Major Appliance Recycling Roundtable (MARR) Stewardship Program; and
- An old corrugated cardboard (OCC) compactor.

In 2021, the following recyclable materials were reported to be diverted at the facility (*RDFFG Mackenzie Regional Landfill Annual Report*, RDFFG 2021):

Material	Units
Waste Oil	5,620 litres
Oil Filters (drums)	4 drums
Antifreeze	410 litres
Batteries	273 units
Scrap Metal	180 tonnes

To increase waste diversion at the facility, opportunities to divert and beneficially use C&D materials that are currently being landfilled should be explored. It is understood that concrete was being diverted and the material which is already on site is stockpiled in the northeast area of the landfill. Opportunities to divert other materials such as clean wood waste and asphalt should be explored with a focus on beneficial use options at the landfill or within the community.

4. LANDFILL DESIGN AND PHASING

4.1 Lifespan Analysis, Airspace Analysis and Cell Design

Available airspace is assessed to evaluate remaining capacity and estimate remaining landfill operational years. This assessment also considers the current waste compaction rate and soil consumption (used for daily and intermediate cover, and other projects at the landfill). The available airspace is based on the conceptual landfill design presented in this section showing the proposed landfill final contours.

Ideally the annual airspace consumption is determined by calculating the volume consumed between two topographic landfill surveys. This can be done by using AutoCAD or similar software. The apparent density can be estimated by comparing the volume consumed compared to the tonnes of waste landfilled during the same period. Airspace volume assessments (estimates of annual airspace consumption) were completed in 2021, 2022 and 2023.

The tonnage, annual airspace consumption and apparent density from the last 3 site assessment surveys (years 2021, 2022 and 2023) is outlined in Table 2 below. The reporting period was from May to May the following year.

Table 2: Volume Site Assessment for Years 2021, 2022 & 2023

Reporting Year	Tonnage (tonnes) disposed in reporting year	Airspace Consumption (m^3) in reporting year	Apparent Density (tonnes/m^3)
May 2020 - 2021	955	850	1.12
May 2021 - 2022	925	2,027	0.46
May 2022 - 2023	460	834	0.55

The density calculated in the 2020-2021 reporting year of 1.12 tonnes per cubic metre is considered an anomaly, possibly due to survey error resulting in underreported volumes in the year 2020. The apparent densities estimated in the following two reporting years were similar at approximately 0.5 tonnes/m^3.

MSW was being landfilled at the site in the first 11 months of 2020 and this is included in the tonnages reported in the May 2020-2021 reporting year. MSW was no longer being landfilled in the May 2021-2022 reporting year, however the C&D disposal quantities are considered higher than a typical year due to major construction projects in the reporting period. The C&D disposal quantities observed between May 2022-2023 are considered more typical of the tonnages expected to be landfilled going forward.

Only the apparent density from the reporting years 2021-2022 and 2022-2023 were used for this DOCP as this is in line with expected apparent density values from a small C&D landfill. This is

principally due to the high consumption of soil for cover to meet covering requirements while disposing of relatively small waste quantities with high pore volumes. MH recommends reviewing the assumed apparent density after each airspace assessment is completed.

It should be noted that the apparent density does not represent the density of the compacted waste but represents the mass of waste disposed in each cubic metre of landfill airspace, which includes soils used as cover.

4.2 Population Projections

As per the *Mackenzie Community Economic Development Strategy* (District of Mackenzie, May 2021), the population of Mackenzie declined between 2001 (from 5,393) to 2011 (to approximately 3,500) largely related to local mill closures. The population increased to 3,714 in 2016 however decreased by 11.7% to 3,281 in 2021.

According to BC Statistics population projections (data updated by BC Statistics in November 2022 and accessed by MH in December 2023), the population of Mackenzie is expected to decline at an average rate of 2% per year until 2032 then see a modest increase of about 1% until 2046.

As noted in the *Mackenzie Community Economic Development Strategy* (District of Mackenzie, May 2021), the population projections do not account for impacts of COVID-19, in- and out-migration, and industry changes (e.g., mill closures, other new industries opening).

Considering the significant fluctuations and mostly declining trend in Mackenzie's population since 2001 (refer to Figure 3 below), it is assumed that Mackenzie's population will remain constant (based on 2021 population) over the projection period for the purposes of the airspace estimates. This population assumption should be reviewed at a minimum every five years.

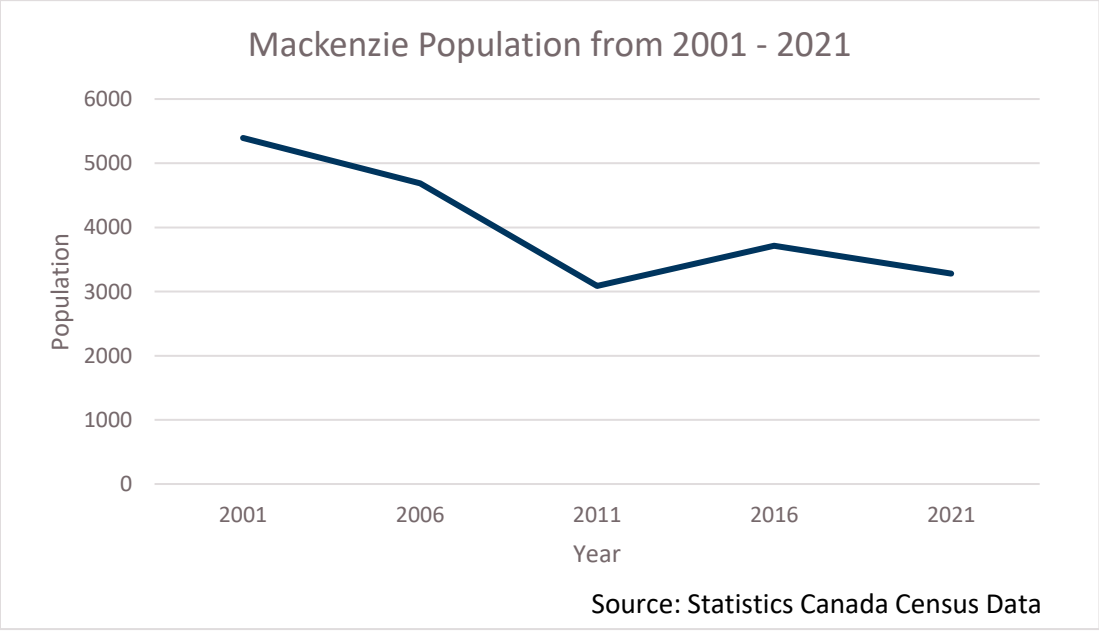


Figure 3: District of Mackenize Population Trend From 2001 to 2021

4.3 Airspace Projection

The following are the key assumptions used in the airspace projection:

- Population growth rate – assumed to be constant (0% growth rate) at 3,281 people based on 2021 census data.
- Annual C&D quantity (tonnage) received and landfilled – conservatively assumed to be a constant 693 tonnes per year based on an average between the reported landfill quantities between May 2021 – 2022 and May 2022 – 2023[1]. This corresponds to a constant C&D landfill disposal rate of 0.21 tonnes C&D waste per capita per year.
- Diversion rate - assumed to remain constant (i.e., not improve over projection period).
- Apparent density - 0.5 tonnes/m^3 (average between values calculated in May 2021 – 2022 and May 2022-2023). The compaction rate achieved at larger landfills using modern landfill compaction equipment is generally over 800 kg/m^3. However, 500 kg/m^3 is considered realistic and on the conservative side when using the current equipment present at the Mackenzie Regional Landfill for compaction of C&D waste.

Based on the above assumptions, the annual airspace consumption is assumed to be 1,386 m^3 per year over the projection period.

Soil is readily available near the site to the east of the operating landfill at a sand and gravel borrow pit. MH completed a preliminary estimate of the available soil assuming the entire area is excavated to a depth of 708.3m ASL at 3:1 side slopes. The borrow pit has approximately 35,000 m^3 of soil available for use as daily, intermediate, and final cover of the landfill as well as for road construction and upgrade projects. Further discussion on materials management is provided in Section 4.7.

The consistency in acquiring survey data every year, mid of May, is sufficient to track the progression of landfilling. This will be particularly important closer to the closure of the landfill. The survey would also facilitate the assessment of the landfill operations performance through compaction, use of operational soil and use of airspace. MH recommends tracking soil used for daily cover separately to assess the efficiency of soil usage. An ideal waste to soil cover ratio is 3:1 (by volume) however this is often less for smaller landfills.

[1] As noted in Section 4.1, the C&D disposal quantities in the May 2021-2022 reporting year are considered higher than a typical year due to major construction projects in the reporting period. The C&D disposal quantities observed between May 2022-2023 are considered more typical of the tonnages expected to be landfilled going forward. A conservative approach was taken by using the average disposal quantities between the two reporting periods. MH recommends reviewing this assumption as more data on annual disposal quantities becomes available.

4.4 Final Landfill Design and Contour Plan

The final landfill design was developed following the general design criteria presented below and with consideration to the BC Landfill Criteria for Municipal Solid Waste, Second Edition (MOECCS, June 2016):

- The final landfill design has been developed to optimize capacity of the facility within the area designated as “primary landfill area” which is bounded by existing final slopes on the west, south, and east sides, and bounded by the existing internal service road on the north side.
- On the west side of the landfill the toe of the slope is adjacent to the transfer station road and on the south and east side the landfill toe is adjacent to the perimeter fencing and perimeter service road. Therefore, it is assumed that the landfill has reached final slopes on the west, south, and east sides and further development on these sides of the landfill will not occur. The slopes appear to be at approximately 3V:1H however final cover has not been placed.
- The landfill side slopes are designed to optimize available airspace while maintaining slope stability. The final side slopes are no steeper than 3V:1H.
- The existing access road around the landfill toe west, south, and east sides will remain in place to maintain a cleared buffer zone between the landfill and property line.
- The plateau of the final landfill is graded to promote runoff at a minimum grade of 10%.
- The landfill crest access road is to be constructed at a maximum of 10% grade to facilitate access by landfilling equipment and waste haulers.
- The proposed filling is generally vertically on existing landfilled waste.
- The landfill will remain a natural attenuation site.

The final contours of the landfill design of the Mackenzie Regional Landfill is presented in Figure 4 and cross sections showing the proposed final contours are provided in Figure 5. The design was developed based on the general design criteria listed above, the airspace analysis, and landfill capacity / remaining site life presented above. The preliminary design is intended to provide a basic design concept and guidance for filling operations. The design does not include a detailed design of the phasing, surface water works or other landfill features.

TH6
TH4
TH3
TH5
TH2
HISTORIC LANDFILL AREA
CONTINGENCY DISPOSAL AREA
CURRENT & FUTURE BORROW AREA
LANDFILL ACCESS ROAD
PRIMARY LANDFILL DISPOSAL AREA (~59 YEARS CAPACITY)
CREST DITCH
LANDFILL PERIMETER ROAD EXTENSION
NEW CULVERT
NEW CULVERT
DOWNCHUTES (TYP.)
EXPAND SURFACE WATER MANAGEMENT POND
734.00
734.00
734.00
739.25
718.62
718.60
734.00
3:1
3:1
3:1
3:1
3:1
10%
11%
10%
A
A'
B
B'
N
0 20 60 100m
1:2000

Legend:

- License Of Occupation Boundary
- Edge Of Existing Access Road
- Existing Fence Line
- Existing Ditch
- Existing Tree / Bush Line
- Existing Retaining Wall
- Existing Culvert Inlet / Outlet
- Existing Groundwater Monitoring Well
- Crest Ditch / Downchute
- Landfill Perimeter Road Extension
- Culvert

Regional District Of Fraser-Fort George

Mackenzie Regional Landfill
Final Contour Plan

REGIONAL DISTRICT of Fraser-Fort George

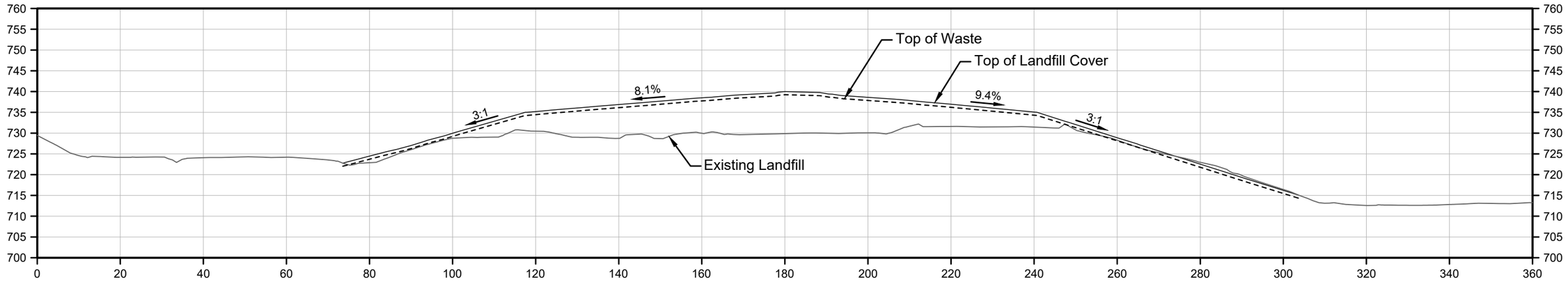
MORRISON HERSHFIELD

Project No. 230259800

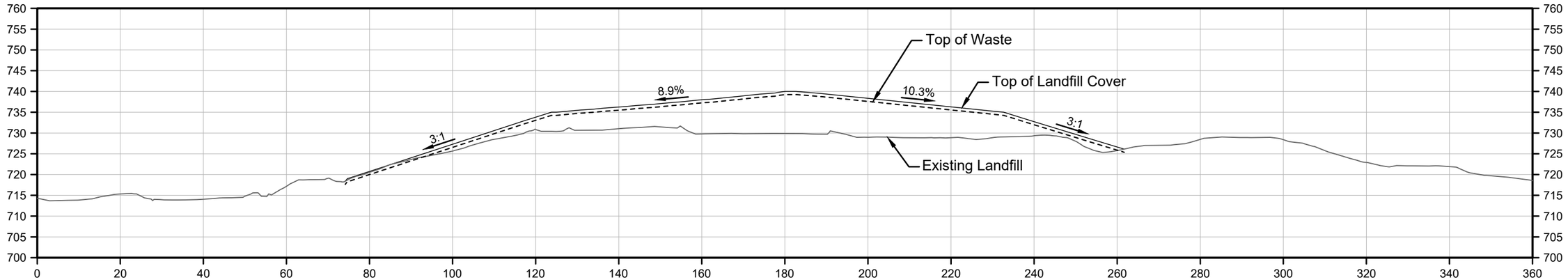
Date February 1, 2024

Figure No. Figure 4

X:\Proj\2023\230259800-RDFFG Mackenzie Regional Landfill\09_CAD\07 Sheets\Final Contour Plan.dwg Plotted: by Warren Pare



Section 'A'



Section 'B'

1:1000 0 10 30 50m

Regional District Of Fraser-Fort George

Mackenzie Regional Landfill
Cross Sections

REGIONAL DISTRICT of Fraser-Fort George

MORRISON HERSHFIELD

Project No. 230259800

Date February 1, 2024

Figure No. Figure 5

Plotted: by Warren Pare

X:\Proj\2023\230259800-RDFFG Mackenzie Regional Landfill\09. CAD\07 Sheets\Cross Sections.dwg

4.5 Phased Fill Plan

The landfill will be developed in five phases within the area labelled in Figure 4 as “primary landfill disposal area”. The landfill phasing plan is shown in Figure 6.

Phases 1, 2, and 3 are located along the northeast side of the landfill and have a final elevation of 730 m. At an assumed annual fill rate of 1,358 m^3, each phase has approximately 5.5 years of capacity for a combined capacity of roughly 17 years. The proposed filling progression is generally from southeast to northwest. Filling will occur in Phase 1 up to an elevation of 730 m by continuing to fill and extending the active face to the northeast to meet the intersection of the two internal access roads. Access to Phase 1 will be via the existing access road to the active face and using the existing access road along the toe of the landfill in the northeast corner. Phase 1 is estimated to provide approximately 7,600 m^3 of airspace.

Phase 2 is to the east of Phase 1 and piggybacks on the east interior slopes of Phase 1 and on the existing landfill slopes to the south. Access to Phase 2 would be provided by the existing access road to the northeast and a new access road constructed on the north side of the landfill. Phase 2 is estimated to provide approximately 7,500 m^3 of airspace.

Phase 3 is on the north end of the landfill and will extend the elevation of 730 m from Phase 2 to the north. Access to Phase 3 will be from the existing service road along the northeast side of the landfill. Eventually as filling progresses in Phase 3 the existing access road at the north end of the landfill will need to be extend further south to provide access to the Phase 3 as it reaches the design elevation of 730 m. Phase 3 is estimated to provide approximately 7,800 m^3 of airspace.

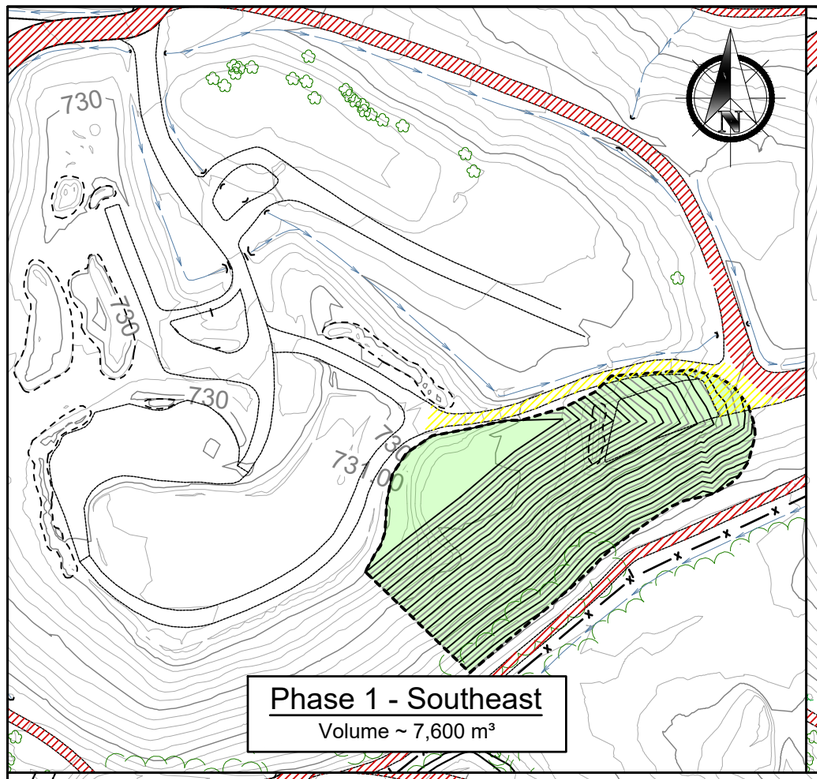
Phase 4 covers an area of approximately 22,000 sq. m and involves filling the Phases 1-3 footprint at 730 m and existing landfill high points between 730 and 731 m approximately 5 m to 735 m. Phase 4 is estimated to provide roughly 50 years of capacity (68,400 m^3 of airspace) at the current fill rate therefore it is recommended that a more detailed fill plan within Phase 4 be developed closer to the anticipated development date. The existing compost piles will need to be relocated in Phase 4 however the exact timing will depend on which areas of Phase 4 are developed first.

Phase 5 is filling on top of Phase 4 to build the final landfill plateau at 10V:1H side slopes to an elevation of 740 m. Phase 5 is estimated to provide approximately 18,000 m^3 of airspace.

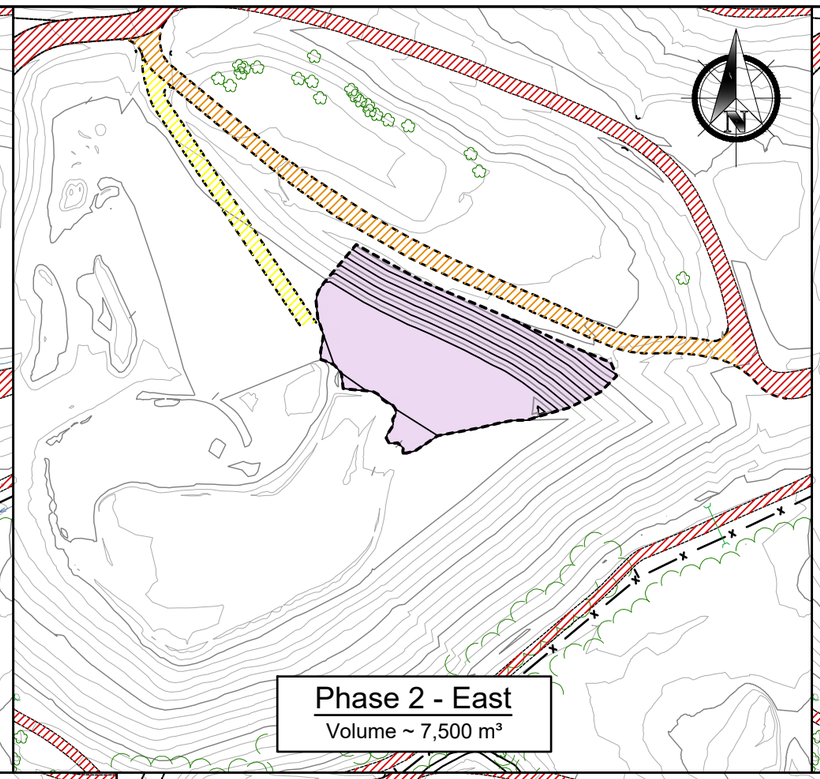
Table 3 below summarizes the available volume in each phase and the estimated lifespan assuming an annual volumetric consumption of 1,358 m^3, which accounts for an average 2% annual settlement rate by volume.

Table 3: Phase Volume and Landfill Lifespan

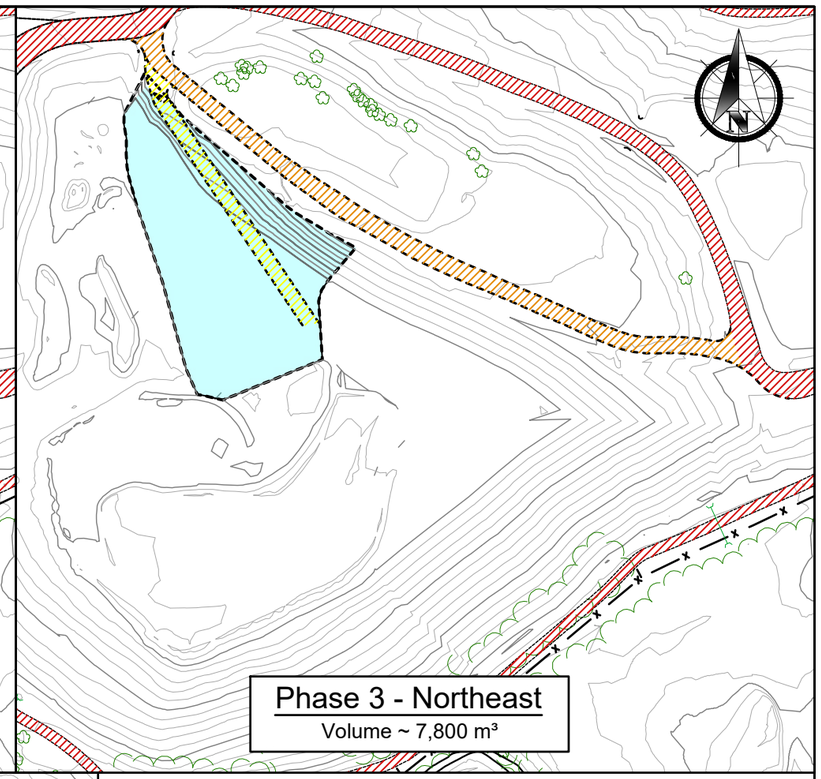
Phase	Fill Volume Available (m^3)	Lifespan (years)
Phase 1	7,600 m^3	5.6 years
Phase 2	7,500 m^3	5.5 years
Phase 3	7,800 m^3	5.7 years
Phase 4	68,400 m^3	50 years
Phase 5	18,000 m^3	13 years
TOTAL	**109,300 m^3**	**80 years**



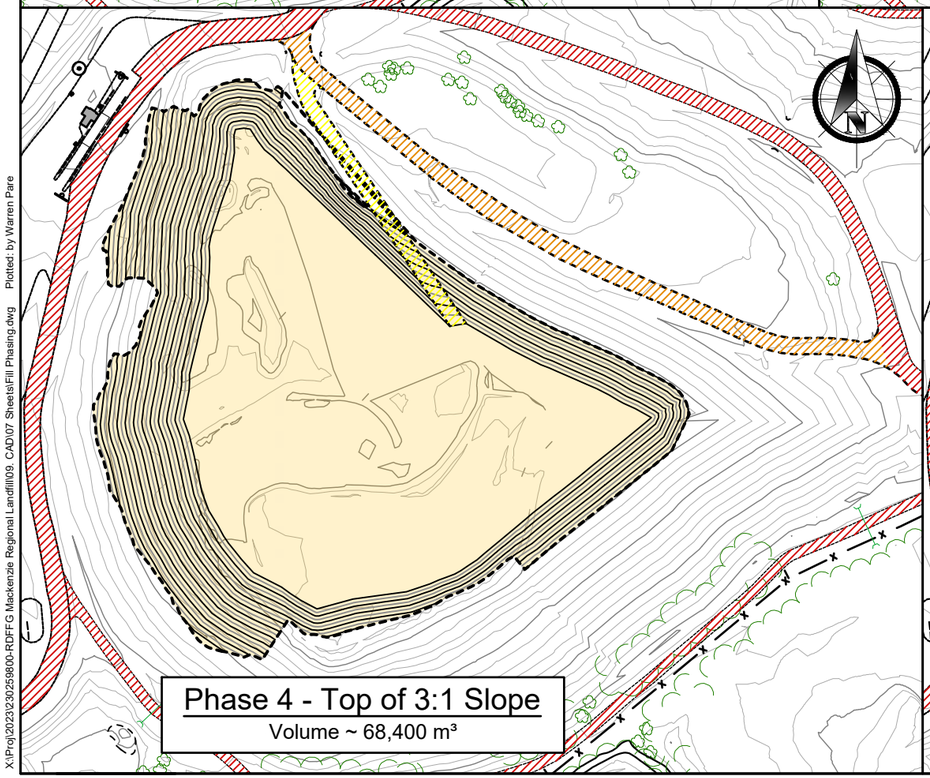
Phase 1 - Southeast
Volume ~ 7,600 m³



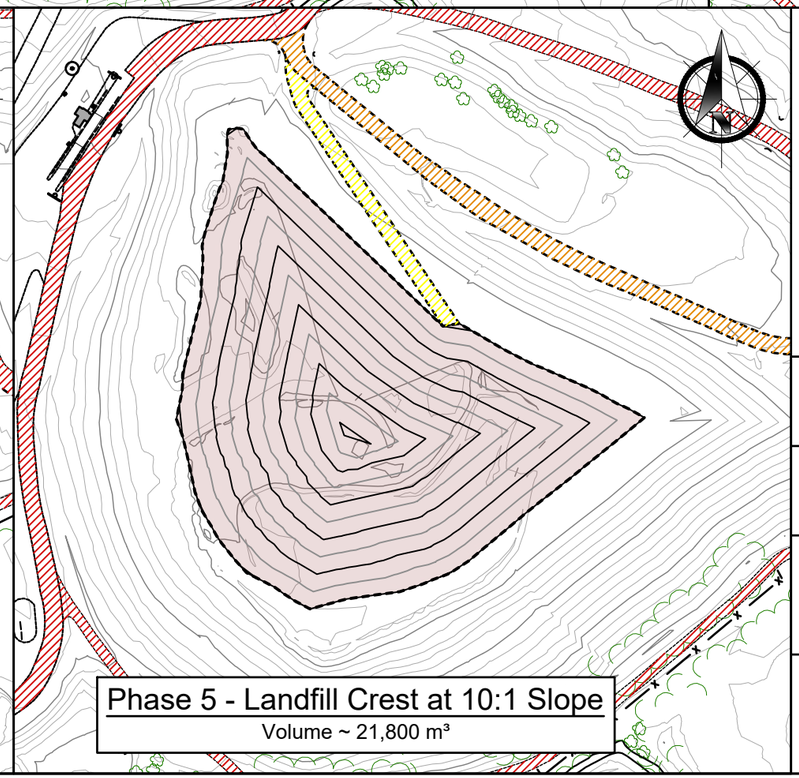
Phase 2 - East
Volume ~ 7,500 m³



Phase 3 - Northeast
Volume ~ 7,800 m³



Phase 4 - Top of 3:1 Slope
Volume ~ 68,400 m³



Phase 5 - Landfill Crest at 10:1 Slope
Volume ~ 21,800 m³

LEGEND:

- NEW PERIMETER ACCESS ROAD
- EXISTING ACCESS ROAD
- INTERIM ACCESS ROAD

1:2000 0 20 60 100m

Regional District Of Fraser-Fort George

Mackenzie Regional Landfill
Fill Phasing

REGIONAL DISTRICT of Fraser-Fort George

MORRISON HERSHFIELD

Project No. 230259800

Date February 1, 2024

Figure No. Figure 6

X:\Proj\2023\230259800-RDFFG Mackenzie Regional Landfill\09_CAD\07 Sheets\Fill Phasing.dwg Plotted by Warren Pare

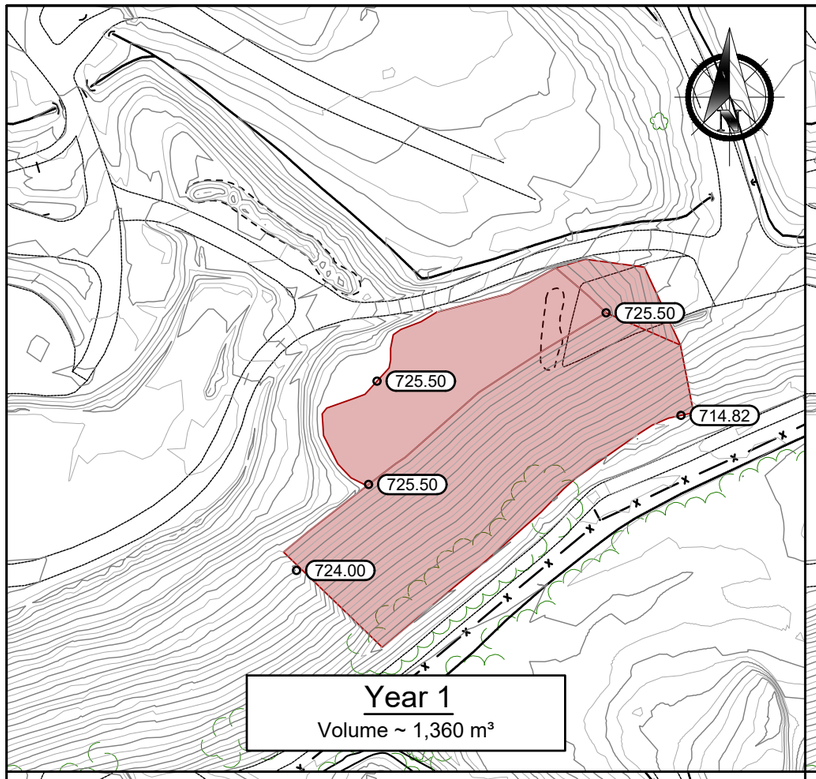
4.6 Detailed Fill Plan

For the purposes of this DOCP, the proposed detailed fill plan for the next 5 years was developed using the annual airspace consumption of 1,358 m^3 and is shown in Figure 7. Development will occur in Phase 1 in the first five years. The detailed fill plan is based on filling in 1.5 m lifts up to the design elevation of each phase.

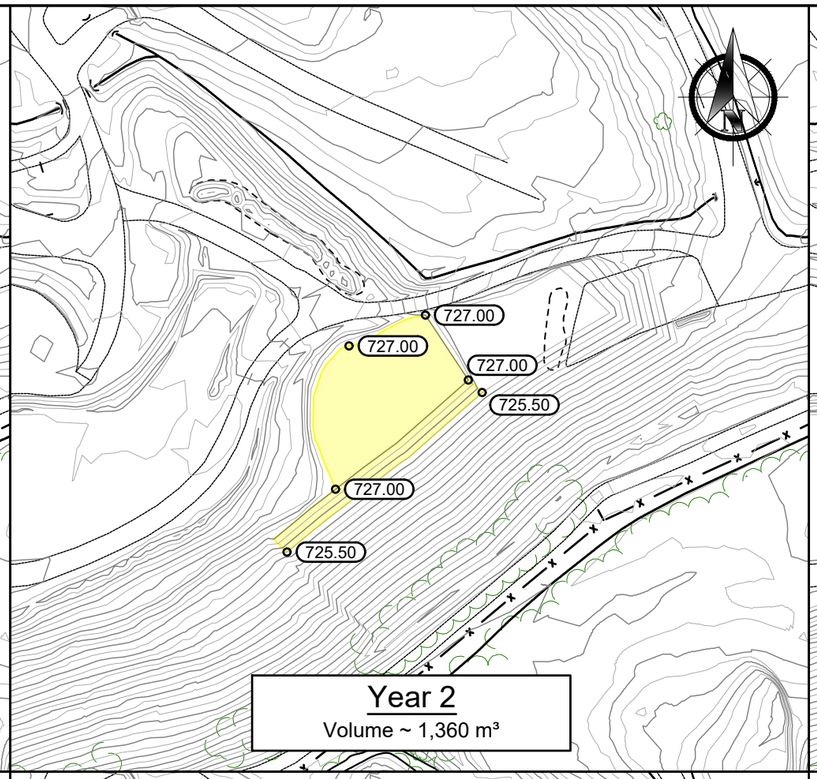
The first year will continue at the current active face area filling the current low area to 725.5 m by extending the fill area to the northeast forming the proposed toe of the landfill along the northeast side of the landfill. Years 2, 3, and 4 will continue filling in Phase 1 at 1.5 m lifts up to an elevation of 730 m at the end of Year 4. Filling in the northeast half of Phase 1 will stop at 728.5 m (end of Year 4) before transitioning filling in a counterclockwise direction to Phase 2.

Filling in Year 5 will bring Phase 2 up to an elevation of approximately 726 m and the northeast half of Phase 1 up to the final design elevation of 730.

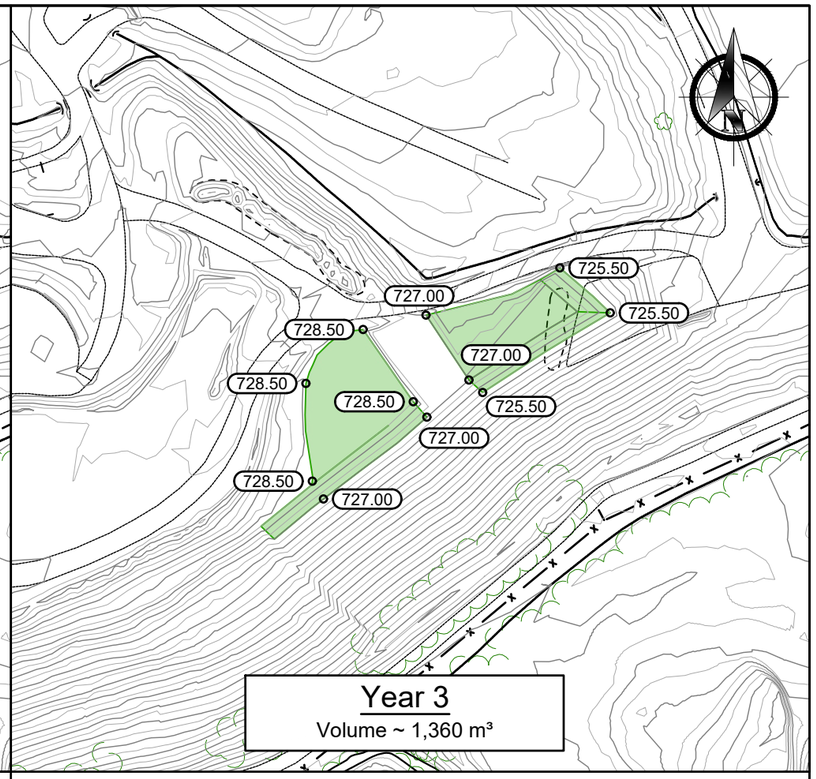
Access to the active face within this five-year timeframe will be using the existing internal access road on the east side of the landfill. In year 5, planning should begin to decommission the existing road (filled) at the east side of the landfill site and transition to a new internal access road further north branching off the existing access road. The transition to the new access road could occur sooner however it is recommended that consideration to operations efficiency be given when determining the timing of decommissioning the existing road. New temporary access roads can be graded at 10% to 12% and then filled in with the next landfill Phase if they are no longer required.



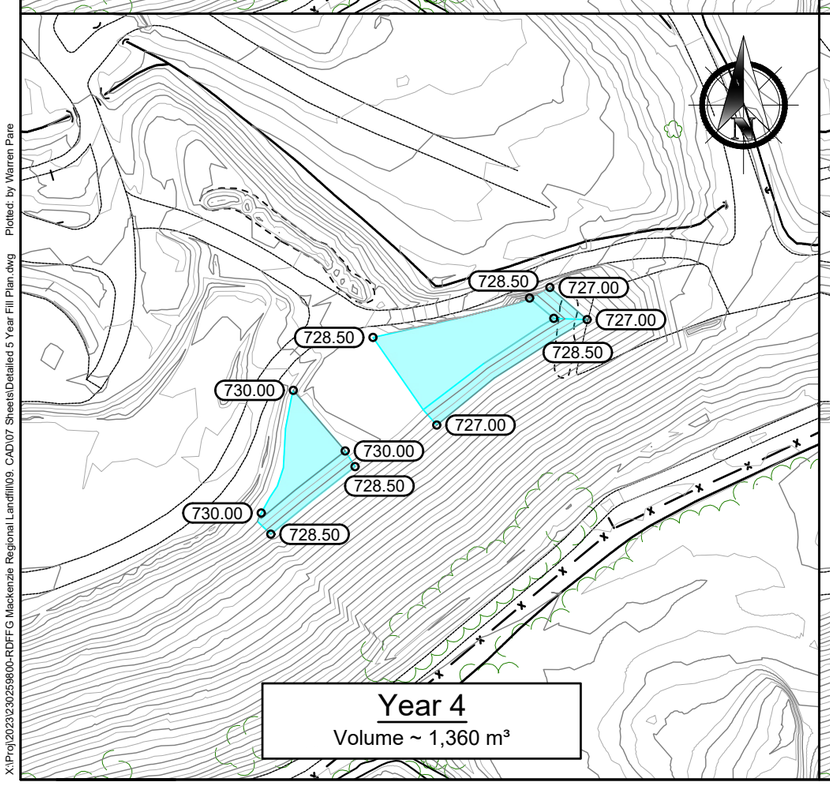
Year 1
Volume ~ 1,360 m³



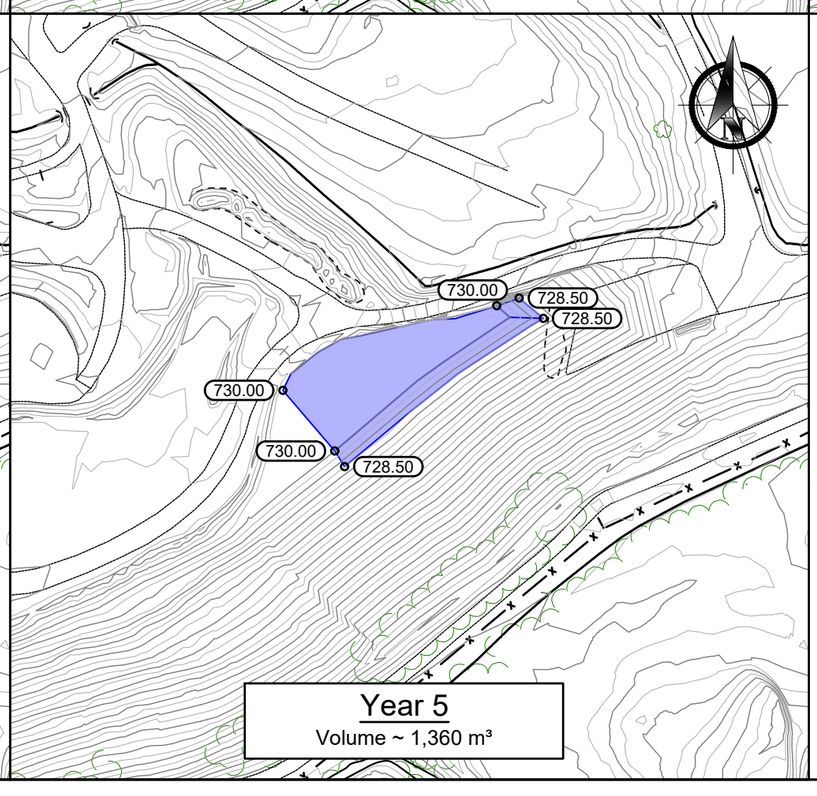
Year 2
Volume ~ 1,360 m³



Year 3
Volume ~ 1,360 m³



Year 4
Volume ~ 1,360 m³



Year 5
Volume ~ 1,360 m³

0 15 45 75m
1:1500

Regional District Of Fraser-Fort George

Mackenzie Regional Landfill
Detailed 5 Year Fill Plan

REGIONAL DISTRICT of Fraser-Fort George

MORRISON HERSHFIELD

Project No. 230259800

Date February 1, 2024

Figure No. Figure 7

4.7 Materials Management Plan and Site Soil Balance

Soil is readily available near the site to the east of the operating landfill at a sand and gravel borrow pit. As noted in Section 4.3, a preliminary estimate was completed assuming an excavation depth of 708.3m ASL at 3:1 side slopes which indicates the borrow pit has approximately 35,000 m^3 of soil available. Soil will be required for daily, intermediate, and final cover of the landfill as well as for road construction projects.

Based on the results of the airspace assessments completed over the past three years, MH estimates that the waste to soil cover ratio is in the 2:1 to 3:1 (by volume) range. At a 2:1 waste to cover ratio, the in-place waste density would be approximately 0.7 tonnes/m^3 and at a 3:1 waste to cover ratio, the in-place waste density would be approximately 0.6 tonnes/m^3 which is considered realistic for C&D waste compaction at a small landfill.

The estimated annual soil consumption based on varying waste to cover ratios and assuming total volume consumption of 1,358 m^3 is presented in Table 4 below.

Table 4: Annual Soil Consumption based on Various Waste to Cover Ratios

Waste to cover ratio (by volume)	Annual soil consumption for daily cover (m^3)	Estimated Soil Required over Remaining Lifespan (80 years)
3:1	340 m^3	27,200 m^3
2:1	450 m^3	36,200 m^3
1:1	680 m^3	54,300 m^3

4.7.1 Soil Balance for Operations

A summary of the estimated sand and gravel soil required from the existing borrow pit for operations and other infrastructure projects identified in this DOCP is provided in Table 5 below (refer to Section 5 for the estimated soil required for closure). The estimated soil required for daily cover is based on a 3:1 waste to cover ratio and assuming 80 years of remaining capacity over Phases 1-5.

Table 5: Estimated Sand and Gravel Soil Required for Landfill Operations and Closure of the Primary Landfill Area

Item	Estimated Soil Required (m^3)
Daily Cover (at 3:1 waste to cover ratio)	27,200 m^3
Entrance Road Re-Alignment	700 m^3
Internal Access Road Construction (Phases 1-5)	600 m^3
TOTAL	28,500 m^3

To assess the soil consumption from the borrow pit, MH compared the survey data between May 2021-2022 and May 2022-2023 to estimate the excavated volume (cut) within those survey dates. The estimated soil consumption is as follows:

- Between May 2021 to May 2022 – 2,643 m^3
- Between May 2022 to May 2023 – 3,096 m^3

At a conservative 2:1 waste to cover ratio, the annual soil used for cover would be approximately 450 m^3. This suggests most of the soil use over the last three years has been related to other projects at the landfill such as road construction. MH recommends using the soil sparingly for covering waste as needed and only for construction projects authorized by the RDFFG. When placing cover, the operations contractor should be targeting a soil cover thickness of 150 mm and no greater than 300 mm for intermediate cover.

As shown in Table 5 above, assuming a 3:1 waste to cover ratio, a total of 28,500 m^3 is estimated to be required over the remaining lifespan of the landfill for daily cover and road construction. This is less than the estimated quantity of soil available in the borrow area of 35,000 m^3 therefore it is estimated that there will be sufficient soil in the borrow area if soil is used sparingly. The waste to cover ratio has the most significant impact on the amount of soil consumed over the operating period of the landfill. The final cover design will also affect the amount of soil needed for final closure and capping (refer to Section 5).

Since the landfill was converted to a C&D select waste landfill, the frequency of soil cover placement has significantly decreased. Cover is currently applied three to four times during Spring and Summer (approximately every 3 weeks) and approximately two times during the Fall and Winter (approximately every 6 to 8 weeks).

A target waste to cover ratio of 3:1 (by volume) is typical at a landfill accepting both C&D waste and MSW however since the Mackenzie Landfill is only accepting select waste and soil cover is not placed on a daily basis, a 3:1 waste to cover ratio should be considered the minimum target.

At a 3:1 waste to cover ratio, the amount of soil needed over the remaining landfill lifespan is 27,200 m^3 which can be sourced from the existing borrow area. At a lower waste to cover ratio, there will likely be insufficient soil in the existing borrow pit. It is understood that additional soil can be sourced from a borrow area located further northeast of the landfill if the current borrow pit does not have enough for the operations at the Mackenzie Regional Landfill. The additional borrow area may potentially require an additional lease agreement.

A more detailed assessment of the soil required for the final landfill cover should be completed as part of the landfill Closure Plan.

5. CLOSURE PLAN

Final closure of a waste disposal facility is required under the 2016 Landfill Criteria for Municipal Solid Waste. Landfills, landfill cells or phases should be closed and capped once capacity has been reached. The final cover should be designed to minimize infiltration of water into the landfill cells and thus limit the generation of leachate. The slope and surface should be contoured to promote surface water runoff while considering long-term slope stability and airspace optimization. The cover can also be designed to help manage landfill gas.

As per Operational Certificate 100206 (dated March 4, 2009), the RDFFG is required to submit a Closure Plan to the BC Ministry of Environment and Climate Change Strategy (MoECCS) at least one year prior to the intended closure date. The closure plan is required to include the final elevation contours including surface water diversion and drainage controls, the specifications for the final cover and proposed end use, and the post-closure monitoring plan.

In addition to the minimum requirement outlined in the OC, the Closure Plan should include the following information:

- Nature and design of the final cover, including cover design details;
- A surface water management plan, including crest ditches, downchutes, toe ditches, and culverts;
- Procedures for notifying the public of facility closure;
- Post-closure environmental monitoring plan and final cover inspection plan;
- Progressive closure plan (if applicable)
- Specific post-closure land use
- Assessment of contaminating lifespan
- Estimated closure and post-closure costs, including reference to closure fund.

Though this DOCP includes the elements required for the official Closure Plan, MH recommends a separate plan be developed by a qualified professional at least two years prior to the anticipated closure date. The separate closure plan would include a detailed closure strategy and the selected cover system.

5.1 Landfill Cover Elements

A final landfill cover is constructed of layers of different materials with different properties and purposes. The typical layers of final cover are briefly described below followed by two proposed cover systems for the Mackenzie Regional Select Waste Landfill.

Vegetation and Surface Layer

The surface layer of the landfill should be constructed with a minimum 0.15 m vegetated topsoil however the thickness of the topsoil layer should be selected with consideration to the type of vegetation and availability of local soils. The main purpose of this layer is to prevent erosion and

protect the underlying layers. The topsoil layer also acts as a moisture buffer by storing moisture and releasing it through transpiration and evaporation. Established vegetation improves the aesthetics of the site, creates habitat for animals and insects, and reduces surface erosion.

There is limited availability of topsoil in the District of Mackenzie area, especially in the quantities needed for final closure of the landfill. A fabricated soil may be more suitable considering the local conditions and availability of organic materials. It is important that a fabricated soil contain sufficient nutrients to promote vegetation growth and that the soil has a relatively good water holding capacity. Alternatives to topsoil include a soil mix with compost, peat or biosolids. Hence, it is recommended that segregation of yard and garden waste and wood waste is continued and that the composting operations are reviewed with consideration to the quantity and quality of topsoil needed for final closure.

Using the May 2023 survey data, the volume of the four Y&G waste piles (both unchipped and chipped) on the landfill is estimated at 1,400 m^3. The chipped yard waste can be used as an erosion control media during landfill closure or blended with mineral soil to create a topsoil material suitable for the final cover.

Any existing vegetation and topsoil stripped and grubbed from existing slopes in preparation for final cover placement should be stockpiled and used in the topsoil layer of the final cover system.

Cushion / Subsoil Layer

Sometimes a layer of soil is applied just below the topsoil (sometimes with a filter layer, in the form of a geotextile, in between). The purpose of this layer is to protect the underlying cover layers, create depth for root growth and provide additional water holding capacity.

The cushion / subsoil layer can be constructed using many different types of soils and is often selected based on soil type available on site or locally. The selection of soil and the thickness is more site-specific with consideration to the intended post-closure end use. The seed mix chosen for final closure should be selected with special consideration to root depth particularly if the final cover is constructed without a cushion / subsoil layer.

Drainage Layer

A drainage layer is commonly constructed above the barrier layer. The purpose of this layer is to facilitate the channelling of infiltrated water, especially on the side slopes, to a surface water ditch or other collection system, thereby reducing head buildup in the barrier layer. Excessive head buildup in any cover layer can lead to failure of the cover system. Without a drainage layer there is also a risk that the topsoil and cushion/subsoil layer becomes saturated which can lead to slumping and erosion. These layers are also called capillary break layers.

Drainage layers/capillary breaks can be constructed using geosynthetics (geonet or non-woven heavy geotextile) or with cohesion-less soils such as gravel and sand. It is important to prevent clogging of the drainage layer which can be done by selecting vegetation with shallow roots, install cushion/subsoil layer with sufficient thickness and/or by the use of a geotextile or sand as a filter between the drainage layer and the overlying layers.

Barrier Layer

The barrier layer can be constructed using a 1. low permeability soil (compacted clay barrier), 2. a polymer geomembrane, or 3. a geosynthetic clay liner (GCL). The purpose of the barrier layer is to prevent surface water from percolating through the waste in the landfill thereby minimizing leachate generation. It also prevents air infiltration in the waste and landfill gas system (if a part of the landfill cover) and aims to minimize the release of landfill gas emissions.

The BC Landfill Criteria (June 2016) specifies the minimum expected requirements for the final cover system. The final cover must at a minimum consist of a 0.6m thick clay liner with a hydraulic conductivity of $1x10^{-7}$ cm/s or less for non-arid regions, such as the District of Mackenzie, or a geomembrane cover.

1) A clay layer is installed in small uniform vertical lifts using clay free from debris and large clods and prepared to proper moisture content to create a low permeability layer. Clay covers allow some water to infiltrate into the waste which increases the rate of waste stabilization as well as landfill gas generation. This is particularity important at landfills where an active landfill gas collections system is installed. Clay is susceptible to freeze-thaw and wet-dry cycles which results in the development of fractures. If this occurs, it would need to be scarified and re-compacted to maintain the cover performance.

2) Geomembranes are factory made polymeric membranes used for final landfill cover systems but also have other applications. There are several different geomembranes on the market with different properties (e.g. thickness, smooth vs textured and density) chosen specific to its application. The most common geomembrane categories include high density polyethylene (HDPE), linear low-density polyethylene (LLDPE) and polyvinyl chloride (PVC). LLDPE is a common material in British Columbia for landfill covers however the selection of geomembrane should always be made specific to application and site-specific conditions and the overall closure and post-closure objectives and plans.

   The performance of the final cover system to tolerate differential settlement is also a key consideration. Certain HDPE membranes, for example, can only tolerate 5% strain before failure which doesn't allow for much differential settlement.

   Another consideration is the risk of puncture and damage to the barrier layer during installation. Geomembranes are generally more susceptible to puncture and damage during installation. Underlying soils must be selected and placed to minimize the risk of damage to the cover. A thick geotextile is often placed immediately below the geomembrane to create a cushion and to protect the cover system. Geomembranes are typically preferred when natural low permeability soils are limited or very expensive to ship and place, or timelines are very tight, and geomembranes are quicker to install.

   Geomembranes consume less airspace compared to a soil cover which is especially important where airspace is limited. During the installation of geomembranes, a certain number of liner defects and pinholes should be expected and considered as part of the installation quality control program.

3) GCLs combine geosynthetics with a layer of sodium bentonite clay. The benefit of a GCL compared to a clay cover is the airspace savings and, in many situations, also cost saving.

The barrier layer is the most important part of the final landfill cover and most of the other layers in the cover system aim to protect or enhance the performance of the barrier layer.

Landfill Gas Collection / Venting Layer

The layer directly below the barrier layer is constructed to create a pathway for landfill gas (and leachate if there would be a breakout) to an active or passive landfill gas system, to reduce the risk for gas pressure build up. The layer is generally constructed using a high permeability soil or an engineered geosynthetic. A network of perforated gas collection pipes is placed within this layer to collect and direct the landfill gas to vents or wells.

Foundation Layer / Intermediate Cover

An intermediate cover is placed on top of the waste once final grade has been reached. The intermediate cover is a temporary landfill cover and is placed to prevent litter, rodent and vectors related issues. The intermediate cover also forms a protective layer between the waste and the final cover system. The final contours for the landfill side slopes and crest are created through placement of the foundation layer / intermediate cover.

5.2 Final Cover Options

5.2.1 Soil Cover System

Borehole logs from the geotechnical investigations completed for the transfer station indicate the surficial geology is primarily sand and gravel, with small pockets of clay. These logs suggest the availability of low-permeability soil on-site may be limited, especially at the quantities required for final closure. However, under Licence of Occupation No. 706803, the RDFFG has access to a clay quarry for the purposes of obtaining material for final landfill cover. The clay quarry is located approximately 1 km from the landfill site. MH recommends that the quantity and characteristics (hydraulic conductivity) of the clay available from the clay quarry be confirmed. This information can then be compared to the estimated quantity required for final closure.

The soil cover system proposed is designed as per the BC Landfill Criteria. According to the requirements, the barrier is to be comprised of a minimum 0.6m thick layer of low permeability clay with a hydraulic conductivity of $1x10^{-7}$ cm/s or less when compacted to 95% of Standard Proctor.

Clay is expected to meet the requirement of hydraulic conductivity of $1x10^{-7}$ cm/s or less, and modeling of the soil performance could be performed to determine the ultimate thickness required to reach similar performance as that of a soil cover described under the BC Landfill Criteria.

The soil requirements for final closure of the primary, contingency, and historic landfill areas using a soil cover are presented in Table 6 below.

Table 6 Quantity of soil required for final closure of Mackenzie Regional landfill using a low permeability soil cover.

	Primary Disposal Area (m^3)	**Contingency Disposal Area** (m^3)	**Historic Disposal Area** (m^3)	**TOTAL** (m^3)
Topsoil	6,400	1,800	3,000	11,200
Low permeability soil	25,700	7,000	9,200	41,900
Intermediate cover	12,800	3,500	4,600	20,900

5.2.2 Geomembrane Cover System

A geomembrane cover system also meets the BC Landfill Criteria and is proposed as Option 2 for final closure of the Mackenzie Regional landfill. The barrier layer is comprised of an engineered geomembrane, which consumes considerably less airspace compared to a clay cover. The geomembrane is protected by an underlying geotextile placed on top of the intermediate cover. A geocomposite, comprised of a drainage net sandwiched between two layers of geotextile, will be placed on top of the geomembrane before a 0.45 m common fill layer is placed. The final layer will consist of topsoil with 0.15 m thickness that is seeded. This type of cover system does not allow for passive landfill gas venting, therefore a network of perforated landfill gas collection pipes will likely be required below the barrier layer to prevent uplift of the geomembrane. Passive landfill gas vents will be required at the high points in the landfill, which will penetrate through the geomembrane cover system.

5.3 Site-Specific Landfill Cover Design and Closure Considerations

The Mackenzie Select Waste Landfill has a large disturbed footprint relative to the amount of waste currently being received at the site. As identified in Figure 3, the following three areas have been defined that will require a separate but related closure strategy.

5.3.1 Primary Landfill Disposal Area

The closure area of the primary landfill disposal footprint covers an area of approximately 42,800 m^2 and is estimated to have approximately 80 years of remaining capacity based on the current fill rate. It is currently the active fill area.

5.3.2 Contingency Disposal Area

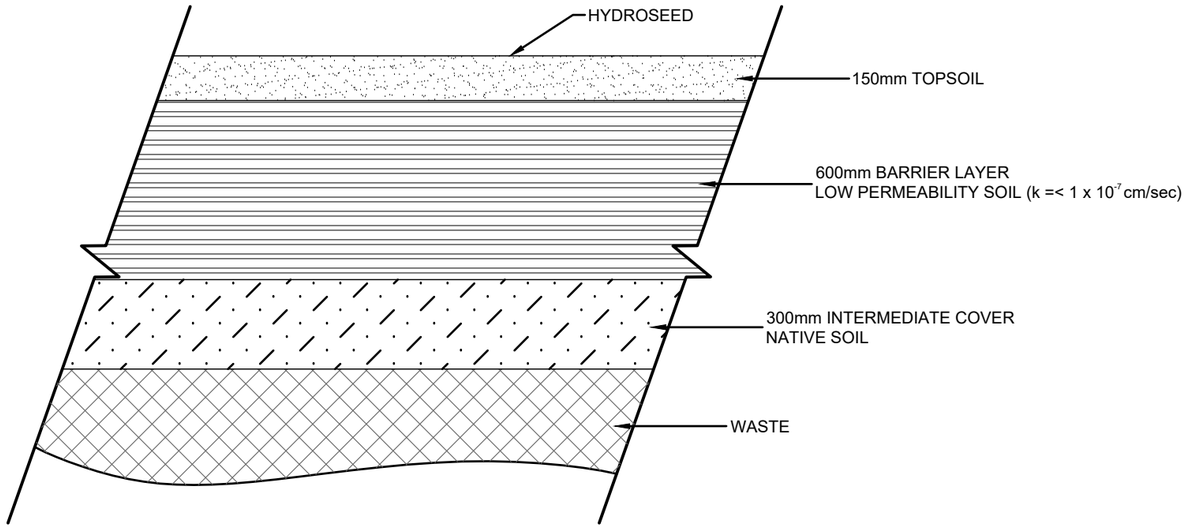
The closure area of the contingency disposal footprint is approximately 11,700 m^2 and has been designated by the RDFFG as a contingency disposal option if the region's primary disposal site at the Foothills Boulevard Regional Landfill becomes unavailable or if disposal capacity is needed in an emergency situation such as a flood, fire, or other natural disaster. Intermediate cover has been placed on the contingency disposal area and it is partially vegetated. The conceptual design of the contingency disposal closure area involves piggybacking on the primary landfill area by placing

waste on the north slopes of the primary landfill disposal area. The contingency disposal area is estimated to provide an additional 90,000 m^3 of airspace, or approximately 66 years of capacity at the current fill rate. Final closure of the contingency disposal area is not expected until the primary landfill disposal area reaches capacity and is closed. Historic records suggest that most of the waste in place at the landfill is located within the primary and contingency landfill areas.

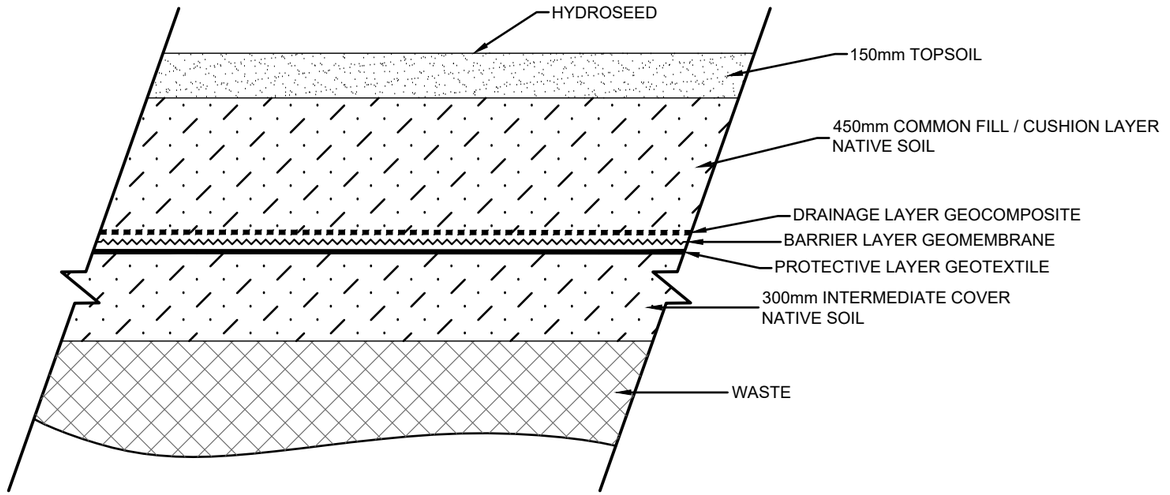
5.3.3 Historic Landfill Area

The historic landfill closure area covers an area of approximately 15,300 m^2. Through discussions with RDFFG staff and based on a review of historic records, landfilling may have only occurred in certain portions of this area over a limited number of years (at least five years). The extent of the waste fill area identified on a September 2005 drawing prepared by Aero Geometrics Ltd. indicates the extent of waste placement is mostly contained within and to the south of the existing internal access road within the contingency disposal area. The September 2005 drawings by Aero Geometrics identifies an elevation of 718.6 in the historic landfill area (outside of the area identified as the active waste fill area). MH compared the elevation in this location to the latest survey data for the site (May 11, 2023) and the elevations are close which suggests substantial filling did not occur in this area. RDFFG staff have confirmed that filling occurred within the northeast corner of the historic landfill area for at least five years.

Two final cover options are presented in this DOCP. The two cover systems are described and briefly discussed below. The two systems are illustrated in Figure 8 (next page).



OPTION 1 - SOIL COVER



OPTION 2 - GEOMEMBRANE COVER

0 0.2 0.6 1.0m
1:20

Regional District Of Fraser-Fort George

Mackenzie Regional Landfill
Landfill Cover Design Options

REGIONAL DISTRICT of Fraser-Fort George

Project No. 230259800

Date February 1, 2024

MORRISON HERSHFIELD

Figure No. Figure 8

5.4 Historic Landfill Area

5.4.1 Closure Options

As part of the development of this DOCP, a preliminary cost estimate was prepared to assess the potential costs of excavating waste from the historic landfill area and moving it to the contingency disposal area. The costs to excavate the waste were then compared to the cost of closing and capping the area using one of the two cover options listed above (i.e., leaving waste in place). The estimated cost to close the historic landfill area is summarized in Table 7 below.

Table 7:Estimated Closure Cost of Historic Landfill Area Assuming Waste Left in Place and Capped

Option A – Place Final Cover (Leave Waste in Place)		
Closure Area (m^2)	Closure Cost – Soil Cover	Closure Cost – Geomembrane Cover
15,300 m^2	$845,000	$1,659,000

The second option (Option B) that was considered was to excavate and relocate the waste from the historic landfill area to the contingency disposal area. The main benefit of excavating and relocating waste in the historic landfill area is to reduce the footprint of the landfill requiring closure thereby reducing closure costs and long-term liability.

As noted in Section 5.2.1, there is considerable uncertainty in the amount of waste in place in the historic landfill area. As noted in the *1995 Interim Operations Plan* (AGRA, 1995), the average depth of the landfill was estimated to be approximately 3 m based on the extent of the site area utilized for landfilling from 1974 to 1995. The area includes the areas now defined as the primary landfill area, contingency disposal area and historic landfill area. Based on discussions with the RDFFG, it is understood that the waste was placed in the northeast corner of the historic landfill area after 1995 for at least 5 years. Based on an assumed annual fill rate of 5,000 tonnes per year over 5 years at an apparent density of 0.5 tonnes per m^3, the estimated volume of the waste in place in the historic landfill area is 50,000 m^3. MH also estimated the potential amount of waste in place (requiring excavation) based on the total historic waste disposal area of 15,300 m^2 and assuming an average 3 m waste depth over the entire area plus an additional 0.5 m over-excavation to remove impacted soils which would result in an estimated 54,000 m^3 requiring removal.

For the purposes estimating the potential cost of excavating and relocating waste, it was assumed that 54,000 m^3 of material (waste and impacted soils) would need to be excavated. The estimated costs are presented in Table 8 below.

Table 8: Estimated Cost to Excavate and Relocate Waste in Historic Landfill Area

Option B – Excavate and Relocate Waste	
Estimated volume waste in place (m^3)	54,000 m^3
Unit Rate for excavation and placement ($/m^3$)	$15/$m^3$
Excavation and placement cost	$810,000
Testing, confirmatory sampling, oversight, reporting by QP	$80,000
Total	$890,000

The main factor affecting the cost of Option B is the amount of waste in place requiring excavation and removal. Option B would also have additional safety considerations due to the potential to encounter hazardous waste during excavation activities.

The contingency disposal area has an estimated 159,000 m^3 of available airspace and based on the high level volume estimates above, relocating the historic waste would consume approximately a third of this volume or about 29 years of capacity based on the current landfill fill rate.

5.4.2 Preferred Closure Option

The preferred closure strategy for the historic landfill area is to leave the waste in place and install final cover (Option A). Since filling is not planned in this area, MH recommends that closure planning be initiated with the objective to close the area within the next five years. Benefits to closing this area include a reduction in the landfill liability and a reduction in leachate generation.

5.5 Closure Cost Estimate

The estimated cost to close the primary disposal area, contingency disposal area, and historic landfill areas is presented in Table 9 below. Capital costs are presented based on the type of cover system selected (soil cover or geomembrane). Detailed cost estimate tables for closure of the primary landfill disposal area are provided as Appendix D.

Table 9: Summary of Estimated Closure Costs

Closure Area	Estimated Cost (Option 1 - Soil Cover)	Estimated Cost (Option 2 - Geomembrane Cover)
Primary Landfill Disposal Area	$ 2,139,000	$ 4,416,000
Historic Landfill Area	$ 845,000	$ 1,659,000
Contingency Disposal Area	$ 585,000	$ 1,207,000
Total	$ 3,569,000	$ 7,282,000

To close all areas, it is estimated that a soil cover system would cost approximately $3.6M and a geomembrane system would cost approximately $7.3M. General assumptions and notes for the estimated costs are as follows:

- Estimates are considered Class D capital cost estimates based on the conceptual closure design presented in this DOCP.
- Costs are in 2023 dollars. An escalation factor, inflation and discounting has not been applied to account for closure in a future date. It is assumed that this analysis will be completed as part of liability reporting separate from this DOCP.
- The following have been applied to the subtotal:
  - Contingency – 40%
  - Engineering and Construction Oversight – 20%
- It is assumed that soil required for new access roads, intermediate cover, and the common fill layer will be sourced from the existing borrow pit and from a borrow area north of the landfill once the existing borrow pit has been depleted.
- It is assumed that clay soil required for the barrier layer under Option 1 will be sourced from the clay borrow pit located approximately 1 km from the Site (identified under License of Occupation No. 706803). It is assumed that there will be sufficient volume of clay from this source and that the clay meets the minimum hydraulic conductivity properties identified above. Importing clay from out of the region (greater than 1 km from the site) has not been considered in the cost estimate.
- Unit rate for topsoil is based on a fabricated topsoil blend consisting of Owner-supplied on-site mineral soil and Owner-supplied organics from decomposed and chipped yard waste and/or grubbed material. Another option considered is Owner-supplied compost (Norgrow) from the Foothills Boulevard Regional Landfill compost facility. Unit rate would increase if the Contractor was required to supply topsoil.

- Option 2 (geomembrane) will require a passive LFG venting system and Option 1 (soil cover) will not require a passive LFG venting system. The need for a passive LFG venting system with either option should be reviewed as part of the detailed Closure Plan.
- Vegetation on existing side slopes will be grubbed and stockpiled prior to placement of final cover and will be reused as part of final topsoil layer.
- The existing perimeter access roads along the west, south, and east toe of the landfill will be maintained. An allowance has been included for construction of a new perimeter access road along the toe of the landfill along the north end (north of Phases 1, 2, 3).
- The existing ditches along the west, south, and east toe of the landfill will be maintained. Costs have been included for new crest ditches and down chutes, upgrades to existing toe ditches and culverts, and an allowance has been included for a new surface water pond (if determined to be required through detailed engineering).
- Closure costs for the historic landfill area is based on the preferred closure strategy (waste being left in place) with the area being re-shaped/re-graded at around 15-20% slopes before final cover placement. Approximately 4000 cu. m of material will need to be excavated to re-shape the area.
- An allowance has been included for new signage.

Due to the availability of clay soil and mineral soil near the site, the soil cover option (Option 1) is considerably less costly than the geomembrane cover option. For both options, it was assumed that the existing borrow pit and the potential borrow pit further north of the landfill would be used to meet the soil requirements for intermediate cover, cushion layer, and access road upgrades. Access to the borrow pit further north of the landfill may require an additional lease agreement.

A benefit of a geomembrane system is that it requires less airspace in comparison to a soil cover system.

The soil cover system (Option 1) is considered the most cost-effective closure option for this site if sufficient quantities of soil with the required performance characteristics can be sourced. The RDFFG should continue to collect and chip yard and garden waste material to reduce the need for imported topsoil.

5.6 Progressive Closure

The purpose of progressive closure is to minimize leachate generation, facilitate clean runoff diversion and spread the capital costs of closure over the life of the landfill. This can be achieved by fully or partially closing and capping each phase as capacity and final grade is reached.

Progressive closure is more suitable when applying a soil clay cover as closure can be performed as suitable materials become available.

5.6.1 Primary Landfill Area

The side slopes on the west, south, and east sides of the primary landfill area have reached final design grades (3V:1H) and progressive closure could begin with grubbing and placing final cover on

the existing slopes. However, since the side slopes are partially vegetated and stable, progressive closure could be initiated once Phase 3 is complete and final cover could be placed on all sides slopes in the primary landfill disposal area up to an elevation of approximately 730 m. Based on the current fill rate, this first progressive closure event would be in about 12 years.

A second progressive closure event of the primary landfill area could be halfway through filling Phase 4 on final slopes, approximately 18 years after the first closure event. The final closure event of the primary landfill area would be once the landfill reaches final contours and the landfill crest is reached.

The total closure area of the primary landfill area is 42,800 m^2.

5.6.2 Historic Landfill Area

As outlined in this DOCP, no waste is expected to be placed in the historic landfill area in the future and it can be closed as part of a progressive closure strategy for the Site. Based on a preliminary earthworks analysis balancing the cut and fill (no additional fill required), approximately 4,000 m^3 of soil and waste will need to be excavated to re-shape the area to achieve slopes of approximately 15-20% which is acceptable to promote drainage. Once the re-shaping is complete, final cover can be placed in this area. This area is currently partially vegetated and it is recommend that the vegetation and any organic layers be removed and stockpiled before regrading so that it can be reused as part of the topsoil layer of the final cover system.

The total closure area of the historic landfill area is 15,300 m^2.

MH recommends that closure planning be initiated with the objective to close the historic landfill area within the next five years.

5.6.3 Contingency Disposal Area

Closure of the contingency disposal area is considered beyond the timeframe of the current DOCP (greater than 100 years based on the current fill rate). Closure of the contingency disposal area depends on several factors including the closure timeline for the historic landfill area and the estimated quantities of waste in contingency events. It is recommended that the closure strategy for the contingency disposal area be re-assessed once the closure timeline for the historic landfill area is determined.

If the contingency disposal area is used, the proposed design would piggyback on the north side of the primary landfill disposal area and the additional area requiring closure would be 11,700 m^2.

5.7 Erosion Prevention Controls

Once the final cover has been applied on the landfill side slopes and crest, these areas will need to be seeded. The seed mix should be chosen with consideration to the local climate and soil characteristics. It is also important to consider root depth of the established vegetation to prevent the roots from entering the cover system and damaging the landfill barrier layer. The established vegetation binds the soil and prevents erosion. The vegetation also contributes to transpiration

which reduces the moisture buildup in the soil, and reduces the chance of slope failure. Hence, it is important that the landfill is seeded as soon as possible or as soon as the growth season begins, once final closure has been completed.

It is recommended that the vegetation is inspected and maintained at least once a year. Areas with sparse vegetation should be reseeded and invasive species removed. Mowing is sometimes required, depending on the post-closure end-use.

As discussed in Section 4.4, the side slopes and crest are to be graded to promote surface water runoff in a controlled and effective way. The final contours of the Mackenzie Regional Select Waste Landfill are designed with 3H:1V side slopes and a 10% crest grading. Surface water will be directed off the crest through crest perimeter ditches and four down chutes (see Section 4.4).

5.8 Closure and Post-Closure Fund

The OC requires that the RDFFG recognize the landfill closure and post-closure liability associated with the Mackenzie Regional Landfill. Public Sector Accounting Board (PSAB) Section PS3280 (asset retirement obligations) was approved in 2018 and replaced the previous accounting standard PS3270 (solid waste landfill closure & post-closure liability) referenced in the OC and landfill criteria.

The estimated closure and post-closure costs and associated liability under PS3280 is reported under separate cover. In accordance with the OC and Landfill Criteria, the RDFFG is required to ensure sufficient funds are available (through a closure and post-closure reserve) for closure and post-closure activities.

6. OPERATIONS PLAN

This section covers the operations plan for the landfill which is operating as a C&D waste landfill and the transfer station which was constructed and became operational at the end of 2019.

6.1 Hours of Operation

The landfill and transfer station facilities are open Sunday to Thursday, 9:00 AM to 5:00 PM. Regional District staff are on site during operational hours.

The facility is closed for the following Statutory Holidays: New Years' Day, Family Day, Good Friday, Easter Monday, Victoria Day, Canada Day, BC Day, Labour Day, National Day for Truth and Reconciliation, Thanksgiving Day, Remembrance Day, Christmas Day & Boxing Day.

6.2 Staffing and Equipment

The Regional District site staff generally includes:

- One environmental services lead hand, and
- One environmental services employee.

With the compaction and cover operations contracted out, the contractor is responsible to perform compaction and applying cover at the landfill. The compaction and cover services are requested by the Regional District approximately three to four times during Spring and Summer (approximately every 3 weeks) and approximately two times during the Fall and Winter (approximately every 6 to 8 weeks). Equipment used at the Site for landfilling related activities, include the following:

- Crawler tractor
- Hydraulic excavator

6.3 Current Tipping Fees

The Mackenzie Regional Transfer Station is currently not charging tipping fees for disposal of small loads of household waste. Curbside collection of municipal solid waste is provided for residents of District of Mackenzie which is dropped off at the transfer station for final disposal at the Foothills Boulevard Regional Landfill.

Currently, tipping fees are applied for disposal of MSW and is based on weight and type of material in accordance with Municipal Solid Waste Tipping Fee and Site Regulation Bylaw No. 3166:

- Residents can drop off small loads of household waste and small amounts of construction waste under the 100 kg at no charge.
- There is no charge to drop off recycling, yard and garden trimmings, or materials for the Swap Shed.
- A tipping fee is applied for disposal of refuse and demolition, land clearing and construction waste in loads over 100 kg with a minimum charge per load.

- All controlled waste has a disposal fee, and some types of controlled waste cannot be disposed of at the Mackenzie Regional Landfill or Transfer Station.

Tipping fees are paid by cheques, credit cards, or debit cards. Commercial customers can apply for credit accounts with the Regional District.

Controlled waste requires special handling and disposal techniques to avoid creating health hazards, nuisances, or environmental pollution. Accepting controlled wastes at the Mackenzie Regional Landfill may require pre-approval or require pre-approval and a permit.

Controlled wastes that require no pre-approval or permit are the following:

- Appliances with ozone depleting substances (fridges, freezers, water coolers, air conditioners) at no charge.
- Food processing waste (tipping fee applied with a minimum charge).
    - This waste is transported/transferred to Foothills Regional Landfill.
- Gypsum board or wallboard (tipping fee applied with a minimum charge).

Some types of controlled waste that require pre-approval for disposal requires further notice to the Regional District. Arrival at the Mackenzie Regional Landfill without pre-approval can result in being turned away without permission to dispose the waste. Controlled wastes that require pre-approval are the following:

- Bulky waste
- Camp waste
- Concrete
- Condemned food
- Creosote treated wood
- Dead animals
- Pumping from commercial laundry lint traps, parking lot drainage sumps or sumps collecting vehicle washing facility run-off
- Vehicle hulks
- Wood ash from industrial operations

In addition to pre-approval, some types of controlled waste require a disposal permit. The users are required to complete an online controlled waste disposal permit application. Controlled wastes that require both pre-approval and a permit are the following:

- Asbestos
- Biosolids
- Contaminated soil
- International waste

6.4 Transfer Station Facilities and Waste Acceptance Procedures

Since 2020, the site has been operating as a select waste C&D landfill facility with the construction and completion of the transfer station building and new scale.

All users enter the facility through the main access road to the north, where they drive towards the transfer station to check in at the site office and weigh scale area. Once vehicles are on the scale, they are directed by the staff to the appropriate location. Users are either directed to the transfer station area for recycling and MSW drop-off, or to the landfill area for C&D waste disposal and Y&G waste composting. All accepted wastes are monitored by the staff at the scale house to prevent disposal of hazardous or other prohibited waste, as outlined in the 2016 BC Landfill Criteria and Operational Certificate.

The transfer station facilities include the following (identified on Figure 2):

- A 27m by 22.3 m pre-enginereed metal transfer station building with three entrance doors with a concrete tipping floor and cantilevered loadout bay;
- Scale house and one 40 foot (12 m) bi-directional scale;
- Cardboard compactor recycling located beside the transfer building;
- A swap shed and staff storage shed;
- Interchange Recycling (formerly BC Used Oil Management Association) Sea-can container for collection of used oil, oil filters, and antifreeze;
- Bin for plastic and mixed container recycling;
- Concrete block bunkers for white goods and scrap metal recycling; and
- Concrete block bunkers for receiving household hazardous waste (HHW)

The transfer station building is where users can drop-off MSW on the tipping floor which is transferred and disposed at the Foothills Boulevard Regional Landfill. Multi-material recycling bins are present to the north of the transfer station building where users can drop-off plastic recyclables. Used oil, oil filters and containers, antifreeze, lead acid batteries, and rechargeable household batteries are received at separate bays further north of the transfer station building. The swap shed is next to the bays at the north.

Vehicles directed to the landfill are instructed to back into the active face to dispose of their C&D waste, then drive back to the scale to weigh the difference and pay the C&D waste tipping fee. The Y&G waste drop-off area is currently located on top of the landfill, currently northwest of the landfill active face. Vehicles are directed to drop-off yard waste at this location, but they do not need to drive back across the scale after disposal as there is currently no tipping fee applied to yard waste.

6.5 Landfill Active Face Operating Procedures

The Regional District shall make reasonable effort to minimize the amount (surface area) of the exposed waste at the tipping face. This is to minimize the amount of cover soil required, as well as reduce volumes of leachate and mitigate access by vectors. Safety and operational considerations are the biggest constraints on reducing the tipping face size. The tipping face should be kept as

small as possible, and the ideal width of the tipping face is approximately 10 m for the size of the Mackenzie Regional Landfill. However, the width of the tipping face must also be sufficiently sized to accommodate the average number of vehicles unloading simultaneously during peak use.

The operator should maintain the active face at the end of each operating day to ensure that users can safely back as close to the tipping area as possible. This keeps the active tipping area tidy and reduces the amount of soil lost while pushing and compacting (soil is shaved/gouged from the tipping area into the waste). The best practice for efficient compaction is to compact 300 mm thick layers of waste, and the typical rule for sufficient compaction is four to six passes over the active face.

The active face should be sloped to provide storm water drainage away from the cell. However, it is best practice to maintain the active face at a slope no greater than 3H:1V to ensure effective compaction. MH recommends the active face is kept close to 3H:1V.

The waste should be placed in lifts about 1.5 m high, spread and compacted in layers no more than 300 mm thick, and a cover should be applied only on an as needed basis, at a minimum with each lift placement.

6.6 Cover Placement and Alternative Daily Cover Options

Daily and intermediate cover layers are barriers that help to contain the waste and help reduce impacts on the surrounding environment. Daily cover can be used to enclose cells daily, or an alternative daily cover can be used, and cells can be enclosed with soil at the end of a specified operation period.

Since the Mackenzie Regional Landfill transitioned to only accepting inert C&D waste in 2019, daily cover is not required as significantly lower quantities of waste is landfilled and the waste is considered relatively inert and does not attract rodents, vectors, and animals to the same extent as MSW with organics. Cover is still required to control vectors, wildlife, dust, litter, odour, stormwater infiltration and manage the risk of fire. Cover is currently applied three to four times during Spring and Summer (approximately every 3 weeks) and approximately two times during the Fall and Winter (approximately every 6 to 8 weeks). Based on an assumed annual C&D waste tonnage of 693 tonnes and waste density of 0.6 tonnes/m^3, the annual volume consumed by waste is estimated to be approximately 1,155 m^3 per year or an average of 3.2 m^3 per day. Based on filling in 10 m by 10 m sections in 1.5 m lifts, this provides about 1.5 months of capacity before cover should be placed. The frequency of cover placement should be adjusted based on the quantity and characteristics of waste received.

The active face should be graded to achieve the smoothest surface possible before applying the cover to reduce material requirements. The maximum thickness of the cover should be no greater than 300 mm and a target thickness of 150 mm is recommended to conserve soil and maximize the waste to cover ratio.

The use of alternative daily covers (ADCs) may help reduce soil use and conserve airspace. The cost of using soil as cover is relatively low due to the proximity of the borrow pit adjacent to the landfill, however an economic analysis could be completed comparing the cost of using an ADC

compared to the current practice of using soil as cover, considering the estimated airspace savings, and considering the estimated soil in the current borrow pit and the amount of soil available in the borrow area further north of the landfill. The following alternative daily cover options may be applicable to Mackenzie Regional Select Waste Landfill.

6.6.1 Geosynthetic Covers

Geosynthetic covers are re-usable materials such as tarps or rubber belts. Suppliers can manufacture the covers with perimeter attachments used to anchor the cover over the active face surface. This is a common method that has been successfully implemented in several facilities across Canada. Photo 1 shows a geosynthetic daily cover used at the RDFFG's Foothill Boulevard Regional Landfill.

Photo 1 Alternative Daily Cover at the Foothills Blvd Landfill (Prince George)

Geosynthetic covers are deployed and removed each operating day, so there is no airspace consumption and no restriction to landfill gas and leachate flow. A benefit of geosynthetic covers is that they are reuseable and can be deployed and removed relatively quickly. Disadvantages include difficulty deploying covers in adverse weather conditions (windy), employee exposure to waste and potential tearing of the material. Eventually they need to be replaced. Specialized deployment equipment can be purchased to improve safety and speed, however there are high capital and maintenance costs associated with this equipment.

Another form of ADC is steel plates which function using the same principle as geosynthetic covers. However, because the Mackenzie Landfill is only accepting relatively small quantities of C&D waste, the use of steel plates as ADC is considered cost prohibitive and would introduce additional complexity to the operations.

Ultimately, the choice of using alternative daily cover for active landfill faces should be based on the specific needs, regulations, and conditions of the landfill site.

6.7 Electric Fence and Wildlife Control

The perimeter of the landfill and transfer station is currently enclosed with an electric fence that has three access points. The three access gates are located as follows:

- First north gate used for transfer trucks to enter the transfer station building from the ground loadout bay level.
- Second north gate for users to enter and exit the facility.
- Third gate on the east side of the site that provides access to the borrow pit.

This electric fence was installed concurrently with the completion of construction of the transfer station at end of 2019, replacing an electric fence that was installed earlier in 1994.

In accordance with the OC, the electric fence must be operational during the period of April 15 to November 15 inclusive each year. If snow is present during this period, the OC requires that any electrified strands above snow line be isolated from the remainder of the system and energised. The electric fence was upgraded in 2022 to enable the fence to be fully energized regardless of the snowpack depth.

Further detail on routine maintenance tasks relating to the electric fence can be found in Section 6.8.

6.8 Routine Inspection Tasks

MH recommends the landfill operator conduct daily inspections that include the following tasks:

- In accordance with the OC, examine and maintain electric fencing during periods of activation to ensure it is sufficiently charged to deter wildlife, and there is no debris contacting the fence that may act as a ground.
- Maintain electric fencing with the aid of a grass trimmer to remove any tall grass from touching the electric fence during growing season.
- Verify correct segregation of waste and transfer improperly segregated wastes, as required.
- Ensure there are no leaks from special waste storage containers, or white goods with Ozone Depleting Substances (ODS).
- Examine and maintain signages around site and clean when dirty. Report any damage to RDFFG and repairs to be arranged as soon as possible.
- Ensure that spill kit containers are readily available and stocked. They are to be stored in an easily accessible location within the facility (i.e., the scale house).
- Inspect groundwater monitoring wells. Report any damage to RDFFG and repairs to be arranged as soon as possible.

MH recommends that surface water run-off is inspected during spring melt and as required by an environmental protection officer or qualified staff. At a minimum, these inspections should include observations of flow rate and direction, and facility impacts caused by run-off. This will assist in

preventing any potential water ponding spots around the landfill, thus reducing leachate production within the landfill area.

MH recommends the landfill operator conduct daily inspections that include the following tasks:

- In accordance with the OC, perform daily checks during the start of operational days on electric fencing voltage with a voltage meter and document the date and time of the checks. The voltage and amperage are to be recorded in the document and filed safely.
- Describe any wildlife observations on site, including the date and time spotted, in the same document mentioned above.
- General housekeeping to maintain the cleanliness of the site, such as, but not limited to, collecting plastic debris around the site, consolidating batteries & stack on pallets, maintaining Swap Shed cleanliness, and clear site office/recycling depot access.
- Consolidate hazardous waste area, and label & list quantities of hazardous waste.
- Inspect access road conditions at the beginning of each operational day. Report any damage to RDFFG and repairs to be arranged as soon as possible.

Maintenance may be required based on the deficiencies noted during weekly and daily inspections. Any deficiencies that have been addressed should be noted in the following inspection report. All maintenance, weekly and daily inspections should be recorded and kept on file.

6.9 Safety and Training Recommendations

MH recommends site operators and any personnel conducting work on site complete the following training:

- Basic first aid (Level 1)
- Workplace Hazardous Materials Information Systems (WHMIS)

Additionally, it is recommended that all operators and managers complete the following training as required under the OC:

- Solid Waste Association of North America’s (SWANA’s) Manager of Landfill Operations (MOLO) course, Landfill Operations Basics (LOB) course or similar

Operations staff should also receive training from the RDFFG on the following:

- Traffic management procedures;
- Waste handling procedures in the transfer station;
- Management of controlled wastes; and
- Electric fence operation.

6.10 Reporting and Record Keeping

The OC requires that all reports and drawings be submitted to the MOECCS in electronic format.

The daily and weekly routine inspection tasks recommended above should be recorded and kept on file (on-site and electronically).

Additional reporting required under the OC and Landfill Criteria includes the following:

- **Non-compliance reporting.** The RDFFG is required to notify the Regional Manager, Environmental Protection (BCMOECCS) immediately of any non-compliance with the requirements of the OC and take appropriate remedial action. Written follow-up of the non-compliance event is required to be provided to the MOECCS within 24 hours of the event.
- **Annual Operations Report.** The RDFFG is required to submit an Annual Report to the MOECCS on or before June 30 each year for the previous calendar year. As specified in the OC, the annual report should contain at a minimum the following for the reporting year:
  - Executive summary;
  - Types and tonnage of waste received, recycled, and landfilled;
  - Current topographic map/survey summarizing airspace consumption and on-site borrow pit development, including estimate of airspace utilization factor (effective compaction density);
  - Updated estimate of remaining capacity, closure date for current phase, and closure date for the current landfill footprint;
  - Any new information or proposed changes related to the DOCP or facilities;
  - Information related to Y&G waste collection and composting operations;
  - Occurrences or observations of wildlife at the facility;
  - Public complaints;
  - Statement regarding the facility's progress in reducing the regional solid waste stream, in accordance with the latest Solid Waste Management Plan (SWMP);
  - Results of all environmental monitoring specified in the OC and DOCP, including data interpretation and trend analysis by a QP.
- **Annual Environmental Monitoring Report.** The annual Environmental Monitoring Report should include the following:
  - Results of the environmental monitoring program in the reporting year;
  - Data tabulation, comparison to applicable performance criteria and water quality standards, interpretation, trend analysis, graphs;
  - Identification of any current or potential non-compliance with applicable standards; and
  - Conclusions, recommendations and proposed changes to the environmental monitoring program.

The reports summarized above should include relevant drawings, signed and sealed by the QP responsible for the report and/or drawings.

7. FIRE SAFETY, EMERGENCY RESPONSE PLAN AND CONTINGENCY PLAN

7.1 Fire Safety Plan & Emergency Response Plan

The most common causes of landfill fires include malfunctioning equipment, or disposal of burning or smoldering material. The spread of landfill fires is largely impacted by landfill operations, such as active face compaction, application of cover material and the types of landfilled material. Measures that should be taken to prevent landfill fires include:

- Placement of soil cover.
- Implementing progressive closure.
- Conducting regular inspections, including load inspections of incoming waste at the scales and general inspections of site.
- Separating recyclable material such as tires, white goods, wood and hazardous waste from the landfill active face.

Proper compaction and cover material application restrict oxygen supply to the cell and act as a fire break, reducing the risk of fire.

A fire safety and emergency response plan for the facility should be developed and maintained.

MH has prepared a fire safety and emergency response plan copy for staff in Appendix E. This plan must be reviewed and updated at least once annually. The plan includes landfill fire response procedures and relevant emergency contact information. Copies must be provided to the staff at visible, easy to reach and known storage places, ideally in the following locations:

- In the scale house building
- In the transfer station building
- In the staff vehicle

The Fire Safety and Emergency Response Plan must be submitted to the appropriate fire authorities and the responding fire departments initially and upon the completion of significant changes.

7.2 Contingency Plan

As defined in the Landfill Criteria, a Contingency Plan is required as part of the DOCP document. A Contingency Plan covers:

- Possible failure and non-compliance scenarios of the leachate and surface water infrastructure.
- Practical and implementable contingency measures to address any failure or non-compliance with the performance criteria.

If the RDFFG suddenly has to close the Mackenzie Regional Landfill either due to a non-compliance or in the event of a failure with the Site's performance criteria, the RDFFG will be sending the waste intended for disposal at the Mackenzie Regional Landfill to the Foothills Boulevard Regional Landfill. The Foothills Boulevard Regional Landfill is located south of Mackenzie and is accessible by Highway 97. The total haul time from the Mackenzie Regional Select Waste Landfill to the Foothills Boulevard Regional Landfill is estimated to be 5 to 6 hours roundtrip, including bin pick up and drop off.

The Mackenzie Regional Landfill has also been identified as a facility that can provide contingency disposal capacity in the event the Foothills Boulevard Regional Landfill cannot accept waste or in the event of an emergency and/or natural disaster requiring the disposal of a large amount of waste in a short period.

Non-compliance scenarios that could be identified during the recommended daily and weekly inspections include issues with the electric fence and failures of slopes and surface water management infrastructure. In the event of non-compliance scenarios, RDFFG staff will work with the landfill operator to address the non-compliance in a timely manner, with immediate priorities on safety and environmental protection. Non-compliance scenarios related to the environmental monitoring program would be identified in the annual environmental monitoring report and corrective actions and recommendations would be provided by the QP.

Reporting of non-compliance events should follow the required reporting procedures outlined in Section 6.10.

8. LANDFILL GAS GENERATION ASSESSMENT

Under the Landfill Gas Management Regulation, the owner or operator of a regulated landfill site must ensure that a landfill gas management facilities design plan is prepared for the landfill site if the landfill is estimated to generate 1,000 tonnes or more of methane in the calendar year immediately preceding the calendar year of the assessment.

Under the Landfill Gas Management Regulation, landfills with greater than 100,000 tonnes of waste in place must complete a landfill gas generation assessment. An initial landfill gas assessment was completed as part of the 1995 landfill Operations and Closure Plan (AGRA, 1995) which concluded a landfill gas recovery and management system was not required.

An updated landfill gas generation assessment was completed as part of the development of this DOCP. The BC MOECCS LFG Generation Estimate Tool was used. The calculation tool estimates the annual methane production in tonnes per year based on user inputs including the amount of waste in place, broken down to relatively inert, moderately decomposable, and decomposable waste. Methane generation rates and precipitation data are other input parameters used in the model, which is based on a first-order decay model.

The annual methane production was estimated since inception at year 1974 to 2023. Additionally, the tool also estimates methane production over the next 5 years.

Key assumptions included in the model are as follows:

- Start of landfilling in 1974 with a constant annual amount of 5,000 tonnes per year.
- Total waste in place in year preceding 2023 – 245,467 tonnes. Refer to Section 3.1.
- Breakdown of decomposability of waste (total 5000 tonnes per year) from 1974 to 2019:
  - 1,500 tonnes relatively inert (30%)
  - 1,500 tonnes moderately inert (30%)
  - 2,000 tonnes decomposable (40%)
- Waste composition from 2020 onwards assumed to be only inert waste at 1,000 tonnes per year.
- Gas production potential, L_0:
  - Relatively inert = 20 m^3 CH_4/tonne
  - Moderately decomposable = 120 m^3 CH_4/tonne
  - Decomposable = 160 m^3 CH_4/tonne
- Methane Generation Rate, k
  - Relatively inert = 0.02 $year^{-1}$
  - Moderately decomposable = 0.06 $year^{-1}$
  - Decomposable = 0.09 $year^{-1}$

The estimated methane production is shown in Figure 9 below. The methane generation is below the 1,000 tonnes BC regulatory threshold and the peak of methane production is estimated at 323

tonnes in the year of 2020, which is well below 1,000 tonnes of methane produced in each calendar year.

Environment and Climate Change Canada (ECCC) is developing regulations under the Canadian Environmental Protection Act to reduce methane emissions from MSW landfills. The proposed regulatory objectives identify a methane generation threshold of 664 tonnes that would trigger the requirement for an active landfill gas collection and control system (or field testing to demonstrate methane generation below this threshold). This ECCC threshold is shown on Figure 9 below as a reference.

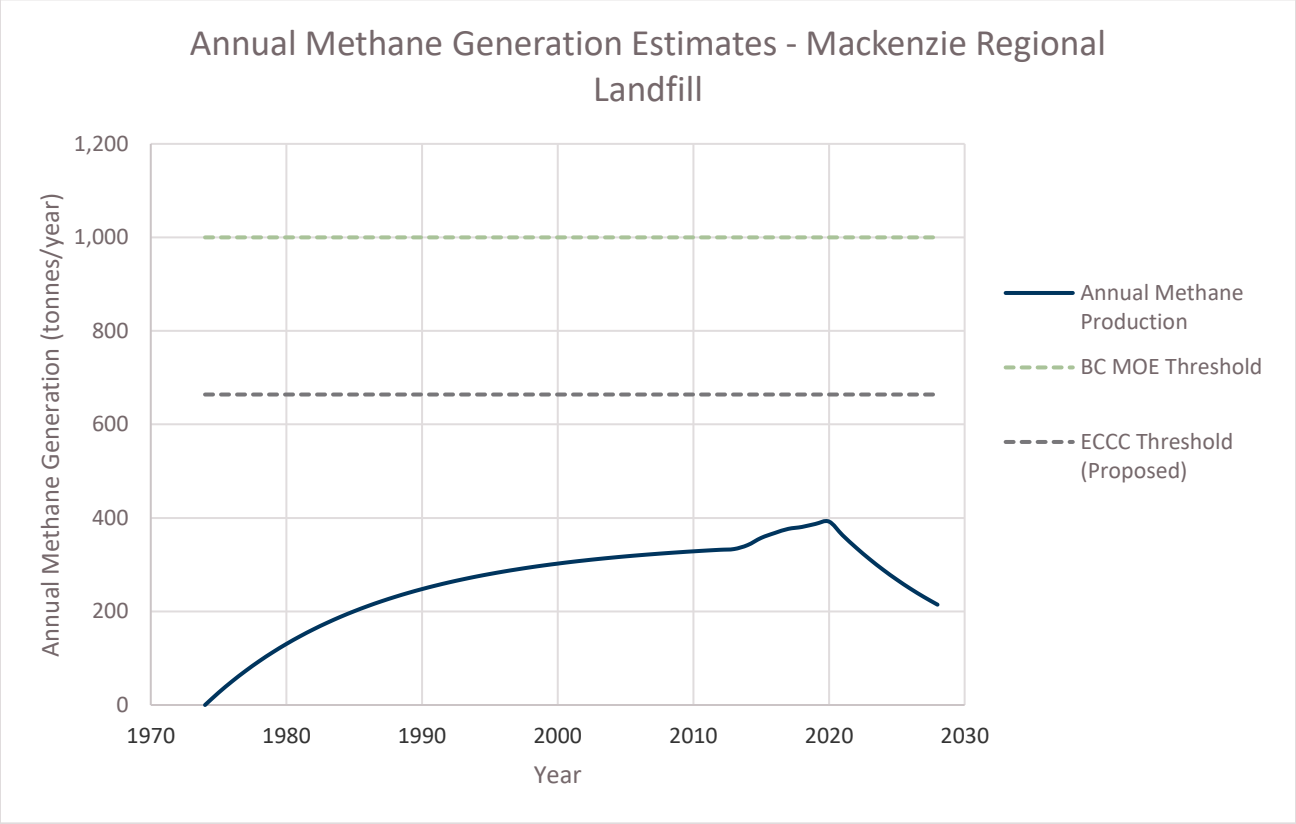


Figure 9: Annual Methane Generation Estimates – Mackenzie Regional Landfill

As shown in the graph above, the methane production peaked in 2020 at 392 tonnes. It is estimated to decrease significantly once the landfill transitioned to only accepting C&D waste (inert waste). Methane generation is expected to steadily decrease from year 2020 onwards due to only C&D waste being landfilled. LFG generation over the next five years is forecasted to drop significantly from 336 to 231 tonnes of methane annually from years 2022 to 2027, assuming a constant 1,000 tonnes of C&D waste landfilled per year.

The estimated methane gas generation is well below the BC MOECCS and proposed ECCC thresholds that would trigger the requirement to actively collect LFG at the Mackenzie Regional Landfill.

Assuming the landfill continues to only accept inert C&D at small quantities, the decreasing amount of methane generated at the Mackenzie Regional Landfill will reduce the environmental impacts and safety risks related to methane and fugitive emissions at the Site. Strategies to minimize methane generation through operational practices and the potential to reduce fugitive emissions through closure design are discussed in other sections of this report.

9. CLIMATE CHANGE CONSIDERATIONS

The effects of climate change on landfill closure activities have been considered at a high-level in this assessment.

9.1 Anticipated Future Climate

Climate change projections present a picture of the future weather patterns. The following are the changes to Mackenzie's weather anticipated over the next 50 years:

- Mean temperatures are predicted to increase for all seasons.
- Wetter throughout the year. Precipitation is predicted to increase for all seasons.
- The number of very hot days (Days where the maximum temperature exceeds 30℃) are predicted to increase.
- Fewer cold days.
- The number of very cold days (Days where the minimum temperature is below -30℃) are predicted to decrease.
- Length of Frost-Free season is predicted to increase.
- Much Longer Growing Season

The table below shows the anticipated changes to key climate patterns. Two time periods are presented; the 2050's are representative for landfills to be closed in the near future and the 2080's is applicable for landfills anticipated to be closed in 50 years time (applicable to the Mackenzie Regional Landfill).

Table 10: Anticipated Changes to Key Climate Patterns

Variable	Time Period (1976-2005)	Time Period (2021-2050)	Time Period (2051-2080)
Precipitation (mm) Annual	653	697	746
Mean Temperature (℃) Annual	0.7	2.7	4.7
Very Hot Days (+30℃) (Days)	1	2	7

Very Cold Days (-30℃) (Days)	10	5	2
Frost Free Season (Days)	93	122	147

Climate forecasts for the Pine Pass region was used as the representative location for data selection. Data is derived using Representative Concentration Pathway (RCP) 8.5 High Emissions Scenario from The Climate Atlas of Canada.

There is very little risk for the Mackenzie Regional Select Waste Landfill to be affected by climate change in the next 50 years. However, to plan for climate change in the future, the RDFFG will have to implement strategies to mitigate any damages that may be due to the climate change. The strategies and considerations are further explained in the next section.

9.2 Consideration of Climate Change on Landfill Closure

The overall resilience of the project to climate change is relatively high. While there are some potential impacts to consider, such as increased precipitation affecting surface water management during closure and post closure, the proposed landfill closures appear relatively resilient when facing climate change.

A wetter and warmer climate will result in slightly increased methane and leachate production. However, this will not materially impact closure and post closure costs. The following considerations have been included in the closure and post closure cost estimates:

- Climate change could potentially modestly impact ditch sizing and cover system design for the sites. Specifically, this may necessitate the upsizing of ditches around the Mackenzie Regional Transfer Station and Select Waste Landfill, although it is not expected to significantly affect closure costs. This should be considered in the detailed design of the site closure.
- Surface water management will be more prevalent in the future with wetter climates and more precipitation annually. Better surface water management will reduce leachate infiltration at the landfill site, thus affecting the environment less. There is not expected to be a substantial increase in cost to maintain more resilient surface water management infrastructure such as larger ditches.
- Wildfire risk may increase as forest fires have been growing more intense in the past decade due to climate change. The landfill is now only accepting C&D waste, however landfill fires will continue to be a risk that needs to be managed. Proper landfilling operations will be more important, especially when it comes to placing daily cover and load inspections.
- Post closure maintenance costs may also be influenced by climate change. With a wetter climate, there may be an increased risk of erosion, which could lead to higher annual maintenance costs to repair the erosion issues. Post closure maintenance costs have been increased moderately to account for this.

The Mackenzie Regional Select Waste Landfill site faces specific climate change risks, including increased precipitation and intense wildfires. As part of the preparation of a detailed Closure Plan, MH recommends conducting a climate change risk assessment on closure activities. This assessment should include the associated costs, such as incorporating a budget allowance of approximately $5,000 to $10,000 specifically for addressing climate change impacts during the closure phase. By considering these potential impacts and allocating appropriate resources, the site closure can be more climate change resilient.

Overall, climate change is neither likely to significantly change closure planning nor affect closure costs severely. Minor adjustment to closure costs has been included to account for climate change effects on closure. Because this landfill is relatively small, remote and generally passive, the landfill appears to be relatively resilient to climate change.

9.3 Contingency Disposal due to Climate Change

The Mackenzie Regional Landfill is considered a contingency disposal facility in the event the region's primary disposal facility (the Foothills Boulevard Regional Landfill) becomes unavailable to accept waste or if additional disposal capacity is needed. This could be due to an extreme weather event caused by climate change.

This potential scenario was considered in this DOCP primarily through ensuring the final landfill contour design provides sufficient capacity based the current waste tonnages being received at the landfill but also by ensuring the landfill has additional capacity available to accept waste quantities greater than the forecasted amounts (refer to Section 3).

9.4 Opportunities for Emission Reductions Associated with Landfill Closure

Landfill closure presents significant opportunities for emissions reductions by reducing harmful greenhouse gasses released from decomposing waste. Final closures can reduce the rate of greenhouse gas production. With careful planning and timely landfill closure, it is possible to reduce the carbon footprint of the waste sites.

Greenhouse gas emissions associated with the closure of the site is primarily the landfill gas release from the sites after closure. There will also be emissions created by heavy equipment, transportation of soil and earthworks during closure. Finally, there will be minor emissions associated with post-closure monitoring and inspection travel.

The key means of emissions reduction during closure is the mitigation of methane gas. Maximizing the diversion of water from the landfill and exploring biocover opportunities can help oxidize methane to carbon dioxide and reduce methane release into the atmosphere. A biocover can greatly reduce the global warming potential of the landfill gas because carbon dioxide is a much less potent greenhouse gas than methane. Since this landfill site is considered too small for active gas flaring, alternative approaches such as biocovers should be considered. The cost and effectiveness of implementing biocovers should be reviewed as part of the development of a detailed Closure Plan. Furthermore, incorporating tree planting initiatives as part of site closure and

reclamation can also be another tool to remove carbon and contribute to emissions reduction efforts.

During closure activities themselves, there are generally limited opportunities for reducing the carbon emissions of the closure. However, there still are potential strategies to minimize emissions during this phase.

During closure, one approach is to focus on reducing emissions associated with heavy machinery and earthworks. This can be achieved through efficient design practices, such as conservative sizing, and incorporating specifications in tender documents that promote reduced fuel usage and minimize idling. Another consideration is the utilization of low carbon vehicles and equipment to further reduce emissions. Lastly, the use of locally sourced soils and/or organic materials can be a low carbon solution for closure activities.

The Mackenzie Regional Select Waste Landfill has been accepting concrete to be landfilled. However, the concrete is currently being stockpiled, away from the active face to the northeast of the landfill for temporary storage to be crushed and used for road use. MH supports the crushing of the concrete blocks to smaller pieces to be used as part of road construction.

10. ENVIRONMENTAL MONITORING PLAN

A preliminary Environmental Monitoring Plan (EMP) is provided in this section with consideration to the monitoring requirements in the Operational Certificate, the requirements specified in the landfill criteria, and the results from the groundwater monitoring program to date.

The EMP, including the applicable water quality criteria, should be reviewed and updated following the installation of additional groundwater monitoring wells along the property boundary and after a hydrogeological assessment has been completed.

10.1 Current Groundwater Monitoring Program

Three groundwater monitoring wells (TH-1, TH-2 and TH-3) were first installed at the site in 1994 as part of the development of the original interim operations plan (Agra, 1995). TH-1 was destroyed by equipment around 2001. Two additional groundwater monitoring wells (TH-4 and TH-5) were added in 2012. Until Spring 2019, the long-term monitoring program consisted of four groundwater monitoring wells located along the southern, eastern, and southwestern perimeters of the landfill. In July 2019, an additional background monitoring well (TH-6) was installed on the northern portion of the landfill to replace the previously destroyed TH-1. Groundwater monitoring is currently completed twice per year, in accordance with the Operational Certificate.

There is currently two upgradient monitoring wells (TH-3 and TH-4), two down gradient monitoring wells (TH-2 and TH-5), and one cross gradient well (TH-6). The groundwater well locations are shown on Figure 2. Based on the Spring and Fall 2022 groundwater elevations, it is inferred that there is a strong west/southwest gradient in the groundwater flow direction. This is found to be consistent with previous interpretations of groundwater flow direction in the preceding years.

10.1.1 Water Use and Potential Receptors

The Landfill Criteria recommends identifying current and planned future uses of groundwater and surface water within 1 km of the landfill footprint. As identified in the 2022 Annual Groundwater Monitoring Report (SNC-Lavalin, 2023), the closest water wells are located approximately 1.3 km northwest of the landfill.

According to SNC-Lavalin, based on review of the MOECC Strategy Protocol 21, Water Use Determination, the site-specific factor “groundwater used for drinking water” is considered applicable in the 2023 reporting year. Additionally, the landfill is located approximately 300 m northwest of two lakes, Tom and Eunice Lakes.

However, the drinking water wells are farther than 1 km northwest of the site and it is considered unlikely that the landfill will affect those well’s water quality considering both the distance and the fact that they are cross-gradient from the landfill. The two nearby lakes (Tom and Eunice) appear to be upgradient of the landfill and thus also are unlikely to be affected. The most likely receptor is the wetland complex approximately 900 m west of the site, across the highway.

MH recommends reassessing the potential receptors and current and planned future uses of groundwater and surface water as part of a Hydrogeological Assessment for the site. The Hydrogeological Assessment should include hydraulic conductivity testing to assess the applicability of the CSR Drinking Water standards.

10.1.2 Applicable Water Quality Standards

Because Tom and Eunice Lakes are located approximately 300 m south of the landfill, the 2022 Annual Groundwater Monitoring Report (SNC-Lavalin, 2022) concludes the applicable groundwater standards for the landfill are the CSR Drinking Water (DW) and Aquatic Life (AW) standards for groundwater discharging to surface water used by freshwater aquatic life at the landfill.

MH recommends continuing to apply the CSR Drinking Water (DW) and Aquatic Life (AW) standards until a Hydrogeological Assessment is completed. As noted above, the two lakes (Tom and Eunice) appear to be upgradient of the landfill and therefore unlikely to be affected. The Hydrogeological Assessment should include an assessment of hydraulic gradient and flow direction with consideration to nearby receptors. The applicable water quality standards should be reassessed as part of the Hydrogeological Assessment.

10.1.3 Recommended Groundwater Monitoring Plan

The groundwater monitoring plan recommended in this section is considered preliminary and should be reviewed as part of the Hydrogeological Assessment.

Groundwater quality monitoring should be continued at the Site twice per year. The samples should be collected once in the spring and once in the late summer to assess seasonal variability in water levels and water quality.

Water levels should be recorded and samples should be analyzed for the parameters shown in Table 11.

Table 11: Recommended List of Landfill Monitoring Parameters

Analysis	Rationale	Minimum List of Parameters	
Dissolved Metals[2]	Major cations in groundwater and indicators of potential landfill operation related impacts. *NOTE: field filtration with 0.45 um filter to remove sediment required. Samples must be preserved after filtration.*	▪ Arsenic ▪ Cadmium ▪ Cobalt ▪ Copper ▪ Calcium ▪ Iron	▪ Lead ▪ Magnesium ▪ Manganese ▪ Potassium ▪ Selenium ▪ Sodium
General Chemistry	Primary indicators of potential landfill related impacts. Includes major anions. *NOTE: all groundwater should be field filtered unless noted otherwise*	▪ Ammonia ▪ Alkalinity ▪ Hardness ▪ Chloride ▪ Laboratory pH	▪ Laboratory conductivity ▪ Sulphate ▪ Nitrate ▪ Nitrite
Field Measurements	Important observations of physical conditions. Also, some parameters change with time and must be measured immediately. *NOTE: all field equipment must be adequately decontaminated between sampling location to prevent cross-contamination*	▪ Water level/depth to water ▪ pH	▪ Temperature ▪ Conductivity
Other Parameters	Miscellaneous other parameters related to human impacts.	▪ Dissolved Organic Carbon (DOC) *(unfiltered)*	▪ LEPH/HEPH (including PAH)

MH recommends monitoring hydrocarbons (LEPH/HEPH + VOCs) twice a year for 2 years. If there are no significant detections of hydrocarbons, the monitoring frequency can be reduced to once every 3 to 5 years.

10.2 Current Surface Water Monitoring

Surface water is currently not being monitored at the landfill site. However the Operational Certificate indicates that the surface water at the property must not exceed concentrations set in the BC Approved Water Quality Guidelines and Working Quality Guidelines.

Considering the landfill is only accepting inert C&D waste, the contributions from surface water from the landfill site to existing bodies of water within a 1 km radius of the landfill is considered low.

[2] Most analytical laboratories provide packages for these parameters. Ensure that the minimum parameters list is included in the selected analytical package.

A long-term surface water monitoring plan has historically not been considered warranted (AGRA, 1995). However, the need for a long-term surface water monitoring plan should be considered in developing the work plan for the Hydrogeological Assessment. This could include a one-time surface water sampling event from nearby surface water bodies or at the ditch discharge locations off-site on the south side of the property to assess potential impacts to surface water. The results would determine the need to incorporate surface water quality monitoring in the EMP.

10.3 Groundwater Quality

This section provides a summary of groundwater quality results based on a cursory review of available annual groundwater monitoring reports (SNC 2023, 2021, 2020, 2019, AMEC 2010).

There are two background sampling locations, namely TH-4 and TH-3, upgradient of the landfill, with the groundwater flow direction being west/southwestward beneath the landfill. Background samples provide a reference point that indicates the natural groundwater quality outside the potential zone of influence from the landfill.

Background samples from TH-4 and TH-3 showed consistent results of low levels of chloride (<0.5 to 4 mg/L), which is typically used as a leachate indicator for any MSW landfill site. TH-2 and TH-5, on the other hand, showed higher elevations of chloride concentrations (between 7 and 40 mg/L) and extremely high ammonia (greater than 10000 ug/L) as both are located downgradient of the landfill. TH-6, however, is a new well that was installed in 2019 to the north of the landfill and indicates low levels of chloride concentrations, indicating that the groundwater at TH-6 location is not affected by the landfill.

The groundwater quality data showed that there are elevated levels of dissolved lithium at certain wells, namely TH-2, TH-3, TH-4, and TH-5. Dissolved lithium concentrations were found to be elevated since 2016 and is found in both the upgradient and downgradient wells. Because it is found in the background wells, the elevated lithium concentrations are not likely related to landfill operations.

Concentrations of dissolved Arsenic, Barium, Cobalt, and Copper exceed the Contaminated Site Regulation Drinking Water Standard in the downgradient wells. Thus, these metal concentrations are likely waste management related.

Ammonia is the key contaminant of concern at MSW landfills. The upgradient wells (TH 3 & 4) have ammonia ranging from less than 5 µg/L in TH 4 to up to 180 µg/L at highest (in 2021 and 2022) in TH 3. Concentrations of ammonia at downgradient wells (TH-2 and TH-5) are consistently high, ranging from 8,620 µg/L (between pH 8.0 to 8.5) to 21,800 µg/L (for less than pH 7.0) and exceed the Aquatic Life standards. The nearest receptor is the wetland complex 900 m west of the site.

Based on slightly elevated ammonia and chloride concentrations at TH-3, there may be some historical effects from cross-gradient flow/run off at TH-3, however the effects are significantly lower than the downgradient impacted wells (TH-2 and TH-5).

To assess the potential offsite impacts, it is recommended that a set of three monitoring wells be installed along the downgradient property boundary to assess groundwater quality leaving the site. Information from these wells should be used to prepare a Hydrogeological Assessment for the site, including consideration of potential environmental receptors of concern. These wells should be

added to the routine monitoring program to assess site impacts on groundwater at the property boundary with consideration to the applicable standards.

10.4 Post-Closure Environmental Monitoring and Maintenance

As per the BC Landfill Criteria, post-closure monitoring is required for a minimum period of 30 years after final landfill closure, which is considered the minimum contaminating lifespan of the landfill. As part of the detailed Closure Plan, the contaminating lifespan of the landfill should be determined using the latest updated environmental monitoring information.

Post-closure operation and maintenance activities should also be included in the detailed Closure Plan.

As summarized in the BC Landfill Criteria, the post-closure operation and maintenance program includes, but is not limited to:

- Maintenance of the final cover including vegetation and repair of damage due to erosion, leachate breakouts, slope failures, settlement, and burrowing animals.
- Operation and maintenance of surface water management works, including repairs due to settlement.
- General site maintenance including maintenance of access roads and fencing.
- Operation and maintenance of landfill gas management facilities (passive venting pipes), including repairs to infrastructure damage by settlement.
- An environmental monitoring program to be carried out during the contaminating lifespan (a minimum of 30 years after final closure).
- Practical and implementable contingency measures to address any failure of the works or non-compliance with the performance criteria.

Groundwater monitoring should continue into the post-closure as outlined in Section 10.1. It is likely that the bi-annual environmental monitoring will be required for at least 10 years, after which monitoring frequency can be reduced. Environmental monitoring program reductions may be determined by the MOECCS.

MH recommends completing general maintenance inspections on a bi-annual basis for the first three years of the post-closure period. After three years the inspection frequency should be reassessed based on the inspection results and revegetation of the site, unless otherwise required under future permits or requirements set out by the MOECCS.

Annual reports documenting the general maintenance inspections and environmental monitoring results are to be prepared and submitted to the MOECCS.

10.5 Landfill Gas Monitoring

It is understood that landfill gas (LFG) has not been monitored at the Mackenzie Regional Landfill. Based on the current annual landfilled tonnages and the characteristics of the landfilled waste (inert C&D waste), LFG generation is relatively low and expected to decrease in the future.

The Mackenzie Regional Landfill is located on highly permeable granular soils and there is currently no known continuous low permeable layer that would encourage lateral landfill gas movement. Once final cover is placed on the landfill, the risk of lateral gas migration increases as the low permeability cover encourages landfill gas to move laterally, unless passive landfill gas wells are installed.

Enclosed spaces are potentially at risk of landfill gas migration. With the recent construction of the transfer building, scale house, and share shed these buildings are potentially at risk of landfill gas migration. However, it is understood all buildings are constructed at grade with concrete slabs with no basements therefore the risk is considered low. To assess potential lateral LFG migration, it is recommended that a one-time landfill gas migration monitoring event is conducted along the toe of the slope at the west face of the landfill, adjacent to the transfer building. Soil vapour probes should be installed and monitored for any indications of lateral LFG movement.

The on-site scale house, transfer building and other enclosed buildings should be equipped with methane gas sensors that notify occupants when methane concentrations reaches 20 percent of the lower explosive limit of methane (1% by volume).

Landfill gas monitoring should be conducted for three years following landfill closure. If soil vapour sampling indicates LFG is within acceptable concentrations for the duration of the monitoring period, landfill gas monitoring will not be required after three years. However, a new landfill gas monitoring plan will be required if gas emission exceedances are encountered in the three year monitoring period following landfill closure.

11. CONTAMINATING LIFESPAN

Contaminating lifespan means the period of time during which the landfilled waste has the potential to produce effluent or air contaminants, as defined in the Environmental Management Act, including at least 30 years after installation of final cover over the entire landfill footprint. At a minimum, the contaminating lifespan is assumed to be at least 30 years when determining the requirements for post-closure operation and maintenance and the amount of financial security required for the landfill site.

As outlined in Section 3.1, the estimated waste in place as of 2023 is roughly 251,000 tonnes. Assuming filling continues in the primary landfill disposal area as outlined in this DOCP, an additional 55,000 tonnes of waste will be placed over the next 59 years for a total of 306,000 tonnes of waste in place when filled to the design capacity. This does not include additional waste placed in the contingency disposal area.

According to the Landfill Criteria, under Section 8.3 Post-Closure Period, because the landfill has more than 100,000 tonnes of MSW in place but less than 1,000,000 tonnes of MSW in place, a contaminating lifespan of 100 years is recommended in the absence of an assessment of the contaminating lifespan by a QP.

MH recommends that a technical analysis of the expected contaminating lifespan be completed by a QP as part of the Hydrogeological Assessment. Factors that should be considered as part of the assessment include trends in groundwater quality and the projected waste quantities expected to be landfilled in the future. The amount of waste landfilled over the next 59 years is expected to be significantly less than historical waste tonnages. Furthermore, the characteristics of the waste (relatively inert C&D waste) is expected to be different than the characteristics of historical waste (MSW). These factors should be considered in the assessment and determination of the contaminating lifespan.

12. RECOMMENDATIONS

Based on the findings from MH's site visit in August 2023, review of current operations and as a part of the development of this DOCP, recommended projects to support site development and closure, and recommendations to address current operational challenges are provided below:

- The existing operational certificate 100206 (issued March 4, 2009) has not been updated since the Mackenzie Regional Landfill transitioned to only accepting C&D waste in 2019 and does not reflect the current facility operations or the new transfer station facilities. MH recommends that the RDFFG consider applying for an amendment to the OC to reflect the changes to facility operations, including an update to the types of waste materials accepted for transfer and disposal at the site. The updated OC should reference the latest DOCP, including any contingency disposal plans specified in the DOCP.
- The final contour landfill is designed within the primary disposal area to minimize the footprint in which future waste is placed. To minimize future closure costs and landfill liability, landfilling should not extend beyond the primary landfill disposal area.
- To conserve soil from the borrow area, the current practice of applying cover three to four times during Spring and Summer (approximately every 3 weeks) and approximately two times during the Fall and Winter (approximately every 6 to 8 weeks) should continue. Because the landfill is only accepting C&D waste, cover can be applied less frequently however it is recommended that the size of the active face be a maximum of 10 m by 10 m to minimize leachate generation and potential operational issues such as wind blown litter and vectors.
- A comparison of soil consumption from the borrow pit suggests some of the soil use over the last three years has been related to projects at the landfill such as road construction not related to landfill cover. MH recommends using the soil sparingly for covering waste as needed and only for construction projects authorized by the RDFFG. A minimum waste to soil cover ratio (by volume) of 3:1 is recommended. To assess the landfill contactor's soil usage, we recommend developing a methodology to track the amount of soil used for cover during the reporting year. Annual surveys of the borrow area provides information on the total soil used at the site however more detailed tracking is required as the contractor uses soil for other projects including road construction.
- When placing cover, the operations contractor should be targeting a soil cover thickness of 150 mm and no greater than 300 mm for intermediate cover.
- To reduce closure costs, MH recommends that yard and garden waste continue to be collected, stockpiled and chipped. Before filling in Phase 4 starts, options to use the material should be assessed including potentially blending the material to be used for progressive closure of final landfill slopes.
- To reduce leachate generation and to spread the closure cost over the life of the landfill, MH recommends placing final cover on finished side slopes along the west and south sides of the landfill and as each Phase is completed. Progressive closure could be considered at the start of Phase 4 in approximately 12 years when side slopes have reached design grades on all sides of the landfill and utilizing and/or relocating the yard waste/compost piles will need to be considered.

- Though this DOCP includes the required elements of a closure plan, MH recommends a separate detailed Closure Plan be developed closer to anticipated closure date. Progressive closure of the primary landfill disposal area may be initiated at the end of Phase 3 in approximately 15 years based on the current fill rate.
- It is recommended that all operators and managers responsible for overseeing or working at the Site complete the Solid Waste Association of North America's (SWANA's) Manager of Landfill Operations (MOLO) course and/or Landfill Operations Basics (LOB) course or similar. Training should be renewed at least once every five years.
- It is understood that landfill gas (LFG) has not been monitored at the Mackenzie Regional Landfill. Enclosed spaces are potentially at risk of landfill gas migration. Therefore, it is recommended that landfill gas migration monitoring is conducted along the toe of the slope along the west side of the landfill, adjacent to the transfer station and scale house. Soil vapour probes should be installed and monitored for any indications of lateral LFG movement.
- Groundwater quality at the west license of occupation boundary needs to be determined. To assess the potential offsite impacts, it is recommended that a set of three monitoring wells be installed along the downgradient (west) property boundary to assess groundwater quality leaving the site. Once property-line groundwater monitoring wells are established, a Hydrogeological Assessment should be completed to evaluate potential for off-site water quality effects.
- Since filling is not planned in the historic landfill area, MH recommends that closure planning be initiated with the objective to close the historic landfill area within the next five years. Benefits to closing this area include a reduction in the landfill liability and a reduction in leachate generation.
- To inform closure planning and refine closure cost estimates, the quantity and quality of the soil available in the clay borrow area should be assessed. The hydraulic conductivity should be compared to the minimum requirements as outlined in this DOCP. The quantity of available clay should also be compared to the amount required for closure (estimated in this DOCP).
- While the amount of waste landfilled at the site has significantly decreased since 2019, the transition to a C&D waste landfill may introduce additional fire risks. C&D landfills are generally considered to be at a higher risk of landfill fires, due to the nature of the material (low moisture content and highly combustible). A preliminary Fire Safety Plan & Emergency Response Plan is included in this DOCP however the plan should be reviewed with RDFFG staff and the landfill operations contractor to ensure the fire risks and prevention measures are understood, and input from all parties is incorporated into the Plans.
- To increase waste diversion at the facility, opportunities to divert and beneficially use C&D materials that are currently being landfilled should be explored. It is understood that concrete is currently being diverted and used in landfill operations. Opportunities to divert other materials such as clean wood waste and asphalt should be explored with a focus on beneficial use options at the landfill or within the community.

- This DOCP should be reviewed and updated as needed at least once every five years with a focus on key assumptions such as fill rates and waste density calculations, airspace consumption, soil usage and lifespan projections.

13. REFERENCES

Agra Earth & Environmental, 1995.The Mackenzie Landfill Operations and Closure Plan.

AMEC Earth & Environmental, May 18, 2011. 2010 Annual Groundwater Monitoring Report Mackenzie Regional Landfill.

BC Ministry of Environment and Climate Change, June 2016. Landfill Criteria for Municipal Solid Waste.

Dillon Consulting, August 8, 2022. 2022 Volume Assessment – Mackenzie Regional Landfill.

Dillon Consulting, July 28, 2023. 2023 Volume Assessment – Mackenzie Regional Landfill.

McElhanney, December 10, 2018. Geotechnical Assessment for the Proposed Mackenzie Transfer Station

MWA Environmental Consultants Ltd & XCG Consultants Ltd., 2015. 2015 Regional Solid Waste Management Plan.

Prairie Climate Centre (2019). Climate Atlas of Canada, version 2 (July 10, 2019). https://climateatlas.ca

Regional District of Fraser-Fort George, 2022. Mackenzie Regional Landfill 2021 Annual Report.

Regional District of Fraser-Fort George, 2021. Mackenzie Regional Landfill 2020 Annual Report.

SNC-Lavalin, April 28, 2023. 2022 Annual Groundwater Monitoring Report.

SNC-Lavalin, March 17, 2023. 2021 Annual Groundwater Monitoring Report.

SNC-Lavalin, April 13, 2021. 2020 Annual Groundwater Monitoring Report.

SNC-Lavalin, March 30, 2020. 2019 Annual Groundwater Monitoring Report.

SNC-Lavalin, May 9, 2019. 2018 Annual Groundwater Monitoring Report.

Tetra Tech, June 15, 2021. Regional District of Fraser-Fort George 2021 Landfill Airspace Volume Assessment – Mackenzie Regional Landfill Technical Memo.

Tri Environmental Consulting Inc., July 31, 2018. 2018 Waste Characterization Study, Regional District of Fraser-Fort George.

14. CLOSURE

The Regional District of Fraser-Fort George retained Morrison Hershfield to conduct the work described in this report, and this report has been prepared solely for this purpose.

This document, the information it contains, the information and basis on which it relies, and factors associated with implementation of suggestions contained in this report are subject to changes that are beyond the control of the author. The information provided by others is believed to be accurate and may not have been verified.

Morrison Hershfield does not accept responsibility for the use of this report for any purpose other than that stated above and does not accept responsibility to any third party for the use, in whole or in part, of the contents of this document. This report should be understood in its entirety, since sections taken out of context could lead to misinterpretation.

We trust the information presented in this report meets Client's requirements. If you have any questions or need addition details, please do not hesitate to contact one of the undersigned.

Morrison Hershfield Limited

Prepared by:

[redacted] **Eng.**
Solid Waste Engineer
cjung@morrisonhershfield.com

[redacted]
Apr 15, 2024
PTP# 1001424

[redacted]

Forest Pearson, P.Eng.
Geological Engineer
FPearson@morrisonhershfield.com

Reviewed By:

[redacted]

Derek Stevens, P.Eng.
Senior Waste Engineer
DStevens@morrisonhershfield.com

APPENDIX A: Operational Certificate #100206, issued March 4, 2009

PROVINCE OF
BRITISH COLUMBIA

MINISTRY OF ENVIRONMENT

OPERATIONAL CERTIFICATE
100206

Under the Provisions of the Environmental Management Act
and In accordance with the
Regional District of Fraser-Fort George
Solid Waste Management Plan

Regional District of Fraser-Fort George

155 George Street

Prince George, British Columbia

V2L 1P8

is authorised to manage recyclable material and municipal solid waste at a sanitary landfill located 4.2 km south of Mackenzie, British Columbia, subject to the conditions listed below. Contravention of any of these conditions is a violation of the *Environmental Management Act* and may result in prosecution.

1. LOCATION OF AUTHORISED FACILITY

The location of the facility for the management of recyclable material and municipal solid wastes to which this Operational Certificate is applicable is the **Mackenzie Regional Landfill**, covering all unsurveyed Crown Land in the vicinity of District Lot 3458, Cariboo District, containing 16.73 hectares, more or less. The Crown Licence of Occupation for the site is #705356.

2. ENTRANCE FACILITIES

The authorised facility includes recyclable material and municipal solid waste drop-off facilities, weigh scales and related appurtenances approximately as shown on attached Site Plan A.

3. MANAGEMENT OF MUNICIPAL SOLID WASTE

3.1. Sanitary Landfill

3.1.1. The authorised facilities are a sanitary landfill area, recyclable material storage areas and related appurtenances approximately as shown on the attached Site Plan. The site reference number for the discharge is E211576.

[redacted]

Del Reinheimer, P.Eng.
for Director, Environmental Management Act

Date Issued: MAR 0 4 2009

3.1.2. The characteristics of the discharge must be municipal solid waste as defined under the *Environmental Management Act* and other wastes as approved in writing by the Director.

3.1.3. Waste may be discharged to the areas specified in the Regional District's Design and Operation Plan, approximately located as shown on attached Site Plan A.

4. GENERAL REQUIREMENTS

4.1. Qualified Professionals

All facilities and information, including works, plans, assessments, investigations, surveys, programs and reports, must be certified by qualified professionals.

4.2. Plans

4.2.1. The Regional District shall prepare a Design and Operation Plan that will include considerations for site operation, development and closure, leachate and landfill gas management, composting operations, monitoring programs and environmental impact mitigation management.

The Design and Operation Plan must be submitted to the Director by May 15, 2009.

4.2.2. The Design and Operation Plan must address, but not be limited to, each of the subsections in the *Landfill Criteria for Municipal Solid Waste* including performance, siting, design, operational and closure and post-closure criteria.

4.2.3. The facilities must be developed and operated in accordance with the Design and Operation Plan.

4.2.4. Any updates to the plan shall be immediately submitted to the Director.

4.3. Additional Facilities or Works

The Director may require investigations, surveys, and the construction of additional facilities or works. The Director may also amend information requirements of this Operational Certificate including plans, programs, assessments and reports.

[redacted]

Date Issued: MAR 0 4 2009

Del Reinheimer, P.Eng.
for Director, Environmental Management Act

5. OPERATIONAL REQUIREMENTS

5.1. Non-Compliance Reporting

The Regional District shall immediately notify the Regional Manager, Environmental Protection, or designate by facsimile (250-565-6629) of any non-compliance with the requirements of this Operational Certificate and take appropriate remedial action.

Written confirmation of all non-compliance events, including available test results, is required by facsimile within 24 hours of the original notification unless otherwise directed by the Regional Manager, Environmental Protection.

5.2. Operator Training and Development

At a minimum, the Regional District will ensure that operating personnel are trained to industry standards and current in a SWANA recognized landfill operator course or equivalent.

5.3. Electric Fencing

Areas where putrescible materials are stored or discharged shall be surrounded by an electric fence.

5.3.1. Design, Construction and Maintenance

The electric fencing shall be designed, constructed, and maintained such that bears are prevented from penetrating the fence. The Director shall be advised of any modifications to the fence.

5.3.2. Operating Period

The electric fence shall be fully operational during the period of April 15 to November 15 inclusive each year. If snow is present during this period, any electrified strands above snow line shall be isolated from the remainder of the system and energised. The Director may vary the operating period with prior written authorisation.

5.3.3. Record Keeping and Reporting

The Regional District is required to monitor wildlife (medium and large camivores) activity at the facility and keep records of occurrences and observations of wildlife (medium and large carnivores).

[redacted]

Del Reinheimer, P.Eng.
for Director, Environmental Management Act

Date Issued: MAR 0 4 2009

5.4. Compost

Composting facilities shall be operated and maintained in accordance with the *Organic Matter Recycling Regulation.*

5.5. Landfill Gas

Landfill gas shall be managed in accordance with the *Landfill Gas Management Regulation.*

5.6. Leachate

The characteristics of the surface water and groundwater at the property boundary must not exceed concentrations set in the *British Columbia Approved Water Quality Guidelines (Criteria)* and *A Compendium of Working Water Quality Guidelines for British Columbia.* Where natural background water quality concentrations exceed the aforementioned guidelines, characteristics of the surface water and groundwater at the property boundary must not exceed background concentrations.

6. HAZARDOUS WASTE MANAGEMENT

6.1. Hazardous Waste

"Hazardous Wastes" as defined by the *Hazardous Waste Regulation* pursuant to the *Environmental Management Act* are prohibited from disposal unless expressly authorised by the *Hazardous Waste Regulation*, approved by the Director or as specified in the Operational Certificate.

6.2. Waste Asbestos

Waste asbestos is authorized for disposal subject to compliance with the requirements of section 40 of the *Hazardous Waste Regulation* and the following conditions:

6.2.1. The asbestos waste may not be mixed with any other hazardous waste.

6.2.2. The Regional District must approve the disposal before disposal takes place.

6.2.3. All other applicable requirements of the *Hazardous Waste Regulation*, including but limited to manifesting and waste record keeping, must also be complied with.

[redacted]

Date Issued: MAR 0 4 2009

Del Reinheimer, P.Eng.
for Director, Environmental Management Act

6.3. Handling of Impacted Soil

The *Environmental Management Act*, the *Contaminated Sites Regulation* and the *Hazardous Waste Regulation* are applicable for the disposal of impacted (contaminated) soil at the facility.

6.4. Hazardous Wastes from Accidental Spills or Abandonment

Hazardous wastes resulting from accidental spills or abandonment of dangerous goods may be accepted at the facility only under the authority of Section 52(1) of the *Hazardous Waste Regulation*.

7. MONITORING

7.1. Monitoring Program

7.1.1. A monitoring program shall be developed by a qualified professional to identify potential impacts to the environment and public health from the facility.

7.1.2. The monitoring program shall be submitted as part of the Design and Operation Plan.

7.1.3. The monitoring program must address, but not be limited to, subsections 4.1, 4.2 and 7.15 of the *Landfill Criteria for Municipal Solid Waste* and the *Guidelines for Environmental Monitoring at Municipal Solid Landfills*.

7.1.4. Monitoring must be conducted in accordance with the monitoring program.

8. REPORTING

All reports and drawings shall be submitted in electronic format unless otherwise requested by the Director.

8.1. Drawings

All drawings shall be certified correct and sealed by a qualified professional. Drawings shall be submitted to the Director within 30 days of completion or as otherwise specified by the Director.

8.2. Annual Report

The Regional District shall submit an Annual Report to the Director on or before June 30 each year for the previous calendar year.

[redacted]

Del Reinheimer, P.Eng.
for Director, Environmental Management Act

Date Issued: MAR 04 2009

The report shall contain, but not be limited to the following information:

i.) an executive summary;

ii.) the type and tonnage of waste received, recycled and landfilled for the year;

iii.) a current topographic map detailing airspace consumption, on-site borrow pit changes and future developments;

iv.) updated estimates for the remaining capacity, closure date for the current phase and closure date for the current landfill footprint;

v.) any new information or proposed changes relating to the facilities and Design and Operation Plan;

vi.) composting operation activity including amount of material received for composting, material composted, material sold and number of composting cycles;

vii.) occurrences or observations of wildlife (medium and large carnivores) at the facility;

viii.) a statement regarding the facility's progress in reducing the regional solid waste stream, in accordance with the hierarchy of reduce, reuse and recycle principles; and,

ix.) the results of all monitoring programs as specified in this Operational Certificate. Data interpretation and comparison to the performance criteria in the *Landfill Criteria for Municipal Solid Waste* and the *Guidelines for Environmental Monitoring and Municipal Solid Waste Landfills*. Trend analysis, as well as an evaluation of the impacts of the discharges on the receiving environment in the previous year shall be carried out by a qualified professional.

9. CLOSURE PLAN

At least one year in advance of decommissioning the landfill, or as otherwise specified by the Director, a Closure Plan shall be submitted which includes at least the following information:

i) a topographic plan showing the final elevations contours of the landfill and surface water diversion and drainage controls;

ii) specifications for the final cap and proposed end use of the site; and,

[redacted]

Date Issued: MAR 0 4 2009

[redacted]: Del Reinheimer, P.Eng.
for Director, Environmental Management Act

iii) provisions for a minimum 25 year post-closure care period at the facility which, at a minimum, considers the following: groundwater monitoring, surface water monitoring, landfill gas management, erosion and settlement monitoring and management.

10. CLOSURE AND POST-CLOSURE FUND

The Regional District will conform to the Public Sector Accounting and Auditing Board's requirements (PS 3270) to recognize solid waste landfill closure and post-closure liability. The Regional District will develop a plan to ensure that sufficient funds are available for closure and post-closure care work.

[redacted]

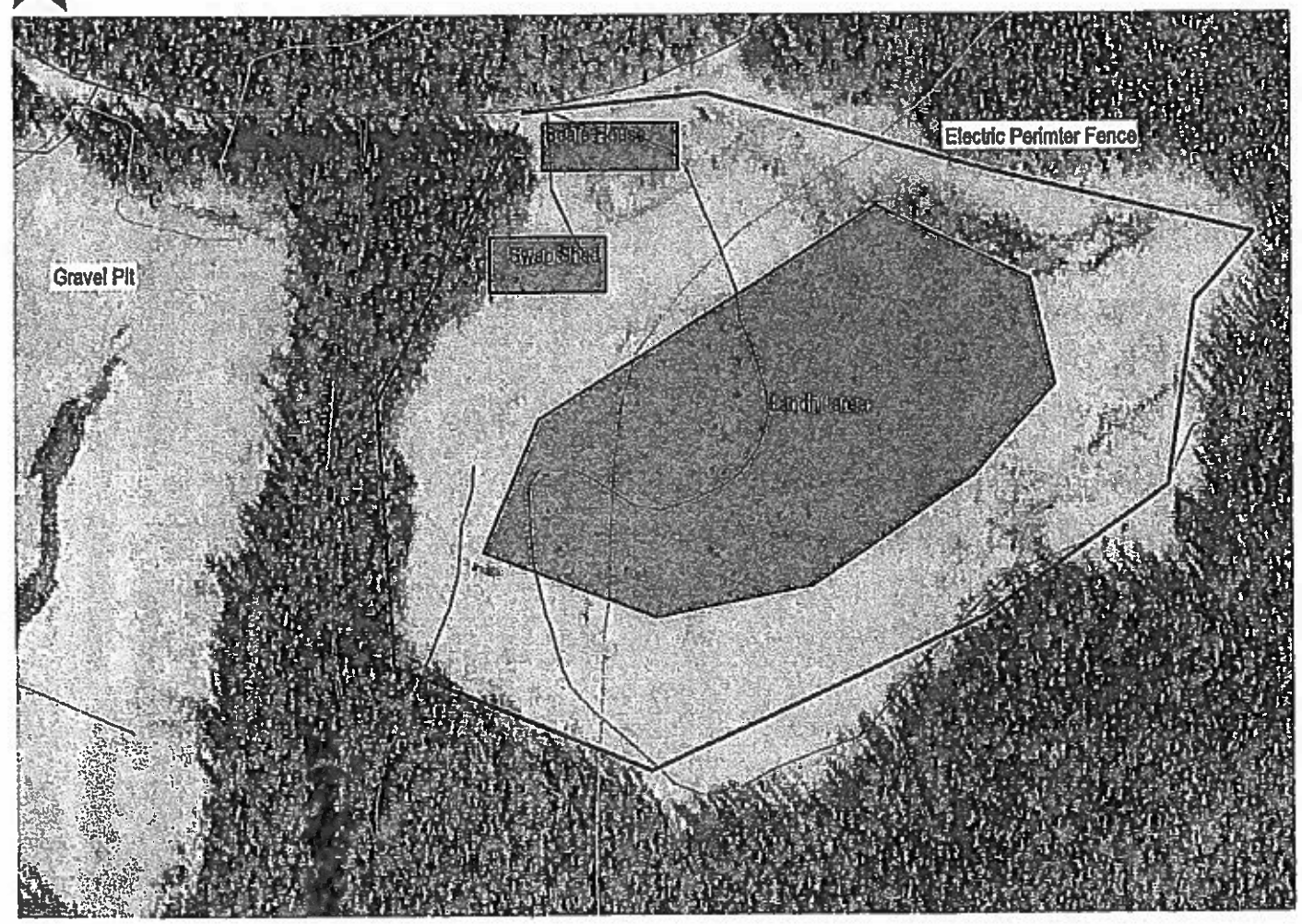
Date Issued: MAR 0 4 2009

Del Rehnheimer, P.Eng.
for Director, Environmental Management Act

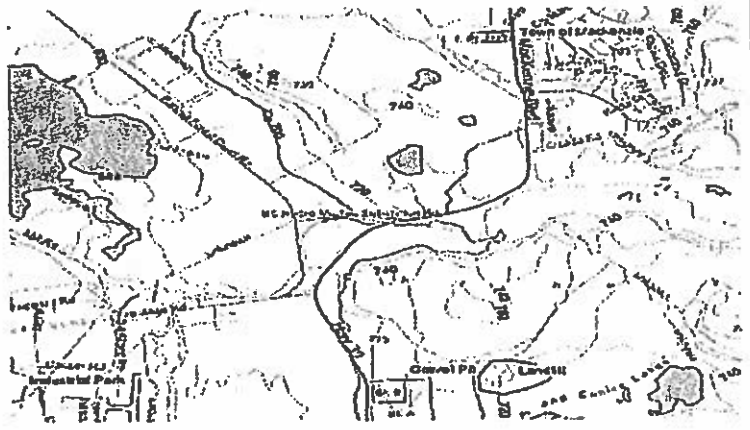
PROVINCE OF
BRITISH COLUMBIA

Environmental Protection

SITE PLAN A



Location Map



Not to Scale

Operational Certificate 100206

Date: MAR 0 4 2009

[redacted]

Del Reinheimer, P.Eng.
for Director, *Environmental Management Act*
Omineca and Peace Regions

APPENDIX B: Geotechnical Assessment for the Proposed Mackenzie Transfer Station

To	From
Mr. Mircea Cvaci Sperling Hansen Associates	Melissa Chappel Ph.D., P.Eng.
On Behalf of	**MCSL Branch**
McElhanney Consulting Services Ltd.	Prince George
Re	**Date**
Geotechnical Assessment for the Proposed Mackenzie Transfer Station	December 10, 2018
	File Number
	2341-02565-00

1. INTRODUCTION

McElhanney Consulting Services Ltd. (McElhanney) is pleased to submit this technical memorandum report to Sperling Hansen Associates (the Client) summarizing the geotechnical assessment and recommendations for the proposed Mackenzie Transfer Station located near Mackenzie, BC.

Authorization to proceed was provided by the final client, Ms. Petra Wildauer of the Regional District of Fraser-Fort George via Mr. Cvaci, via email on September 4, 2018. This letter report is subject to the appended Statement of Limitations – Geotechnical Services.

In conducting the geotechnical assessment and submitting this report, McElhanney has:

- Completed a desktop review of publicly available data including surficial geology, bedrock, water resources, seismic hazard, GIS, etc.;
- Conducted a site visit assessment to observe the general site conditions including equipment access;
- Performed a field assessment including thirteen (13) boreholes;
- Completed a laboratory testing on select soil samples; and,
- Prepared this report summarizing the results of the geotechnical assessment and preliminary geotechnical recommendations for the design and construction of the proposed development.

2. SITE DESCRIPTION

The proposed transfer station “the Site” will be located adjacent to the west side of the existing Mackenzie landfill. The landfill which is operated by the Regional District of Fraser-Fort George (RDFFG) is located approximately 3 km south of Mackenzie on Dump Road on RDFFG land previously used as a gravel pit. The landfill receives used oil, oil filters and containers, antifreeze, lead acid batteries, and household batteries. In addition to large quantities of yard and garden waste as well as scrap metal, demolition, land clearing and construction (DLC) waste. The Site is confined by steep sand and gravel slopes to the south and west, the landfill to the east, and Dump Road to the north (Figure 1).

Figure 1- Site Overview (Google Earth image, 2018)

3. SOIL AND GROUNDWATER CONDITIONS

Historically the geology on the east side of the south end of Williston Lake is glacial drift overlying bedrock, consisting of gravel, sand and silt.

The geotechnical field assessment was carried out on September 17, 2018, and comprised thirteen (13) boreholes, with locations depicted in the site plan found in Attachment A. The boreholes were drilled by Geotech Drilling Services Ltd. of Prince George BC, to depths ranging between 0 and 6.4 m below ground surface.

The subsurface conditions encountered in each borehole were observed and recorded by a McElhanney representative. Detailed borehole logs have been included in Attachment B. The soils observed in the field were classified in accordance with the Modified Unified Classification System for Soils (MUSCS). The borehole locations were recorded using a hand-held GPS.

Upon completion of the field program, select soil samples were transported to McElhanney's laboratory for index testing including moisture content and sieve analysis. The laboratory testing results are summarized in the following section and the laboratory test reports in Attachment C.

The soils observed in all test locations can be generally classified as compact to dense, well graded sand and gravel. Poor recovery in the split spoons, combined with refusal at some locations suggests that there are occasional cobbles and/or boulders in the soil. Groundwater was not encountered in any of the boreholes. Moisture content of the native material ranged from approximately 3-6%. Based on the interpretation of the subsurface conditions encountered during

this field assessment, the preliminary soil properties provided in Table 1 are recommended for preliminary static design of the proposed structures.

Table 1 Interpreted Soil Parameters

Application	Soil Description	Unit Weight (kN/m^3)	Friction Angle (°)	Cohesion	Subgrade Modulus (kN/m^3)
Subgrade Soil	Compact to Dense Sand and Gravel	20	34	0	1.5×10^6
Retained or Reinforced soil	Engineered Fill (Section 4.6)	21	35	0	N/A

4. Recommendations

4.1 Site Preparation

The following recommendations are provided for subgrade preparation activities required for grade-supported load-bearing structures:

Remove any existing organic soil, soft, and other deleterious materials underlying load-bearing structures to expose the underlying sand subgrade soils. The suitability of the material for use as subgrade should be evaluated during subgrade preparation by a qualified geotechnical engineer to assess the type and quantity of deleterious materials that might be present within this soil unit. Note that the subsurface conditions may change in locations not explicitly investigated and/or may vary due to activities carried out at the Site following the field assessment. The thickness of unsuitable materials in areas not assessed by McElhanney due to limited access should be confirmed during site preparation activities.

All prepared subgrades should be inspected in the field by a Geotechnical Engineer or their representative to confirm that the subgrade conditions are consistent with the design conditions assumed in this report. The exposed subgrade should be proof-rolled using either a fully-loaded tandem truck or a single-drum compaction roller under the direction of McElhanney or their representative to identify any loose areas before placement of any Engineered Fill or grade-supported building foundations.

Subject to field review at the time of construction, approved subgrade of any sub-excavations within the proposed development limits should be backfilled to design subgrade elevation with approved granular materials in accordance with material selection, placement and compaction specifications for Engineered Fill, as defined in Section 4.6 below.

General non-structural site grading fills that may be required to raise local site grades beyond the building site limits should consist of approved common fill comprising clean inorganic granular materials from approved local or imported sources. Subject to surface grading, drainage and settlement tolerances required for site grading design, common fill materials may be placed in uniform layers not exceeding 300 mm thickness and compacted to a minimum of 95% Standard Proctor Maximum Dry Density (SPMDD) unless otherwise specified in this report. Topsoil and deleterious materials are considered to be unsuitable on which to place load-bearing structures and should be removed from the foundation areas of any proposed buildings or gravel yard or road structures.

4.2 Site Drainage

It is necessary to control surface water run-off and to minimize infiltration in areas with silty subgrade. The subgrade surface for the Site should be shaped to prevent ponding of water and prepared as recommended above.

The finished grades should provide surface drainage away from all structures. Within 2 m of structures, the exterior should be graded to slope away from the structure at a sufficient gradient; a gradient of 2% should be used wherever possible. Positive surface drainage across the yard should be established to prevent ponding. Recommended minimum grades of 2% should be used on gravel surfaced areas, where possible. The subgrade may require capping to prevent infiltration into the existing foundation.

4.3 Groundwater

Groundwater seepage could be encountered during construction due to seasonal variation and/or during a wetter construction season, therefore there is the potential for perched groundwater conditions due to varying subsurface soil materials. Construction plans should include means and methods to control and remove groundwater infiltration from all excavations if encountered.

4.4 Temporary Excavations

To protect any adjacent infrastructure during construction, and to allow for safe worker access, temporary excavation slopes shall be constructed as per the most current applicable British Columbia Occupational Health & Safety Code. For planning purposes, it is recommended that temporary excavation slopes be sloped no steeper than 1.5 Horizontal to 1.0 Vertical (1.5H:1.0V) within areas of fine-grained sands. Flatter slopes or other temporary support measures may be required if significant seepage or groundwater inflow conditions are encountered. Steeper temporary slopes of up to 1.0H:1.0V may be considered in shallow excavations based on conditions encountered during construction. If steeper slopes or slopes greater than 6 m are to be considered, or poor/saturated soil conditions are encountered, a Geotechnical Engineer should be consulted to review.

4.5 Seismic Site Classification

Seismic site classification according to the 2015 National Building Code of Canada (NBCC) requires soil characterization of the upper 30 m of the soil profile. It is noted that the maximum depth of investigation at the Site was 6.4 m below ground surface. Based on the findings of the drilling program and our understanding of the geological history and surficial geology in the area, the Site is classified as Site Class D “Stiff Soil” for seismic design purposes.

4.6 Engineered Fill

Any fill soil placed to support structural elements of the development shall be considered Engineered Fill. Recommendations for material quality and placement of Engineered Fill are summarized as follows:

Engineered Fill should consist of well-graded sand and gravel with less than 5% fines (material passing the 0.075 mm sieve) and a maximum aggregate size not exceeding 75 mm. Any granular materials proposed for use as Engineered Fill should be tested and approved by the Geotechnical Engineer before placement. The gradation for Select Granular Sub Base (SGSB) in Table 2 (Section 4.7) is an approved gradation for Engineered Fill.

Engineered Fill should be placed on prepared subgrade surfaces (Section 4.1) consisting of inorganic soils and approved by the Geotechnical Engineer before fill placement.

Engineered Fill used to support load-bearing structures, utilities, or any other component that may be settlement-sensitive should be compacted to a minimum of 100% SPMDD. For the gravel yard structure, Engineered Fill should be

compacted to a minimum of 98% SPMDD with the upper 300 mm compacted to 100% SPMDD. In landscaped areas or other areas where the risk of differential and/or total settlement greater than 25 mm may be acceptable, Engineered Fill may be compacted to a minimum of 95% SPMDD.

Engineered Fill should be placed in horizontal lifts to a maximum loose thickness not exceeding 300 mm or less, dependent on the compaction equipment utilized. Engineered Fill should be placed at moisture conditions within 3% of the optimum moisture content as determined by a Standard Proctor Moisture-Density Test (ASTM D698).

Engineered Fill areas should extend from the proposed foundation at a minimum of a two horizontal to one vertical (2H:1V) slope starting at least 3 m (horizontally) from the foundation to allow for the distribution of stresses and to provide frost protection.

Continuous Quality Control and Quality Assurance (QC/QA) compaction testing and construction reviews should be performed by the Geotechnical Engineer's representative or a qualified testing agency during placement of all Engineered Fill to verify compliance with the above recommendations.

4.7 Gravel Yard and Access Road Surfacing Recommendations

Gravel yard recommendations are based on the sand and gravel encountered in the boreholes. There are two possible approaches to the construction of the gravel access road and yard:

- apply a minimum 150 mm of crushed base course (CBC referred to in Table 2) over the native soil. The finished surface should be compacted to 100% SPMDD; or
- use the native sand and gravel and grade as necessary. For areas that are sandy, this option would require significant maintenance and is not recommended.

The finished surface for either option should have a 2% slope from the center of the road to the shoulder.

Table 2 Recommended Gradation of CBC and SGSB

Sieve Size (mm)	Percent Passing (%)	
	CBC	SGSB
100	-	100
75	-	-
25	100	-
19	80-100	15-100
9.5	50-85	0-100
4.75	35-70	-
2.36	25-50	-
1.18	15-35	-
0.60	-	0-100
0.30	5-20	0-15
0.075	0-5	0-5

4.8 Spread Footings

Strip and square footings are considered feasible for the proposed development, provided that the footings are placed on the native soil or on Engineered Fill placed on the native soils. Subgrade preparation and Engineered Fill placement must be as outlined in this report. The subgrade bearing surfaces for all foundation construction must be inspected and approved by the Geotechnical Engineer or their representative before placing formwork.

Based on proposed shallow foundations and expected subsurface conditions, bearing pressures for the design depth of 1.2 m are provided in Table 3 below.

Table 3 Summary of Factored Bearing Capacity for depth of 1.2 m

Subgrade Soil	Minimum Width of Foundation (m)	Net Bearing Capacity (kPa)[1]	
		Factored ULS [(2)]	SLS [(3)]
Compact to Dense Sand and Gravel	1	400	400
	3	500	250

1. Canadian Foundation Engineering Manual, 4th Edition, Canadian Geotechnical Society, Bitech Publishing Ltd., Richmond, BC.
2. ULS - Ultimate Limit State, based on semi-empirical data and calculated using a geotechnical resistance factor of 0.5.
3. SLS – Serviceability Limit State, based on SPT data gathered in the field investigation, valid for settlements less than 25 mm

To ensure a uniform stress distribution, the entire foundation must be constructed on a uniform bearing surface. A 150 mm leveling course of 25 mm crushed base course meeting compacted to 100% SPMDD should be placed below foundation elements if required to provide a level uniform surface on prepared subgrade. Crushed Base Course should conform to the gradation specification provided for well graded base in Table 2 (Section 4.7).

Groundwater seepage and/or surface water runoff must not be allowed to enter or collect in foundation excavations. Any water or snow that accumulates in the footing excavations must be removed and subgrade allowed to dry before construction of the footings.

A perimeter sub-drain pipe consisting of minimum 100 mm PVC SDR 28 or 35 perforated pipe, sloped at minimum 1%, should be installed along the outside perimeter of the building foundations at or below the foundation grade to collect any groundwater seepage and help maintain unsaturated soil conditions at the foundation level. The sub-drain should consist of perforated pipe, with perforations located at 4 and 8 o'clock, surrounded by free draining drain rock and wrapped by a non-woven filter fabric to minimize soil contamination and clogging of the drain rock material. The perimeter drain pipe should be allowed to collect, transport, and discharge groundwater seepage to an appropriately designed frost-free outfall.

4.9 Slab-on-Grade

The following recommendations are provided for grade support floor slabs construction:

- Subgrades should be prepared as recommended in Section 4.1 with any unsuitable subgrade material being removed and replaced with Engineered Fill due to the risk of differential settlement of any loose, deleterious or compressible materials.
- A minimum of 150 mm thick CBC layer should be placed below the underside of the floor slab before concrete placement; the gradation should conform to the specifications provided above in Table 2. The base course should be compacted to a minimum 100% SPMDD.
- A heavy-duty vapour barrier should be provided on the underside of the floor slab.

4.10 Frost Protection

Concrete foundations must not be placed on frozen soils, and soils beneath the foundation should not be allowed to freeze during or after construction; therefore, the foundation subgrade must be protected from freezing during and after construction. Concrete foundations should be protected from freezing, and proper curing conditions should be provided as per Canadian Standard Association (CSA) concrete specifications. Footings founded above the frost depth must be protected using insulation. Frost depth and Insulation requirements are discussed below.

The potential presence of silt in the native soils encountered at the Site cause the soil to be considered to be potentially frost-susceptible. If frost is permitted to penetrate, there is a risk of heaving and frost action on the concrete slab or footings. Frost must not be allowed to penetrate beneath footings prior to, during, or after construction. If the building is constructed during freezing conditions, the subgrade soil at the design footing elevation must be protected from freezing. Foundation concrete should be cured in appropriate conditions as per Canadian Standards Association specifications (CSA A23.1-14).

To reduce the potential for frost heave, foundations in soil should be provided with a minimum cover of 2.5 m. Alternatively, for the design depth of 1.2 m, for an unheated structure, it is recommended to have 100mm of insulation placed at a minimum depth of 0.3 m below the ground surface. Based on the design freezing index for the closest station to Mackenzie (Chetwynd Airport) and the Site conditions, the insulation should be extended to a minimum horizontal distance of at least 2.44 m for unheated structures, per Figure 13.11 of the Canadian Foundation Engineering Manual 4th Edition. The adjacent finished grade should be designed with a gradient of at least 2% over a horizontal distance of 2 m to direct surface water away from the building.

4.11 Concrete Block Retaining Wall

Concrete block retaining walls are considered suitable at the Site. In order to accommodate and reduce the potential for differential movement and achieve an appropriate drainage surface, a 200 mm thick layer of CBC compacted to 100% SPMDD is to be constructed under the footprint of the wall.

Infill material shall be SGSB or free draining imported granular soils as approved by the Engineer. Unsuitable soils for backfill (poor quality fills, soil with organics or greater than 5% fines) shall not be used in the reinforced soil mass.

Drainage should be provided behind the wall to prevent hydrostatic pressure. Retaining wall design should be reviewed by a Geotechnical Engineer, specifically the global stability should be modeled.

5. DESIGN AND CONSTRUCTION REVIEW

Once a final detailed foundation design has been prepared, it is recommended that the design be reviewed by McElhanney to verify that the geotechnical recommendations have been included in the final design.

To issue applicable Building Code Schedules and/or construction QA/QC letters, all foundation, backfill and Engineered Fill subgrade must be reviewed by the geotechnical engineer as specified in this report. McElhanney can provide these construction reviews as well as material testing services during construction if requested.

6. CLOSURE

We trust this report submission meets your requirements for the project. Should you have any queries, please do not hesitate to contact the undersigned.

Sincerely,

McElhanney Consulting Services Ltd.

Prepared By:

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
Dr. M. J. CHAPPEL
41245

[redacted]

Dec 10/18

Reviewed By:

[redacted]

Melissa Chappel, P.Eng.
Geotechnical Engineer
mchappel@mcelhanney.com

Shiloh Carlson, P.Eng.
Geotechnical Division Manager
scarlson@mcelhanney.com

Statement of Limitations – Geotechnical Services

Attachment A: Site Plan

Attachment B: Borehole Logs

Attachment C: Laboratory Reports

Statement of Limitations – Geotechnical Services

Use of this Report. This report was prepared by McElhanney Consulting Services Ltd. ("**McElhanney**") for the particular site, design objective, development and purpose (the "**Project**") described in this report and for the exclusive use of the client identified in this report (the "**Client**"). The data, interpretations, and recommendations pertain to the Project and are not applicable to any other project or site location, and this report may not be reproduced, used or relied upon, in whole or in part, by a party other than the Client, without the prior written consent of McElhanney. The Client may provide copies of this report to its affiliates, contractors, subcontractors and regulatory authorities for use in relation to and in connection with the Project provided that any reliance, unauthorized use, and/or decisions made based on the information contained within this report are at the sole risk of such parties. McElhanney will not be responsible for the use of this report on projects other than the Project, where this report or the contents hereof have been modified without McElhanney's consent, to the extent that the content is in the nature of an opinion, and if the report is preliminary or draft. This is a technical report and is not a legal representation or interpretation of laws, rules, regulations, or policies of governmental agencies. The professional services retained for this Project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in this report. In particular, environmental conditions such as surface and subsurface contamination are outside the scope of this report.

Standard of Care and Disclaimer of Warranties. This study and report have been prepared in accordance with generally accepted engineering and scientific judgments, principles and practices. McElhanney expressly disclaims any and all warranties in connection with this report including, without limitation, any warranty that this report and the associated site review work has uncovered all potential geotechnical liabilities associated with the subject property.

Effect of Changes. All evaluations and conclusions stated in this report are based on facts, observations, site-specific details, legislation and regulations as they existed at the time of the site assessment. Some conditions are subject to change over time, and the Client recognizes that the passage of time, natural occurrences, and direct or indirect human intervention at or near the site may substantially alter such evaluations and conclusions. Construction activities can significantly alter soil, rock and other geologic conditions on the site. McElhanney should be requested to re-evaluate the conclusions of this report and to provide amendments as required prior to any reliance upon the information presented herein upon any of the following events: a) any changes (or possible changes) as to the site, purpose, or development plans upon which this report was based, b) any changes to applicable laws subsequent to the issuance of the report, c) new information is discovered in the future during site excavations, construction, building demolition or other activities, or d) additional subsurface assessments or testing conducted by others.

Subsurface Risks. Soil, rock and groundwater data were collected in general accordance with the standards and methods described in the document. The classification and identification of soils, rocks, and geologic formations was based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Interpretations of groundwater levels and flow direction are based on water level observations at selected test hole locations and are expected to fluctuate. Observations at test holes indicate the approximate subsurface conditions at those locations only. Subsurface conditions between test holes were based, by necessity, on judgement and assumptions of what exists between the actual locations sampled and may vary significantly from actual site conditions and all persons making use of this report should be aware of, and accept this risk. Even a comprehensive sampling and testing program, implemented in accordance with appropriate

equipment by experienced personnel, may fail to detect all or certain conditions.

Information from Client and Third Parties. McElhanney has relied in good faith on information provided by the Client and third parties noted in this report and has assumed such information to be accurate, complete, reliable, non-fringing, and fit for the intended purpose without independent verification. McElhanney accepts no responsibility for any deficiency, misstatements or inaccuracy contained in this report as a result of omissions or errors in information provided by third parties or for omissions, misstatements or fraudulent acts of persons interviewed.

Underground Utilities and Damages. In the performance of the services, McElhanney has taken reasonable precautions to avoid damage or injury to subterranean structures or utilities. Subsurface sampling may result in unavoidable contamination of certain subsurface areas not known to be previously contaminated such as, but not limited to, a geologic formation, the groundwater or other hydrous body. McElhanney will adhere to an appropriate standard of care during the conduct of any subsurface sampling.

Independent Judgments. McElhanney will not be responsible for the independent conclusions, interpretations, interpolations and/or decisions of the Client, or others, who may come into possession of this report, or any part thereof. This restriction of liability includes decisions made to purchase, finance or sell land or with respect to public offerings for the sale of securities.

Construction. The subsurface information contained in this report were obtained for the owner's information and design. The extent and detail of assessments necessary to determine all relevant conditions that may affect construction costs would normally be greater than the assessments carried out for this report. Accordingly, a contingency fund to allow for the possibility of variations of subsurface conditions should be included in the construction budget to cover costs associated with modifications of the design and construction procedures resulting from conditions that vary from the assumptions in this report. If during construction, subsurface conditions are found to be other than those described in this report, McElhanney is to be notified and may alter or modify the geotechnical report recommendations. If McElhanney is not retained to provide services during construction, then McElhanney is not responsible for confirming or recording that subsurface conditions do not materially differ from those interpreted conditions contained in this report or for confirming or recording that construction activities have not adversely affected subsurface conditions or the recommendations contained in this report.

ATTACHMENT A: SITE PLAN

Map By: KKlazek Date: 10/24/2018 Document Path: H:\PROJ\23k\12500-25950\565-00 RDFEG - Full Service Transfer Station\7.0 Survey & Mapping\7.8 GIS\7.8.2 MXD\8.5 x11_GeotechAssessmentMackenzieTransferStation_KK_10232018.mxd Coordinate System: NAD 1983 UTM Zone 10N Projection: Transverse Mercator

McElhanney
McElhanney Consulting Services Ltd.
12-556 North Nechako Road
Prince George, BC Canada V2K 1A1
Tel. 250 561 2229

SPERLING HANSEN ASSOCIATES
MACKENZIE, BC

GEOTECHNICAL ASSESSMENT FOR THE
MACKENZIE TRANSFER STATION
SITE PLAN

0 25 50 100
Metres
ORIGINAL SIZE: LETTER (8.5" X 11") 1:2,500

Drawing No. 01

Project No. 2341-02565-00

Rev. 01

ATTACHMENT B: BOREHOLE LOGS

McElhanney Consulting Services Ltd.
12-556 North Nechako Road
Prince George, BC V2K 1A1
Telephone: 250-561-2229

BH18-01

CLIENT Regional District Fraser Fort George
PROJECT NAME Mackenzie Transfer Station
PROJECT NUMBER 2341-02565-00
PROJECT LOCATION Mackenzie Regional Landfill
DATE STARTED 9/17/18 **COMPLETED** 9/17/18
GROUND ELEVATION 733 m MASL **HOLE SIZE**
DRILLING CONTRACTOR Geotech Drilling Ltd.
GROUND WATER LEVELS:
DRILLING METHOD Odex - Truck-mounted
AT TIME OF DRILLING ---
LOGGED BY T.Garden **CHECKED BY**
AT END OF DRILLING ---
NOTES Weather: Cool and overcast
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
	GB S01	100		MC=5%		SAND, some gravel, some silt, well graded, trace cobbles (150mm), subrounded to subangular, inferred compact, massive, brown, moist
2	SPT S02	38	5-13-13-13 (26)	MC=4%		- at 1.5m, compact -Wash sieve (S01b): 17% gravel, 72% sand, 11% fines
4	SPT S03	55	16-20-19-17 (39)	MC=5%		4.30 728.70 GRAVEL and SAND, trace silt, well graded, coarse to fine gravel, subrounded,dense, massive, grey, moist
6	SPT S04	60	10-15-16-17 (31)	MC=6%		6.40 726.60

Groundwater not encountered.
Backfilled with drill cuttings and bentonite from 0.0m-1.0m and 5.4m-6.4m.
Bottom of borehole at 6.40 meters.

McElhanney Consulting Services Ltd.
12-556 North Nechako Road
Prince George, BC V2K 1A1
Telephone: 250-561-2229

BH18-02

CLIENT Regional District Fraser Fort George
PROJECT NAME Mackenzie Transfer Station
PROJECT NUMBER 2341-02565-00
PROJECT LOCATION Mackenzie Regional Landfill
DATE STARTED 9/17/18 **COMPLETED** 9/17/18
GROUND ELEVATION 731 m MASL **HOLE SIZE**
DRILLING CONTRACTOR Geotech Drilling Ltd.
GROUND WATER LEVELS:
DRILLING METHOD Odex - Truck-mounted
AT TIME OF DRILLING ---
LOGGED BY T.Garden **CHECKED BY**
AT END OF DRILLING ---
NOTES Weather: Cool and overcast
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
	GB S01	100		MC= 3%		SAND and GRAVEL, trace silt, well graded, trace cobbles (150 mm), subrounded, inferred compact, massive, brown, moist
2	SPT S02	60	9-10-10-10 (20)	MC= 3%		- at 1.5m, compact
	SPT S03	60	8-12-12-12 (24)	MC= 0%		3.66 727.34

Groundwater not encountered.
Backfilled with drill cuttings and bentonite from 0.0m-1.0m and 2.66m-3.66m.
Bottom of borehole at 3.66 meters.

McElhanney Consulting Services Ltd.
12-556 North Nechako Road
Prince George, BC V2K 1A1
Telephone: 250-561-2229

BH18-03

CLIENT Regional District Fraser Fort George
PROJECT NAME Mackenzie Transfer Station
PROJECT NUMBER 2341-02565-00
PROJECT LOCATION Mackenzie Regional Landfill
DATE STARTED 9/17/18 **COMPLETED** 9/17/18
GROUND ELEVATION 732 m MASL **HOLE SIZE**
DRILLING CONTRACTOR Geotech Drilling Ltd.
GROUND WATER LEVELS:
DRILLING METHOD Odex - Truck-mounted
AT TIME OF DRILLING ---
LOGGED BY T.Garden **CHECKED BY**
AT END OF DRILLING ---
NOTES Weather: Cool and overcast
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
	GB S01	100		MC= 3%		SAND and GRAVEL, trace silt, well graded, trace cobbles (200mm), subrounded, massive, brown, moist
2	SPT S02	51	18-26-17-29 (43)	MC= 3%		- at 1.52m, dense
						3.05 728.95
	SPT S03	21	23-28-32-24 (60)	MC= 1%		GRAVEL, some sand, trace silt, well graded, coarse to fine gravel, subrounded, very dense, massive, moist, brown
						3.66 728.34

Groundwater not encountered.
Backfilled with drill cuttings and bentonite from 0.0m-1.0m and 2.66m-3.66m.
Bottom of borehole at 3.66 meters.

McElhanney Consulting Services Ltd.
12-556 North Nechako Road
Prince George, BC V2K 1A1
Telephone: 250-561-2229

BH18-04

CLIENT Regional District Fraser Fort George
PROJECT NAME Mackenzie Transfer Station
PROJECT NUMBER 2341-02565-00
PROJECT LOCATION Mackenzie Regional Landfill
DATE STARTED 9/17/18 **COMPLETED** 9/17/18
GROUND ELEVATION 729 m MASL **HOLE SIZE**
DRILLING CONTRACTOR Geotech Drilling Ltd.
GROUND WATER LEVELS:
DRILLING METHOD Odex - Truck-mounted
AT TIME OF DRILLING ---
LOGGED BY T.Garden **CHECKED BY**
AT END OF DRILLING ---
NOTES Weather: Cool and overcast
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
	GB S01	100		MC= 4%		GRAVEL and SAND, some silt, well graded, trace cobbles (150mm), subrounded, inferred compact, massive, brown, moist - Wash sieve (S01): 48% gravel, 37% sand, 15% fines.
2	SPT S02	33	12-21-24-22 (45)	MC= 3%		- at 1.52m dense
	SPT S03	33	11-15-14-13 (29)	MC= 3%		- at 3.05m compact
					3.66	725.34

Groundwater not encountered.
Backfilled with drill cuttings and bentonite from 0.0m-1.0m and 2.66m-3.66m.
Bottom of borehole at 3.66 meters.

McElhanney Consulting Services Ltd.
12-556 North Nechako Road
Prince George, BC V2K 1A1
Telephone: 250-561-2229

BH18-05

CLIENT Regional District Fraser Fort George
PROJECT NAME Mackenzie Transfer Station
PROJECT NUMBER 2341-02565-00
PROJECT LOCATION Mackenzie Regional Landfill
DATE STARTED 9/17/18 **COMPLETED** 9/17/18
GROUND ELEVATION 730 m MASL **HOLE SIZE**
DRILLING CONTRACTOR Geotech Drilling Ltd.
GROUND WATER LEVELS:
DRILLING METHOD Odex - Truck-mounted
AT TIME OF DRILLING ---
LOGGED BY T.Garden **CHECKED BY**
AT END OF DRILLING ---
NOTES Weather: Cool and overcast
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
	GB S01	100		MC= 4%		SAND and GRAVEL, trace silt, well graded, coarse to fine gravel, trace cobbles (200m), subrounded, massive, brown, moist
2	SPT S02	22	15-16-23-28 (39)	MC= 2%		- at 1.52m gravelly, dense
	SPT S03	7	15-33-41 (74)	MC= 1%		- at 3.05m, SPT refusal inferred cobble or boulder
					3.51	726.49

Groundwater not encountered.
Backfilled with drill cuttings and bentonite from 0.0m-1.0m and 2.51m-3.51m
Bottom of borehole at 3.51 meters.

McElhanney Consulting Services Ltd.
12-556 North Nechako Road
Prince George, BC V2K 1A1
Telephone: 250-561-2229

BH18-06

CLIENT Regional District Fraser Fort George
PROJECT NAME Mackenzie Transfer Station
PROJECT NUMBER 2341-02565-00
PROJECT LOCATION Mackenzie Regional Landfill
DATE STARTED 9/17/18 **COMPLETED** 9/17/18
GROUND ELEVATION 735 m MASL **HOLE SIZE**
DRILLING CONTRACTOR Geotech Drilling Ltd.
GROUND WATER LEVELS:
DRILLING METHOD Odex - Truck-mounted
AT TIME OF DRILLING ---
LOGGED BY T.Garden **CHECKED BY**
AT END OF DRILLING ---
NOTES Weather: Cool and overcast
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
	GB S01	100		MC= 4%		SAND, some gravel, trace silt, well graded, trace cobbles (150mm), subrounded, inferred compact, massive, brown, few fine rootlets, moist - Wash sieve (S01): 17% gravel, 75% sand, 8% fines
2	SPT S02	30	16-19-16-11 (35)	MC= 3%		- at 1.52m, dense
	SPT S03	55	11-14-15-23 (29)	MC= 5%		- at 3.05m, compact
					3.66	731.34

Groundwater not encountered.
Backfilled with drill cuttings and bentonite from 0.0m-1.0m and 2.66m-3.66m.
Bottom of borehole at 3.66 meters.

McElhanney Consulting Services Ltd.
12-556 North Nechako Road
Prince George, BC V2K 1A1
Telephone: 250-561-2229

BH18-07

CLIENT Regional District Fraser Fort George
PROJECT NAME Mackenzie Transfer Station
PROJECT NUMBER 2341-02565-00
PROJECT LOCATION Mackenzie Regional Landfill
DATE STARTED 9/17/18 **COMPLETED** 9/17/18
GROUND ELEVATION 735 m MASL **HOLE SIZE**
DRILLING CONTRACTOR Geotech Drilling Ltd.
GROUND WATER LEVELS:
DRILLING METHOD Odex - Truck-mounted
AT TIME OF DRILLING ---
LOGGED BY T.Garden **CHECKED BY**
AT END OF DRILLING ---
NOTES Weather: Cool and overcast
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
	GB S01	100		MC= 3%		SAND and GRAVEL, trace silt, well graded, coarse to fine gravel, trace cobbles (200mm), subrounded, inferred compact, massive, brown, moist
2	SPT S02	33	42-32-22-23 (54)	MC= 2%		- at 1.59m, subangular, very dense, grey
	SPT S03	27	39-55	MC= 2%		- at 2.59m, SPT refusal inferred cobble or boulder
4	SPT S04	50	18-24-28-27 (52)	MC= 2%		- at 4.11m, subangular, very dense, grey
6	SPT S05	55	14-18-20-24 (38)	MC= 3%		- at 5.64m, dense - at 5.7m, wash sieve (SPT05): 36% gravel, 57% sand, 7% fines.
					6.25	728.75

Groundwater not encountered.
Backfilled with drill cuttings and bentonite from 0.0m-1.0m and 5.25m-6.25m.
Bottom of borehole at 6.25 meters.

McElhanney Consulting Services Ltd.
12-556 North Nechako Road
Prince George, BC V2K 1A1
Telephone: 250-561-2229

BH18-08

CLIENT Regional District Fraser Fort George
PROJECT NAME Mackenzie Transfer Station
PROJECT NUMBER 2341-02565-00
PROJECT LOCATION Mackenzie Regional Landfill
DATE STARTED 9/18/18 **COMPLETED** 9/18/18
GROUND ELEVATION 736 m MASL **HOLE SIZE**
DRILLING CONTRACTOR Geotech Drilling Ltd.
GROUND WATER LEVELS:
DRILLING METHOD Odex - Truck-mounted
AT TIME OF DRILLING ---
LOGGED BY T.Garden **CHECKED BY**
AT END OF DRILLING ---
NOTES Weather: Cool and sunny
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
	GB S01	100		MC=4%		SAND, some gravel, trace silt, well graded, coarse to fine gravel, trace cobbles (200mm), subrounded, inferred compact, massive, brown, moist
	SPT S02	38	2-5-10-9 (15)	MC=3%		- and GRAVEL, some cobbles (150mm), subangular, compact
2						
	SPT S03	68	9-11-11-11 (22)	MC=5%		- trace cobbles, cobbles (150mm), subangular, compact, occasional cobble
4						
	SPT S04	63	13-21-18-16 (39)	MC=6%		- at 4.27m, dense
6	SPT S05	77	9-13-14-15 (27)	MC=4%	6.40	- gravelly, compact - Wash sieve (SPT05): 31% gravel, 62% sand, 7% fines. 729.60

Groundwater not encountered.
Backfilled with drill cuttings and bentonitefrom 0.0m-1.0m and 5.4m-6.4m.
Bottom of borehole at 6.40 meters.

McElhanney Consulting Services Ltd.
12-556 North Nechako Road
Prince George, BC V2K 1A1
Telephone: 250-561-2229

BH18-09

CLIENT Regional District Fraser Fort George
PROJECT NAME Mackenzie Transfer Station
PROJECT NUMBER 2341-02565-00
PROJECT LOCATION Mackenzie Regional Landfill
DATE STARTED 9/18/18 **COMPLETED** 9/18/18
GROUND ELEVATION 737 m MASL **HOLE SIZE**
DRILLING CONTRACTOR Geotech Drilling Ltd.
GROUND WATER LEVELS:
DRILLING METHOD Odex - Truck-mounted
AT TIME OF DRILLING ---
LOGGED BY T.Garden **CHECKED BY**
AT END OF DRILLING ---
NOTES Weather: Cool and sunny
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
	GB S01	100		MC= 5%		SAND and GRAVEL, trace silt, well graded, coarse to fine gravel, trace cobbles (200mm), subrounded, inferred comapct, massive, brown, moist
	SPT S02	17	12-18-21-26 (39)	MC= 3%		- at 1.22m, dense
2						2.40 734.60
	SPT S03	21	16-19-27-18 (46)	MC= 4%		SAND, trace gravel, trace silt, well graded, coarse to fine gravel, subrounded, dense, massive, brown
4						
	SPT S04	76	9-9-10-11 (19)	MC= 5%		-at 4.27m, compact
6	SPT S05	68	7-12-16-14 (28)	MC= 4%		- gravelly - at 5.57m, wash sieve (SPT05): 25% gravel, 65% sand, 10% fines. 6.40 730.60

Groundwater not encountered.
Backfilled with drill cuttings and bentonite from 0.0m-1.0m and 5.4m-6.4m.
Bottom of borehole at 6.40 meters.

McElhanney Consulting Services Ltd.
12-556 North Nechako Road
Prince George, BC V2K 1A1
Telephone: 250-561-2229

BH18-10

CLIENT Regional District Fraser Fort George
PROJECT NAME Mackenzie Transfer Station
PROJECT NUMBER 2341-02565-00
PROJECT LOCATION Mackenzie Regional Landfill
DATE STARTED 9/18/18 **COMPLETED** 9/18/18
GROUND ELEVATION 735 m MASL **HOLE SIZE**
DRILLING CONTRACTOR Geotech Drilling Ltd.
GROUND WATER LEVELS:
DRILLING METHOD Odex - Truck-mounted
AT TIME OF DRILLING ---
LOGGED BY T.Garden **CHECKED BY**
AT END OF DRILLING ---
NOTES Weather: Cool and sunny
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
	GB S01	100		MC= 3%		SAND, some gravel, trace silt, well graded, coarse to fine gravel, trace cobbles (200mm), subrounded, inferred compact, massive, moist
	SPT S02	38	10-18-17-17 (35)	MC= 3%		- at 1.22m, angular, dense
2						2.74 732.26
	SPT S03	21	25	MC= 1%		GRAVEL and SAND, well graded, coarse to fine gravel, subrounded to angular, very dense, massive, brown, moist - at 2.74m, SPT refusal inferred cobble or boulder
4						
	SPT S04	30	25-29-23-19 (52)	MC= 3%		
6	SPT S05	0	16-14-23-29 (37)	MC= 1%		- no recovery at 5.79m, inferred cobble or boulder
						6.40 728.60

Groundwater not encountered.
Backfilled with drill cuttings and bentonite from 0.0m-1.0m and 5.4m-6.4m.
Bottom of borehole at 6.40 meters.

McElhanney Consulting Services Ltd.
12-556 North Nechako Road
Prince George, BC V2K 1A1
Telephone: 250-561-2229

BH18-11

CLIENT Regional District Fraser Fort George
PROJECT NAME Mackenzie Transfer Station
PROJECT NUMBER 2341-02565-00
PROJECT LOCATION Mackenzie Regional Landfill
DATE STARTED 9/18/18 **COMPLETED** 9/18/18
GROUND ELEVATION 736 m MASL **HOLE SIZE**
DRILLING CONTRACTOR Geotech Drilling Ltd.
GROUND WATER LEVELS:
DRILLING METHOD Odex - Truck-mounted
AT TIME OF DRILLING ---
LOGGED BY T.Garden **CHECKED BY**
AT END OF DRILLING ---
NOTES Weather: Cool and sunny
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
	GB S01	100		MC= 4%		SAND, some gravel, trace silt, well graded, coarse to fine gravel, trace cobbles (200mm), subrounded, inferred compact, massive, brown, moist
	SPT S02	21	8-12-14-19 (26)	MC= 3%		- at 1.22m, rounded, compact
2						
	SPT S03	51	7-10-10-11 (20)	MC= 4%		
4						
	SPT S04	55	11-12-12-11 (24)	MC= 6%		- trace gravel - at 5.8m, wash sieve (SPT05): 6% gravel, 86% sand, 8% fines.
6	SPT S05	72	10-9-11-14 (20)	MC= 4%	6.40	729.60

Groundwater not encountered.
Backfilled with drill cuttings and bentonite from 0.0m-1.0m and 5.4m-6.4m.
Bottom of borehole at 6.40 meters.

McElhanney Consulting Services Ltd.
12-556 North Nechako Road
Prince George, BC V2K 1A1
Telephone: 250-561-2229

BH18-12

CLIENT Regional District Fraser Fort George
PROJECT NAME Mackenzie Transfer Station
PROJECT NUMBER 2341-02565-00
PROJECT LOCATION Mackenzie Regional Landfill
DATE STARTED 9/18/18 **COMPLETED** 9/18/18
GROUND ELEVATION 734 m MASL **HOLE SIZE**
DRILLING CONTRACTOR Geotech Drilling Ltd.
GROUND WATER LEVELS:
DRILLING METHOD Odex - Truck-mounted
AT TIME OF DRILLING ---
LOGGED BY T.Garden **CHECKED BY**
AT END OF DRILLING ---
NOTES Weather: Cool and sunny
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
	GB S01	100	MC= 4%		SAND, some gravel, trace silt, well graded, coarse to fine gravel, trace cobbles (200mm), subrounded, inferred compact, massive, brown, moist
2	GB S02	100	MC= 4%		
3.05					730.95

Groundwater not encountered.
Backfilled with drill cuttings and bentonite from 0m-1m and 2.05m-3.05m.
Bottom of borehole at 3.05 meters.

McElhanney Consulting Services Ltd.
12-556 North Nechako Road
Prince George, BC V2K 1A1
Telephone: 250-561-2229

BH18-13

CLIENT Regional District Fraser Fort George
PROJECT NAME Mackenzie Transfer Station
PROJECT NUMBER 2341-02565-00
PROJECT LOCATION Mackenzie Regional Landfill
DATE STARTED 9/18/18 **COMPLETED** 9/18/18
GROUND ELEVATION 732 m MASL **HOLE SIZE**
DRILLING CONTRACTOR Geotech Drilling Ltd.
GROUND WATER LEVELS:
DRILLING METHOD Odex - Truck-mounted
AT TIME OF DRILLING ---
LOGGED BY T.Garden **CHECKED BY**
AT END OF DRILLING ---
NOTES Weather: Cool and sunny
AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
	GB S01	100	MC= 3%		SAND, gravelly, trace silt, well graded, trace cobbles (150mm), subrounded, inferred compact, massive, brown, moist - at 0.5m, wash sieve (S01): 29% gravel, 63% sand, 8% fines.
2	GB S02	100	MC= 3%		
3.05					728.95

Groundwater not encountered.
Backfilled with drill cuttings and bentonite from 0.0m-1.0m and 2.05m-3.05m.
Bottom of borehole at 3.05 meters.

ATTACHMENT C: LABORATORY REPORTS

McElhanney Consulting Services Ltd.
Suite 12-556 North Nechako Rd
Prince George, BC

SIEVE ANALYSIS REPORT
8 16 30 50 SERIES

PROJECT NO. 2341-02565-00
CLIENT Sperling Hansen Associates
C.C.

TO
Sperling Hansen Associates
#8-1225 East Keith Road
North Vancouver, BC,
V7J 1J3

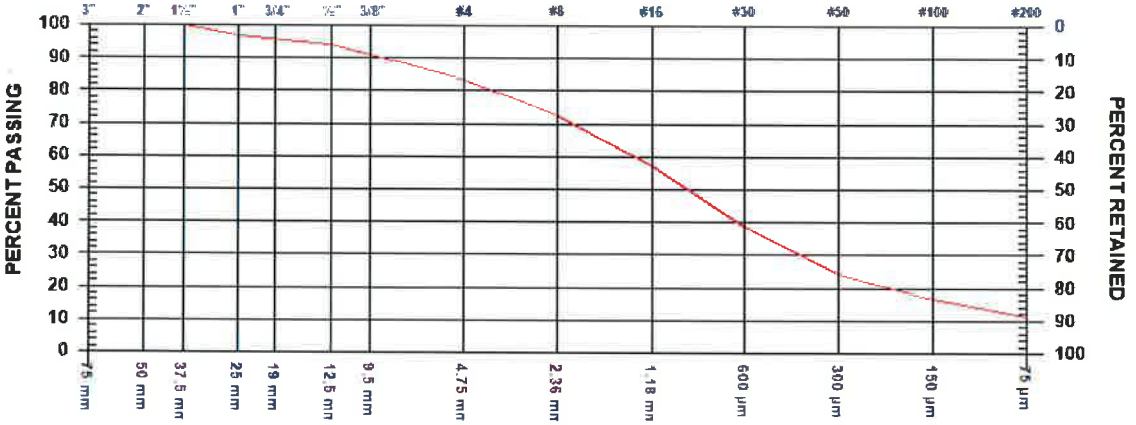
ATTN: Mr. Mircea Cvaci

PROJECT Proposed Mackenzie Transfer Station Mackenzie, BC
Geotechnical Assessment
CONTRACTOR

SIEVE TEST NO. 1 DATE RECEIVED 19.Sep.2018 DATE TESTED 21.Sep.2018 DATE SAMPLED 17.Sep.2018

SUPPLIER
SOURCE BH18-01, S01(b) @1.5-3.0 m
SPECIFICATION
MATERIAL TYPE SAND, some gravel, some fines

SAMPLED BY T.Garden
TESTED BY S.Wall
TEST METHOD WASHED



GRAVEL SIZES		PERCENT PASSING	GRADATION LIMITS
3"	75 mm		
2"	50 mm		
1 1/2"	37.5 mm	100.0	
1"	25 mm	97.0	
3/4"	19 mm		
1/2"	12.5 mm	94.0	
3/8"	9.5 mm	91.1	

SAND SIZES AND FINES		PERCENT PASSING	GRADATION LIMITS
No. 4	4.75 mm	83.3	
No. 8	2.36 mm	72.6	
No. 16	1.18 mm	57.3	
No. 30	600 µm	38.7	
No. 50	300 µm	24.2	
No. 100	150 µm	16.7	
No. 200	75 µm	11.2	

MOISTURE CONTENT 3.9%

COMMENTS
Tested as per ASTM C136.
Gravel=16.7%, Sand=72.1%, Silt/Clay=11.2%

 16.Oct.2018 McElhanney Consulting Services Ltd. PER [redacted]

McElhanney Consulting Services Ltd.
Suite 12-556 North Nechako Rd
Prince George, BC

SIEVE ANALYSIS REPORT
8 16 30 50 SERIES

PROJECT NO. 2341-2565
CLIENT Sperling Hansen Associates
C.C.

TO
Sperling Hansen Associates
#8-1225 East Keith Road
North Vancouver, BC,
V7J 1J3

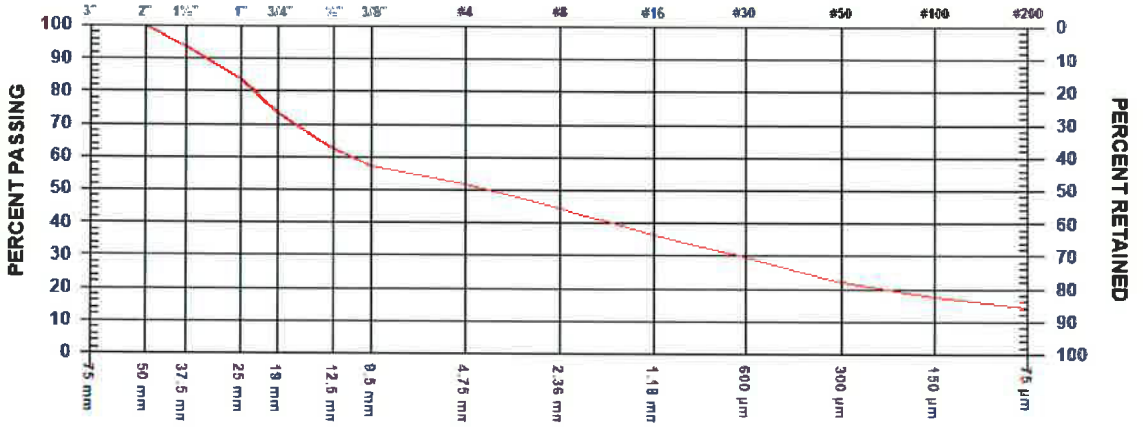
ATTN: Mr. Mircea Cvaci

PROJECT Proposed Mackenzie Transfer Station Mackenzie, BC
Geotechnical Assessment
CONTRACTOR

SIEVE TEST NO. 2 DATE RECEIVED 19.Sep.2018 DATE TESTED 10.Oct.2018 DATE SAMPLED 17.Sep.2018

SUPPLIER
SOURCE BH18-04, S01 @ 0-1.5 m
SPECIFICATION
MATERIAL TYPE GRAVEL and SAND, some fines

SAMPLED BY T.Garden
TESTED BY S.Wall/T.Rail
TEST METHOD WASHED



GRAVEL SIZES		PERCENT PASSING	GRADATION LIMITS
3"	75 mm		
2"	50 mm	100.0	
1 1/2"	37.5 mm	93.5	
1"	25 mm	83.6	
3/4"	19 mm	73.6	
1/2"	12.5 mm	62.6	
3/8"	9.5 mm	57.0	

SAND SIZES AND FINES		PERCENT PASSING	GRADATION LIMITS
No. 4	4.75 mm	51.9	
No. 8	2.36 mm	44.5	
No. 16	1.18 mm	36.4	
No. 30	600 µm	29.6	
No. 50	300 µm	22.0	
No. 100	150 µm	17.5	
No. 200	75 µm	14.5	

MOISTURE CONTENT 3.6%

COMMENTS
Tested as per ASTM C136.
Gravel=48.1%, Sand=37.4%, Silt/Clay=14.5%

 16.Oct.2018 McElhanney Consulting Services Ltd. PER. [redacted]

McElhanney Consulting Services Ltd.
Suite 12-556 North Nechako Rd
Prince George, BC

SIEVE ANALYSIS REPORT
8 16 30 50 SERIES

PROJECT NO. 2341-02565-00
CLIENT Sperling Hansen Associates
C.C.

TO
Sperling Hansen Associates
#8-1225 East Keith Road
North Vancouver, BC,
V7J 1J3

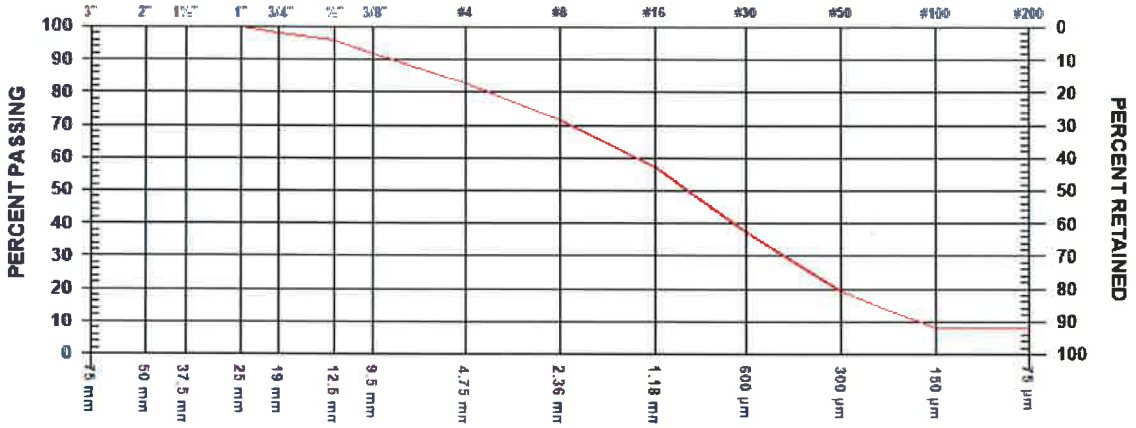
ATTN: Mr. Mircea Cvaci

PROJECT Proposed Mackenzie Transfer Station Mackenzie, BC
Geotechnical Assessment
CONTRACTOR

SIEVE TEST NO. 3 DATE RECEIVED 19.Sep.2018 DATE TESTED 21.Sep.2018 DATE SAMPLED 17.Sep.2018

SUPPLIER
SOURCE BH18-06, S01 @ 0-1.5 m
SPECIFICATION
MATERIAL TYPE SAND, some gravel, trace fines

SAMPLED BY T.Garden
TESTED BY S.Wall/T.Rail
TEST METHOD WASHED



GRAVEL SIZES		PERCENT PASSING	GRADATION LIMITS
3"	75 mm		
2"	50 mm		
1 1/2"	37.5 mm		
1"	25 mm	100.0	
3/4"	19 mm	98.2	
1/2"	12.5 mm	96.1	
3/8"	9.5 mm	91.8	

SAND SIZES AND FINES		PERCENT PASSING	GRADATION LIMITS
No. 4	4.75 mm	82.8	
No. 8	2.36 mm	71.6	
No. 16	1.18 mm	57.4	
No. 30	600 µm	37.5	
No. 50	300 µm	19.4	
No. 100	150 µm	7.9	
No. 200	75 µm	7.9	

MOISTURE CONTENT 3.5%

COMMENTS
Tested as Per ASTM C136
Gravel=17.2%, Sand=74.9%, Silt/Clay=7.9%

 16.Oct.2018 McElhanney Consulting Services Ltd. PER. [redacted]

McElhanney Consulting Services Ltd.
Suite 12-556 North Nechako Rd
Prince George, BC

SIEVE ANALYSIS REPORT
8 16 30 50 SERIES

PROJECT NO. 2341-02565-00
CLIENT Sperling Hansen Associates
C.C.

TO
Sperling Hansen Associates
#8-1225 East Keith Road
North Vancouver, BC,
V7J 1J3

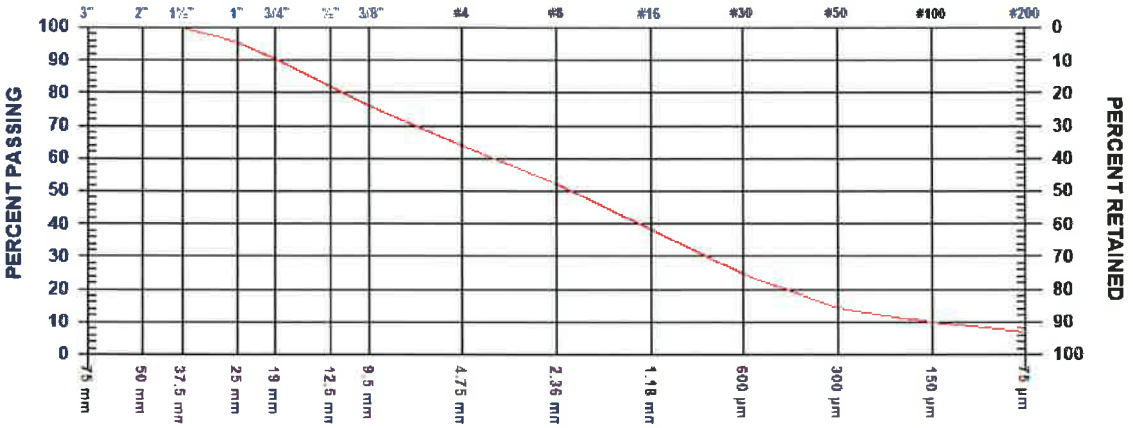
ATTN: Mr. Mircea Cvaci

PROJECT Proposed Mackenzie Transfer Station Mackenzie, BC
Geotechnical Assessment
CONTRACTOR

SIEVE TEST NO. 4 DATE RECEIVED 19.Sep.2018 DATE TESTED 21.Sep.2018 DATE SAMPLED 17.Sep.2018

SUPPLIER
SOURCE BH18-07, S05 @ 5.6-6.2 m
SPECIFICATION
MATERIAL TYPE SAND and GRAVEL, trace fines

SAMPLED BY T.Garden
TESTED BY S.Wall/T.Rail
TEST METHOD WASHED



GRAVEL SIZES		PERCENT PASSING	GRADATION LIMITS
3"	75 mm		
2"	50 mm		
1 1/2"	37.5 mm	100.0	
1"	25 mm	95.7	
3/4"	19 mm	90.5	
1/2"	12.5 mm	81.8	
3/8"	9.5 mm	76.1	

SAND SIZES AND FINES		PERCENT PASSING	GRADATION LIMITS
No. 4	4.75 mm	64.0	
No. 8	2.36 mm	52.2	
No. 16	1.18 mm	38.4	
No. 30	600 µm	25.0	
No. 50	300 µm	14.3	
No. 100	150 µm	9.8	
No. 200	75 µm	6.7	

COMMENTS
Tested as per ASTM C136.
Gravel=36.0%, Sand=57.3%, Silt/Clay=6.7%

 16.Oct.2018 McElhanney Consulting Services Ltd. PER. [redacted]

McElhanney Consulting Services Ltd.
Suite 12-556 North Nechako Rd
Prince George, BC

SIEVE ANALYSIS REPORT
8 16 30 50 SERIES

PROJECT NO. 2341-02565-00
CLIENT Sperling Hansen Associates
C.C.

TO
Sperling Hansen Associates
#8-1225 East Keith Road
North Vancouver, BC,
V7J 1J3

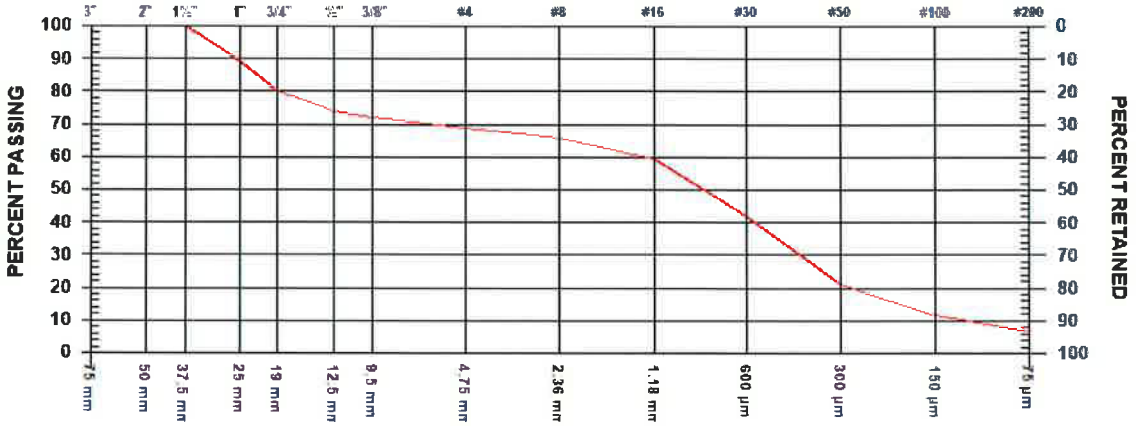
ATTN: Mr. Mircea Cvaci

PROJECT Proposed Mackenzie Transfer Station Mackenzie, BC
Geotechnical Assessment
CONTRACTOR

SIEVE TEST NO. 5 DATE RECEIVED 19.Sep.2018 DATE TESTED 21.Sep.2018 DATE SAMPLED 18.Sep.2018

SUPPLIER
SOURCE BH18-08, S05 @ 5.8-6.1 m
SPECIFICATION
MATERIAL TYPE SAND, gravelly, trace fines

SAMPLED BY T.Garden
TESTED BY S.Wall/T.Rail
TEST METHOD WASHED



GRAVEL SIZES		PERCENT PASSING	GRADATION LIMITS
3"	75 mm		
2"	50 mm		
1 1/2"	37.5 mm	100.0	
1"	25 mm	89.2	
3/4"	19 mm	80.3	
1/2"	12.5 mm	73.7	
3/8"	9.5 mm	72.2	

SAND SIZES AND FINES		PERCENT PASSING	GRADATION LIMITS
No. 4	4.75 mm	68.8	
No. 8	2.36 mm	65.9	
No. 16	1.18 mm	59.3	
No. 30	600 µm	41.9	
No. 50	300 µm	21.3	
No. 100	150 µm	11.7	
No. 200	75 µm	6.7	

MOISTURE CONTENT 3.6%

COMMENTS
Test as per ASTM C136.
Gravel=31.2%,Sand=62.1%,Silt/Clay=6.7%

 16.Oct.2018 McElhanney Consulting Services Ltd. PER. [redacted]

McElhanney Consulting Services Ltd.
Suite 12-556 North Nechako Rd
Prince George, BC

SIEVE ANALYSIS REPORT
8 16 30 50 SERIES

PROJECT NO. 2341-02565-00
CLIENT Sperling Hansen Associates
C.C.

TO
Sperling Hansen Associates
#8-1225 East Keith Road
North Vancouver, BC,
V7J 1J3

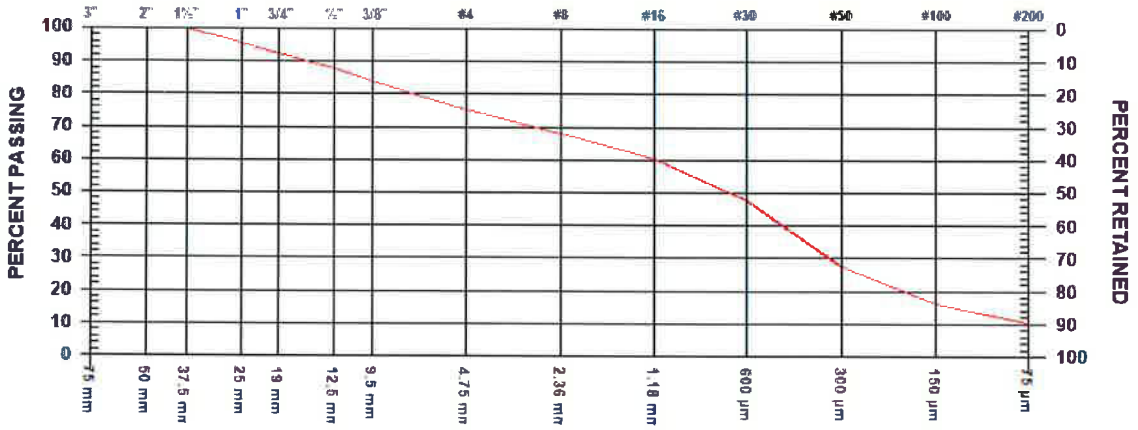
ATTN: Mr. Mircea Cvaci

PROJECT Proposed Mackenzie Transfer Station Mackenzie, BC
Geotechnical Assessment
CONTRACTOR

SIEVE TEST NO. 6 DATE RECEIVED 19.Sep.2018 DATE TESTED 21.Sep.2018 DATE SAMPLED 18.Sep.2018

SUPPLIER
SOURCE BH18-09, S05 @ 5.8-6.4 m
SPECIFICATION
MATERIAL TYPE SAND, gravelly, trace fines

SAMPLED BY T.Garden
TESTED BY S.Wall/T.Rail
TEST METHOD WASHED



GRAVEL SIZES		PERCENT PASSING	GRADATION LIMITS
3"	75 mm		
2"	50 mm		
1 1/2"	37.5 mm	100.0	
1"	25 mm	95.3	
3/4"	19 mm	92.4	
1/2"	12.5 mm	87.8	
3/8"	9.5 mm	83.9	

SAND SIZES AND FINES		PERCENT PASSING	GRADATION LIMITS
No. 4	4.75 mm	75.4	
No. 8	2.36 mm	67.9	
No. 16	1.18 mm	60.2	
No. 30	600 µm	47.7	
No. 50	300 µm	27.4	
No. 100	150 µm	16.0	
No. 200	75 µm	10.2	

MOISTURE CONTENT 3.7%

COMMENTS
Tested as per ASTM C136.
Gravel=24.6, Sand=65.2%, Silt/Clay=10.2%

 16.Oct.2018 McElhanney Consulting Services Ltd. PER. [redacted]

McElhanney Consulting Services Ltd.
Suite 12-556 North Nechako Rd
Prince George, BC

SIEVE ANALYSIS REPORT
8 16 30 50 SERIES

PROJECT NO. 2341-02565-00
CLIENT Sperling Hansen Associates
C.C.

TO
Sperling Hansen Associates
#8-1225 East Keith Road
North Vancouver, BC,
V7J 1J3

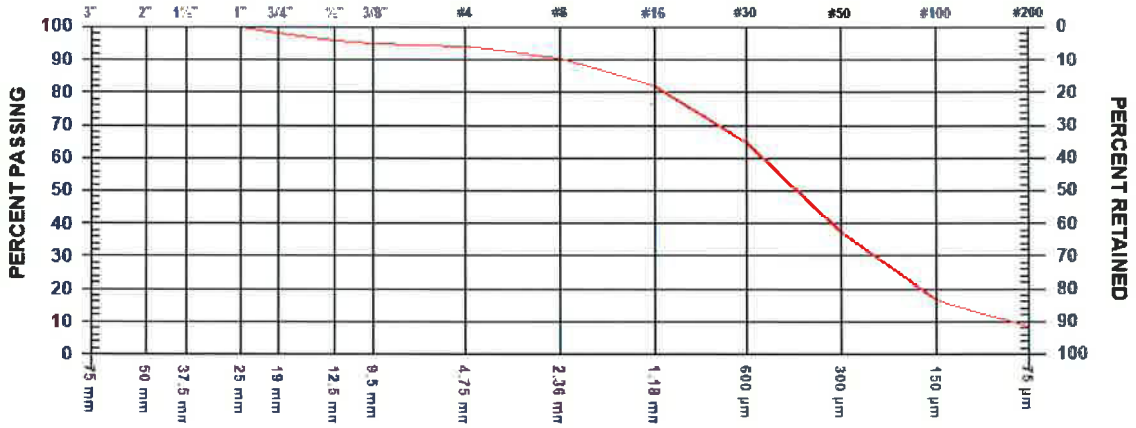
ATTN: Mr. Mircea Cvaci

PROJECT Proposed Mackenzie Transfer Station Mackenzie, BC
Geotechnical Assessment
CONTRACTOR

SIEVE TEST NO. 7 DATE RECEIVED 19.Sep.2018 DATE TESTED 21.Sep.2018 DATE SAMPLED 18.Sep.2018

SUPPLIER
SOURCE BH18-11, S05 @5.8-6.4m
SPECIFICATION
MATERIAL TYPE SAND, trave gravel, trace fines

SAMPLED BY T.Garden
TESTED BY T.Rail
TEST METHOD WASHED



GRAVEL SIZES		PERCENT PASSING	GRADATION LIMITS
3"	75 mm		
2"	50 mm		
1 1/2"	37.5 mm		
1"	25 mm	100.0	
3/4"	19 mm	98.1	
1/2"	12.5 mm	95.9	
3/8"	9.5 mm	95.2	

SAND SIZES AND FINES		PERCENT PASSING	GRADATION LIMITS
No. 4	4.75 mm	94.2	
No. 8	2.36 mm	90.6	
No. 16	1.18 mm	81.9	
No. 30	600 µm	64.8	
No. 50	300 µm	37.2	
No. 100	150 µm	16.8	
No. 200	75 µm	8.5	

MOISTURE CONTENT 4.3%

COMMENTS
Tested as per ASTM C136.
Gravel=5.8%, Sand=85.7%, Silt/Clay=8.5%

 16.Oct.2018 McElhanney Consulting Services Ltd. PER. [redacted]

McElhanney

McElhanney Consulting Services Ltd.
12-556 North Nechako Rd
Prince George BC
Canada V2K 1A1
Tel 250 561 2299
Fax 250 563 1941
www.mcelhanney.com

MOISTURE CONTENT WORKSHEET
Oven Dry Method
ASTM D2216

PROJECT NAME: Mackenzie Transfer Station
PROJECT NO. 2341-02565-00
CLIENT: Sperling Hansen Associates

DATE SAMPLED: 2018-09-17
SAMPLED BY: T.Garden
DATE TESTED: 2018-09-21
TESTED BY: S.Wall

TH/TP NO.	Sample No.	Depth	Moisture	Comments
BH18-01	S01	0-1.5 m	5.2	
BH18-01	S01(b)	1.5-3.0 m	4.9	
BH18-01	S02	1.5-2.1 m	4.7	
BH18-01	S03	4.3-4.9 m	3.9	
BH18-01	S04	5.8-6.4 m	5.7	
BH18-02	S01	1-1.5 m	3.4	
BH18-02	S02	1.5-2.7 m	3.1	
BH18-02	S03	3.0-3.7 m	-	Sample not found
BH18-03	S01	0-1.5 m	3.3	
BH18-03	S02	1.5-2.7 m	2.9	
BH18-03	S03	3.0-3.7 m	1.1	
BH18-04	S01	0-1.5 m	3.6	
BH18-04	S02	1.5-2.1 m	2.5	
BH18-04	S03	3.0-3.7 m	3.0	
BH18-05	S01	0-1.5 m	4.0	
BH18-05	S02	1.5-2.1 m	2.4	
BH18-05	S03	3.0-3.5 m	0.5	
BH18-06	S01	0-1.5 m	3.6	
BH18-06	S02	1.5-2.1 m	2.9	
BH18-06	S03	3.0-3.7 m	4.9	
BH18-07	S01	0-1.5 m	3.1	
BH18-07	S02	1.5-2.1 m	2.2	
BH18-07	S03	2.6-3.2 m	1.6	
BH18-07	S04	4.1-4.7 m	1.8	
BH18-07	S05	5.5-6.2 m	2.9	
BH18-08	S01	0-1.5 m	4.0	
BH18-08	S02	1.5-2.1 m	3.4	
BH18-08	S03	3.0-3.7 m	4.6	
BH18-08	S04	4.1-4.7 m	5.5	
BH18-08	S05	5.5-6.2 m	3.6	
BH18-09	S01	0-1.5 m	4.7	
BH18-09	S02	1.5-2.1 m	2.8	
BH18-09	S03	3.0-3.7 m	3.5	
BH18-09	S04	4.1-4.7 m	4.9	
BH18-09	S05	5.5-6.2 m	3.7	

COMMENTS:

McElhanney

McElhanney Consulting Services Ltd.
12-556 North Nechako Rd
Prince George BC
Canada V2K 1A1
Tel 250 561 2299
Fax 250 563 1941
www.mcelhanney.com

MOISTURE CONTENT WORKSHEET
Oven Dry Method
ASTM D2216

PROJECT NAME: Mackenzie Transfer Station
PROJECT NO. 2341-02565-00
CLIENT: Sperling Hansen Associates

DATE SAMPLED: 2018-09-17
SAMPLED BY: T.Garden
DATE TESTED: 2018-09-21
TESTED BY: S.Wall

TH/TP NO.	Sample No.	Depth	Moisture	Comments
BH18-10	S01	0-1.5 m	3.2	
BH18-10	S02	1.5-3.0 m	2.5	
BH18-10	S03	1.5-2.1 m	1.0	
BH18-10	S04	4.3-4.9 m	3.2	
BH18-10	S05	5.8-6.4 m	0.4	
BH18-11	S01	0-1.5 m	4.2	
BH18-11	S02	1.5-2.1 m	2.8	
BH18-11	S03	2.6-3.2 m	3.8	
BH18-11	S04	4.1-4.7 m	6.0	
BH18-11	S05	5.5-6.2 m	4.3	
BH18-12	S01	0-1.5 m	4.0	
BH18-12	S02	1.5-3.0 m	3.5	
BH18-13	S01	0-1.5 m	2.5	
BH18-13	S02	1.5-3.0 m	3.0	

COMMENTS:

APPENDIX C: Assumed Historical Annual Disposal Quantities

Annual Tonnage Mackenzie Regional Landfill

Year	Tonnage (*est)	
1995	4,700	Source: Mackenzie Landfill, Interim Operations Plan, AGRA, December 12, 1995
1996	5,000	
1997	5,000	
1998	5,000	
1999	5,000	
2000	5,000	
2001	5,000	
2002	5,000	Source: Mackenzie Landfill, Interim Operations Plan, AGRA, December 12, 1995
2003	5,000	
2004	5,000	
2005	5,000	
2006	5,000	Extrapolated estimate
2007	7,107	Source: Scale Reords
2008	7,033	
2009	7,033	
2010	7,033	
2011	7,033	
2012	7,033	Source: RDFFG Annual Report/scale avg
2013	6,325	Source: RDFFG Annual Report
2014	7,778	Source: RDFFG Annual Report
2015	7,063	Source: RDFFG Annual Report
2016	6,892	Source: RDFFG Annual Report
2017	6,117	Source: RDFFG Annual Report
2018	6,645	Source: RDFFG Annual Report
2019	6,439	Source: RDFFG Annual Report
2020	779	Changed to a Transfer station. All MSW transported to FBRLF. DLC burried on site
2021	1,429	Source: RDFFG Annual Report

Red estimated

Black actual

Note: Estimate for residential tonnage drop off based on population and 1 tonne per capita as follows; 2007 thru 2016 3,855 tonnes.

From 1996 to 2012 based on population and 0.76 tonnes per capita 4,700 tonnes, exclusing 2007

In 2020 the site began operations as a trasnsfer station with a select only DLC area.

APPENDIX D: Detailed Closure Cost Estimates

MORRISON HERSHFIELD

Table D.1 - Closure Cost Estimate - RDFFG Mackenzie Regional Landfill DOCP
Soil Cover Option 1 - Primary Landfill Disposal Area

	Description	Quantity	Units	Estimated Unit Rate	Estimated Cost
1	**Site Preparation**				
1.01	Mobilization	1	LS	$15,000.00	$15,000
1.02	General site cleanup	1	LS	$5,000.00	$5,000
1.03	Hauling, filling and grading	1	LS	$5,000.00	$5,000
1.04	Smoothing, proof rolling, minor grubbing and topsoil stripping	42,800	m^2	$3.00	$128,400
	Subtotal				**$153,400**
2	**Landfill Cover System**				
2.01	Intermediate cover - haul, place and compact	12,840	m^3	$15.00	$192,600
2.02	Clay Barrier layer (600 mm thick) - haul, place and compact	25,680	m^3	$20.00	$513,600
2.03	Supply, Import, Place 150mm topsoil	6,420	m^3	$35.00	$224,700
2.04	Hydroseed topsoil	42,800	m^2	$2.00	$85,600
	Subtotal				**$1,016,500**
3	**Access Roads and Perimeter Fencing Improvements**				
3.01	Internal Access road construction	750	m^3	$15.00	$11,250
3.02	Perimeter fencing upgrades	1	LS	$30,000.00	$30,000
3.03	Perimeter access road upgrades	1	LS	$50,000.00	$50,000
	Subtotal				**$91,250**
4	**Surface Water Management**				
4.01	New crest ditching and downchutes	717	m	$50.00	$35,850
4.02	Upgrades to existing toe ditches and culverts	300	m	$50.00	$15,000
4.03	Expansion of surface water pond	1	LS	$20,000.00	$20,000
	Subtotal				**$70,850**
5	**Signage and Access**				
5.01	Signage and Access	1	LS	$5,000.00	$5,000
	Subtotal				**$5,000**
				Subtotal	**$1,337,000**
				Contingency (40%)	**$534,800**
				Engineering (20%)	**$267,400**
				Total Cost	**$2,139,000**
				Cost per m^2	**$49.98**

MORRISON HERSHFIELD

Table D.2 - Closure Cost Estimate - RDFFG Mackenzie Regional Landfill DOCP
Geomembrane Cover Option 2 - Primary Landfill Disposal Area

	Description	Quantity	Units	Estimated Unit Rate	Estimated Cost
1	**Site Preparation**				
1.01	Mobilization	1	LS	$15,000.00	$15,000
1.02	General site cleanup	1	LS	$5,000.00	$5,000
1.03	Hauling, filling and grading	1	LS	$5,000.00	$5,000
1.04	Smoothing, proof rolling, minor grubbing and topsoil stripping	42,800	m^2	$3.00	$128,400
	Subtotal				**$153,400**
2	**Landfill Cover System**				
2.01	Intermediate cover - haul, place and compact	12,840	m^2	$15.00	$192,600
2.02	Geotextile (heavy weight) - Supply and install	42,800	m^2	$4.75	$203,300
2.03	LLDPE Geomembrane - Supply and installl	42,800	m^2	$13.75	$588,500
2.04	Geocomposite drainage layer - Supply and install	42,800	m^2	$15.00	$642,000
2.05	Common fill layer (450 mm thick) - supply and install	19,260	m^3	$15.00	$288,900
2.06	Supply, Import, Place 150mm topsoil	6,420	m^3	$35.00	$224,700
2.07	Hydroseed topsoil	42,800	m^2	$2.00	$85,600
2.08	Passive LFG venting system	42,800	m^2	$5.00	$214,000
	Subtotal				**$2,439,600**
3	**Access Roads and Perimeter Fencing Improvements**				
3.01	Internal Access road construction	750	m^3	$15.00	$11,250
3.02	Perimeter fencing upgrades	1	LS	$30,000.00	$30,000
3.03	Perimeter access road upgrades	1	LS	$50,000.00	$50,000
	Subtotal				**$91,250**
4	**Surface Water Management**				
4.01	New crest ditching and downchutes	717	m	$50.00	$35,850
4.02	Upgrades to existing toe ditches and culverts	300	m	$50.00	$15,000
4.03	Expansion of surface water pond	1	LS	$20,000.00	$20,000
	Subtotal				**$70,850**
5	**Signage and Access**				
5.01	Signage and Access	1	LS	$5,000.00	$5,000
	Subtotal				**$5,000**
				Subtotal	**$2,760,100**
				Contingency (40%)	**$1,104,040**
				Engineering and Construction Oversight (20%)	**$552,020**
				Total Cost	**$4,416,000**
				Cost per m^2	**$103.18**

APPENDIX E: Fire Safety & Emergency Plan

MORRISON HERSHFIELD

Fire Safety & Emergency Response Plan (STAFF)

Mackenzie Regional Landfill

Date: December 12, 2023

TABLE OF CONTENTS

FIGURES

APPENDICES

1. INTRODUCTION

This document is prepared for the Mackenzie Regional Landfill (the Site) staff for use in a case of a fire or emergency. This response plan sets out procedures to address foreseeable emergencies. This plan should be reviewed with staff and all relevant parties on a recurring basis. Updates to this plan should be considered should operations at the landfill change. The key points to note of this plan are:

- What is the nature and severity of the emergency?
- What needs to be done?
- Who does it?

This handbook is meant for **STAFF** use to be kept at an easily accessible and known place on site. Ideally, copies of this handbook are to be kept in a transfer station building, scale house building and in all staff vehicles.

This document will cover the following:

- Important notes and terms related to an emergency response
- Procedure form to follow
- Relevant contacts
- Emergency Response form to fill (Appendix A)
- An emergency preparedness checklist (Appendix B)

This plan should be reviewed with the local fire department and make any further changes necessary to fit the site's needs.

2. DEFINITIONS AND TERMS

An emergency is when a serious, unexpected, and often dangerous situation occurs that requires immediate action. An emergency response is when the encountered staff responds to an emergency to defuse or lessen the negative impact of the incident. The goal of an emergency response plan is NOT to endanger self or others in the process of defusing or lessening the negative impact of the incident, it is to behave and act rationally in a safe manner without emotion to solve the emergency response.

Emergency responses include the following:

- Fires
- Accidents and medical emergencies (i.e., vehicular crashes, fall from heights)
- Environmental and operation contingencies (i.e., exposed electrical lines)

The following two levels of reporting is required by any individual who locates a fire or emergency:

- **Report to a Supervisor:** Refers to a direct supervisor in charge of the individual who encountered or witnessed an emergency incident.

and

- **Report to the Owner (the Regional District of Fraser-Fort George):** The owner shall immediately be given details of the emergency incident. It is the owner's responsibility to ensure protection of human health and safety, provide directions to defuse or lessen the negative impact of the emergency, and report the incident to affected agencies prior to investigating the incident themselves.

3. FIRE MANAGEMENT

3.1 Fire Response Procedures

All fires should be treated seriously and reported as an emergency. Should an emergency occur, employees shall report to the primary muster point. Should the primary muster point be inaccessible, employees shall report to the secondary muster point.

The muster points for the Mackenzie Landfill are shown on Figure 1.

In the event of a fire, the following general procedures should be followed:

- **Do not panic.** The greatest danger lies not in fighting the fire, but in the panic that arises from a fire.
- Do not fight fire alone.
- Do not place yourself or others in danger while fighting the fire.
- Contact other nearby employees and bystanders, direct them to first muster point when safe.
- Summon the appropriate landfill equipment.
- Notify the Fire Department. Tell them the location and type of fire and whether it looks like it will spread out of the immediate area.
- Notify the Solid Waste Services Manager immediately. Follow their instructions.
- Notify surrounding property owners, particularly if it appears that the fire could spread beyond the landfill.
- When the Fire Department arrives, follow their instructions.

All fires will be reported as an emergency situation. Should an emergency occur, employees shall report and direct all bystanders to the primary muster point. Should the primary muster point be inaccessible, employees shall report to the secondary muster point.

Figure 1: Site Plan

3.2 General Fire Fighting Guidelines

- For a landfill fire, the fire is better controlled with the use of a dozer and dirt. If it is safe to do so, dig out and isolate the burning waste. Then either let it burn out or cover with dirt. Lots of water will not necessarily extinguish the fire and can cause more problems than it solves.
- Do not overuse water. Remember that most landfill fires can be controlled with a relatively small amount of water. In most cases, soil is more effective than water.
- If two or more water trucks are being used, try to use shifts so that at least one water truck is at the fire at all times.
- Do not waste time trying to fight a large fire with a fire extinguisher.
- Do not approach any fire with a tractor unless a water truck is close by for backup.
- Never risk personal injury or death attempting to save a machine or building.
- Remember, **SAFETY FIRST**.

3.3 Fire Prevention on Landfill

Preventative fires are the best way to not require a fire response and lessens the risk of staff and bystanders from exposing to any dangers. The Mackenzie landfill will be operated in a manner that will minimize the potential for landfill fires.

The risk of a landfill fire occurring due to spontaneous combustion or surface ignition can be minimized by maintaining the active excavation size as small as practical.

Fire prevention techniques will include:

- Thoroughly compacting waste.
- Applying daily cover to completely cover each cell's daily waste with inert mineral soil.
- Maintaining adequate soil resources near the excavation face to fight a fire.
- Maintaining sufficient water resources available to fight a fire.
- A smoking ban, especially in refueling areas and landfill excavation areas.
- Good site security to prevent arson.
- Maintaining a comprehensive load checking program to prevent the dumping of hot/burning materials.
- Maintaining a program of separating the dumping of ash barrels from general waste tipping face.
- Maintenance around pits to keep weeds and grass down to maintain a fire break reaching in or out of the landfill.
- Ongoing employee training on early fire hazard recognition.

3.4 Wind-Blown Litter & Debris

Managing wind-blown litter and debris control is required at landfills, which is as important as fire prevention. Wind-blown litter and debris can be found from all sorts of waste, such as lightweight papers, cardboard, plastic bags, to even plastic Tupperware. Controlling and collecting wind-blown litter and debris will be a routine for landfill staff to take part in.

The following are preventative methods to control wind-blown litter and debris:

- Encourage covers on inbound loads.
- Maintain small working face as practical.
- Maintain portable litter catchment fences around active areas.
- Maintain perimeter fencing.
- Regular inspection of loads to make sure all objects and wastes are secured.
- Litter retrieval program for staff.
- Employee training and awareness.

It is recommended the staff performs the following routines, but not limited to:

- Review working face and litter catchment fence placement before starting work and before end of day.
- Off-site litter pick-up daily.
- On-site litter pick-up weekly.

4. FIRE PROCEDURE CHECKLIST

THE FIRST PERSON ON THE SCENE MUST:

1. **PROTECT** human health and safety. Eliminate possible dangerous sources. Warn/remove bystanders.
2. **EVACUATE** the building when safe to do so.
3. **DIRECT** self and bystanders to a muster point when it is safe to do so.
4. **CALL 911** and wait for emergency response personnel to arrive. Direct personnel to Civic Address:

   CHECK FOR CIVIC ADDRESS
5. **CONTACT** the Supervisor and Owner to update the situation.
6. **REPORT** in writing on the emergency response as needed when help arrives.

5. EMERGENCY RESPONSE

Unexpected accidents can happen in any situation and staff at the landfill are no exception. The staff at the landfill will require training and understanding of the state of emergency and be considered as part of their daily job routine to be aware of the situation around them.

Staff at the Landfill will require to have the following:

- Employee Safety Training and Awareness
- First Aid Training
- Access to Safety Plan and Procedures

There are a number of different emergencies and accidents that the staff may encounter. Below are a couple of examples of emergencies that staff may encounter and should know how to handle when such situations occur.

5.1 Medical Emergencies:

All injuries should be considered important and will be reported as a safety incident to the Landfill Manager.

First Aid should be applied that is appropriate to the nature of the injury, and in the even the injury requires medical assistance, the individual should either be taken to a medical emergency center, or an ambulance service contacted.

A medical doctor should be consulted for all injuries that may result in infections as a result of working with waste materials. This includes injuries such as cuts and scrapes, skin punctures with sharp items, and fire or chemical burns.

If the person injured is a site customer or visitor, Landfill employees are to provide any assistance necessary and will apply appropriate First Aid.

For any serious medical injuries that involve life or death, contact 911 immediately.

5.2 Vehicular or Equipment Accidents:

All vehicle accidents should be reported and an investigation as to the cause should be carried out. Following the investigation, appropriate mitigative measure should be determined an implemented to avoid future accidents.

6. EMERGENCY PROCEDURE CHECKLIST

THE FIRST PERSON ON THE SCENE MUST:

1. **PROTECT** human health and safety. Eliminate possible dangerous sources. Warn/remove bystanders.
2. **ATTEND** to the injured person and apply First Aid.
3. **CALL 911** and wait for emergency response personnel to arrive. Direct personnel to Civic Address:

   CHECK FOR CIVIC ADDRESS
4. **STAY** with injured person until medical assistance arrives.
5. **CONTACT** the Supervisor and Owner to update the situation.
6. **REPORT** in writing on the emergency response as needed when help arrives.

7. EMERGENCY RELATED RESOURCES AND CONTACT NUMBERS

Supervisor	**XXXXXXXXXXXXXXX**
Alternate	XXXXXXXXXX
Firehall	**911**
Alternate	XXXXXXXXX
Chief Administrative Officer	**XXXXXXXXXXXXXXXXXX**
Alternate	XXXXXXXXXX
Environment Canada	**XXXXXXXXXXXX**

APPENDIX A: Emergency Checklist Sheet

EMERGENCY RECORD SHEET

Date of Emergency: _____ **Time:** _____am / pm

Location: _____

(Facility and exact location at facility)

Type of Emergency:

- ☐ Fire
- ☐ Medical (minor or major)
- ☐ Vehicle or equipment accidents
- ☐ Others: _____

What caused the emergency?

_____

_____

_____

Actions Taken: _____

_____

_____

_____

Who was the Emergency Reported to: _____

Emergency Impacts (Injuries, accidents, damage to property)

_____

_____

_____

Report Completed by: _____ **Date:** _____

Signature: _____

Mackenzie Regional Landfill – Incident Report

Reported by: _____ **Reported to:** _____

Department: _____ **Date of Report:** _____

INCIDENT INFORMATION

Date of Incident: _____ **Time of Incident:** _____ (am/pm)

Location (please be specific): _____

Nature of Incident:

☐ Injury/Illness ☐ Fire ☐ Vehicle Collision

☐ Property Damage ☐ Spill ☐ Other: _____

Incident Description (use additional form if necessary): _____

_____

_____

_____

Nature of Injury (if applicable):

☐ First Aid ☐ Medical Aid ☐ Modified Work ☐ Lost Time ☐ Fatal

Property Damage and Estimated Loss/Damage (if applicable): _____

_____

_____

Name	Contact Information	Staff	Contractor	Witness
		☐	☐	☐
		☐	☐	☐
		☐	☐	☐
		☐	☐	☐

Was a Police Report Filed? ☐ **YES** ☐ **NO** **File No.:** _____

Reporting Officer: _____ **Phone:** _____

Contributing Factors (if any): _____

_____

_____

_____

Corrective Actions: _____

_____

_____

_____

Disciplinary Actions: ☐ **Verbal Warning** ☐ **Written Warning** ☐**N/A**

Follow-Up Actions (use additional form if necessary): _____

_____

_____

_____

Reporting Employee Name/Position: _____

Employee Signature: _____ **Date:** _____

Supervisor Name: _____

Supervisor Signature: _____ **Date:** _____

Manager Name: _____

Manager Signature: _____ **Date:** _____

Comments/Recommendations: _____

_____

_____

WITNESS STATEMENT #1

Please give as many details about the incident as possible (who, what where, when how & why)

Witness Name: _____

Witness Signature: _____ **Date:** _____

WITNESS STATEMENT #2

Please give as many details about the incident as possible (who, what where, when how & why)

Witness Name: _____

Witness Signature: _____ **Date:** _____

APPENDIX B: Emergency Preparedness Checklist

Emergency Preparedness Checklist			
Checked by:		Date:	
Item List			Check Box
Soil/Cover Pile nearby active face (2-3 loads)			
Fire Extinguisher:			
• Inside excavator			
• Inside transfer station building			
• Inside staff vehicle			
Muster Points			
Are they clear?			
• Muster Point A			
• Muster Point B			
Are signages visible?			
• Muster Point A			
• Muster Point B			
First Aid Kit:			
• Inside transfer station building Expiry Date: _____			
• Inside staff vehicle Expiry Date: _____			