



2021 ANNUAL REPORT FOR THE VANCOUVER LANDFILL

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EXECUTIVE SUMMARY

The purpose of this report is to fulfill the annual reporting requirements defined in the Landfill's Operational Certificate (BC Ministry of Environment, Lands and Parks, hereafter MOE, 2001) and the BC *Landfill Criteria for Municipal Solid Waste, Second Edition* (MOE, 2016).

Background

The Vancouver Landfill opened in 1966 and is owned and operated by the City of Vancouver. It is located at 5400 72nd Street in Delta, in the southwest corner of Burns Bog, and is only accessible via Highway 99 Southbound.

The Landfill plays an integral role in the management of municipal solid waste (MSW) from commercial and residential sources within Metro Vancouver as part of Metro Vancouver's 2010 *Integrated Solid Waste and Resource Management Plan* (Metro Vancouver, 2010). Most of the waste received at the Landfill is first delivered to either the Vancouver South Transfer Station (VSTS), also owned and operated by the City of Vancouver, or one of Metro Vancouver's Recycling and Waste Centres.

Regulatory

Landfill operations are regulated under Operational Certificate MR-01611 (MOE, 2001) issued by the BC Ministry of Environment and Climate Change Strategy (MOE) and conducted according to engineered plans and legal agreements with Metro Vancouver and the City of Delta. These legal agreements expire in 2037, which coincide with current fill and closure plans and associated financing. The engineered plans, titled *Design Plan, Vancouver Landfill, Delta BC* (Golder, 2019a), and *Operating Plan, Vancouver Landfill, Delta BC* (Golder, 2019b), were submitted to the MOE in early 2019. In October 2021, the City submitted updated final contour drawings for Phases 4 and 5.

Site Plan

The Landfill property is 320 hectares (ha) in size, which contains the footprint (operational area within the perimeter ditches) at 225 ha and a 16.7 ha pond historically used for dredging cover material. Approximately 320 ha of undeveloped land that were part of the original Landfill property were transferred back to the City of Delta as shown in Figure 1. The site plan for the Landfill property is shown in Figure 2.



Figure 1: 2021 Vancouver Landfill Property and Footprint



Figure 2: 2021 Vancouver Landfill Site Plan

Authorized Waste Discharge

The Landfill is authorized to accept up to 750,000 tonnes of MSW for disposal each year. Materials used beneficially, such as for cover, road building and closure, are not counted towards this annual discharge limit. In November 2021, due to the provincial state of emergency in response to severe flooding in BC, the MOE temporarily approved:

1. An increase to the maximum annual authorized discharge rate up to 825,000 tonnes for the 2021 calendar year (MOE, 2021d);
2. The discharge of out-of-region waste until March 31, 2022 (MOE 2021b); and
3. The discharge of agricultural waste until December 31, 2021 (MOE 2021c).

In 2021, a combined total of 756,472 tonnes of waste were disposed at the Vancouver Landfill. This amount consisted of 726,838 tonnes of MSW (of which 5,739 tonnes were Out-of-Region MSW and 356 tonnes were agricultural waste) and 29,635 tonnes of demolition waste. This reflects approximately 71% of the total MSW generated in Metro Vancouver, with the remaining 29% delivered to the Burnaby Waste-to-Energy Facility and out-of-region landfills.

Leachate and Stormwater Runoff

Leachate and surface runoff (including stormwater from closed areas of the site) are collected in the inner ditch of a double ditch collection system. The combined leachate and surface runoff is then pumped to the Annacis Island Wastewater Treatment Plant for treatment, under Greater Vancouver Sewerage & Drainage District (GVS&DD) Waste Discharge Permit SC-100168-FSA (GVS&DD, 2011). In 2021, approximately 2.35 million m³ of combined leachate and surface runoff was delivered to Annacis Island for treatment at a cost of roughly \$3.6 million.

A total of 52 leachate, surface and groundwater monitoring stations are sampled quarterly as part of the Landfill's Water Quality Monitoring Program to confirm the effectiveness of the leachate collection and containment system. As part of the Landfill's Stormwater Monitoring Program, 15 additional monitoring stations were sampled during the fall and winter months in 2021 to assess stormwater quality from closed areas and potential receiving water bodies. Seven of these 15 monitoring stations were sampled at more frequent intervals during the stormwater discharge pilot test that commenced in late 2020.

A stormwater discharge pilot test that began in November 2020 resulted in the discharge of approximately 183,130 m³ of clean stormwater to the Dredge Pond in the first quarter of 2021 (AECOM, 2021c). This stormwater originated from the Phase 1, Phase 2 and Phase 3 retention ponds. These ponds were selected for the pilot study since stormwater monitoring program water quality results indicated that water from these three ponds was suitable for off-site discharge. The pilot test demonstrated that discharging clean stormwater from the three retention ponds did not appreciably affect Dredge Pond water quality. Furthermore, there were no indications or reports of appreciable flooding downstream of the Dredge Pond during the test. The stormwater discharge pilot test was considered a success based on these favourable outcomes. Following the successful pilot test, discharge of clean stormwater from the three retention ponds to the Dredge Pond became an operational practice. As a result, it is estimated that in 2021, approximately 395,000 m³ of clean stormwater was diverted from the leachate collection system resulting in an approximate savings of \$610,000 in leachate conveyance and treatment costs.

Landfill Gas Collection

At the end of 2021, there were a total of 263 vertical gas wells, 129 horizontal gas collectors, 32 Draintube gas collectors, 11 side slope gas collectors, and three pressure relief gas collectors for a total of 438 gas collection points. In 2021 approximately 27% of the landfill gas

(LFG) was used off site to generate electricity for sale to BC Hydro and heat for Village Farms' greenhouses. A small portion of LFG was used to heat the Landfill Operations and Engineering Buildings. Excess gas was flared at the on-site Flare Station. Approximately 72.4 million m³ of LFG (normalized to 50% methane) was collected and destroyed in 2021, which is equivalent to the emissions of approximately 133,375 vehicles (City of Vancouver, 2022).

In 2018, FortisBC and the City signed an agreement for FortisBC to develop a facility at the Landfill to convert LFG to renewable natural gas (RNG) for distribution to residents and businesses through the FortisBC utility system. The agreement received approval from the BC Utilities Commission in September 2019. In December 2021, FortisBC successfully selected their technology provider and awarded the balance of plant design work. Commissioning of the facility is expected to start in Q4 2023 (City of Vancouver, 2022).

Closure Capacity

As each phase of the Landfill is filled to design height it is closed using an engineered cover system. The cover system is designed to minimize leachate generation and maximize landfill gas capture. Since 2009, Western 40 Hectares as well as Phases 1, 2, 3 and 4 have progressively closed; with the exception of 4 ha on the crest of Phase 4 North which was deferred to 2022. This equates to closure of a total of 122.8 ha, or 71% of the 173 ha projected waste footprint.

Recycling

The Landfill Zero Waste Centre, formerly known as the Residential Drop-Off Area, is located at the entrance to the site and provides a safe and convenient location for residential and small commercial customers to drop off waste and recyclables. Over 20 categories of materials were collected for reuse and recycling in 2021, including six categories of residential packaging and printed paper collected on behalf of Recycle BC. The majority of recyclables are collected free of charge. The Paint Plus depot opened in December 2020 to allow for the collection of paint, aerosol paint, other aerosols, solvents and pesticides in cooperation with Product Care Association of Canada.

Compost

The City operates a composting facility to process yard trimmings dropped off at the VSTS and Landfill into finished compost for sale and donation. In 2021, approximately 21,600 tonnes of yard trimmings were composted and approximately 9,950 tonnes of finished compost were distributed.

Status Form and Historical Reports

This report includes the MOE Annual Status Form. Additional information on the Landfill including hours of operation, location and disposal rates is available online at vancouver.ca/landfill. Historical annual reports are also available online at vancouver.ca/landfill-annual-report.

TABLE OF CONTENTS

1. Introduction	1
2. Design and Operating Plans	3
2.1. Fill Plan & Progressive Closure Status.....	3
2.2. Operational Efficiency	6
2.3. Remaining Capacity.....	7
3. Closure and Post Closure Costs	7
4. Planned Improvements	8
4.1. Leachate, Surface Water Runoff and Stormwater Management.....	8
4.2. Landfill Gas Collection	9
4.3. Progressive Landfill Closure	10
4.4. Landfill Facilities	11
4.5. Material Diversion	11
4.6. Landfill End Use.....	11
5. Waste Disposal.....	12
5.1. Waste Composition	14
5.2. Municipal Solid Waste Disposal	14
5.3. Other Authorized Waste	15
5.4. Bottom Ash	18
5.5. Demolition Material	18
5.6. Cover Materials.....	18
5.7. Road Construction & Other Beneficial Use Materials	19
5.8. Closure Materials.....	19
6. Waste Reduction & Recycling Initiatives	20
6.1. Zero Waste Centre.....	20
6.2. Disposal Bans.....	22
6.3. Yard Trimmings Collection and Composting.....	22
6.4. Diversion Projections	24
7. Environmental Protection Programs.....	24
7.1. Leachate, Surface Runoff and Stormwater Management.....	24
7.2. Leachate Generation Control Measures.....	28
7.3. Water Quality Monitoring Program & Annual Review.....	29
7.4. Landfill Gas Management System	30
7.5. Landfill Gas Collection Efficiency	32
7.6. Landfill Gas Surface Emissions Monitoring Program.....	33
7.7. Subsurface Soil Landfill Gas Monitoring.....	33
7.8. Building Methane Monitoring.....	34
7.9. Landfill Gas Migration & Emissions Monitoring Program	34
8. Operational Information.....	34
8.1. Nuisance Waste.....	34
8.2. Bird Control & Counts	35
8.3. Household Hazardous Waste.....	36
8.4. Site Inspections	36
8.5. Operating Problems and Corrective Actions.....	38

8.6.	Operational and Maintenance Expenditures.....	40
8.7.	Public Complaint and Resolution Log.....	40
8.8.	Landfill Tours.....	41

LIST OF TABLES

Table 1:	Operational Certificate Reporting Requirements.....	1
Table 2:	Additional Reporting Requirements as per the Landfill Criteria.....	2
Table 3:	2021 Progressive Closure Status.....	5
Table 4:	Implemented Modifications and System Upgrades in 2021.....	9
Table 5:	Planned Modifications and Upgrades in 2022.....	10
Table 6:	2022-2023 Progressive Closure Plan.....	10
Table 7:	Inbound Material Quantities for 2020 & 2021.....	12
Table 8:	Recycling Quantities for 2020 & 2021.....	21
Table 9:	Compost Quality for 2020 & 2021.....	24
Table 10:	2021 Leachate Flow Volumes and Precipitation.....	27
Table 11:	2021 Landfill Gas Collection and Beneficial Use.....	32
Table 12:	2021 Nuisance Waste Quantities.....	35
Table 13:	2021 Site Inspection Activities.....	36
Table 14:	2021 Operating Problems and Corrective Actions.....	38
Table 15:	Operational and Maintenance Expenditures for 2020 & 2021.....	40

LIST OF FIGURES

Figure 1:	2021 Vancouver Landfill Property and Footprint.....	iii
Figure 2:	2021 Vancouver Landfill Site Plan.....	iii
Figure 3:	2021 Landfill Fill and Progressive Closure Plan.....	4
Figure 4:	Historical Waste Quantities.....	13
Figure 5:	Leachate, Surface Runoff and Stormwater Management.....	26
Figure 6:	Leachate Collection System Cross-Section.....	26
Figure 7:	Final Cover System Cross-Section.....	28
Figure 8:	Landfill Gas Collection & Beneficial Use System.....	31
Figure 9:	2021 Landfill Gas Collection System.....	31

APPENDICES

Appendix 1:	Annual Waste Quantities.....	46
Appendix 2:	2021 Recyclable and Banned Materials.....	49
Appendix 3:	2021 Water Quality Monitoring Location Plan.....	52
Appendix 4:	2021 Water Quality Monitoring Program Parameters.....	53
Appendix 5:	2021 Public Complaint and Resolution Log.....	55
Appendix 6:	2021 Annual Water Quality Monitoring Report Executive Summary.....	57
Appendix 7:	2021 Weekly Leachate and Drainage Ditch Water Elevations.....	64
Appendix 8:	2021 Non-Recyclable Marine Debris Waste Assessment Forms.....	65
Appendix 9:	2021 Annual Status Form.....	68

1. Introduction

This report covers the period from January 1, 2021 to December 31, 2021. It has been prepared to fulfill the requirements of the Landfill's Operational Certificate (OC) MR-01611 (MOE, 2001). This report is available online at vancouver.ca/landfill-annual-report, along with reports from previous years.

The Operational Certificate for the Vancouver Landfill authorizes the discharge of Municipal Solid Waste (MSW) from within Metro Vancouver and specifies the operating and environmental protection requirements for the Landfill. Waste from other sources must be authorized by the MOE prior to acceptance.

This report addresses the reporting requirements described in Section 3.5.2 of the Operational Certificate by providing the site details and information as listed in Table 1, which also indicates where the information is located in this report.

Table 1: Operational Certificate Reporting Requirements

Reporting Requirement	2021 Annual Report Section(s)
Updates to the design and operating plan.	2. Design and Operating Plans
Revised closure/post closure costs.	3. Closure and Post Closure Costs
Planned improvements.	4. Planned Improvements
Records for waste, recyclable material and compost quantities.	Table 5: Inbound Material Quantities for 2020 & 2021 Table 6: 2020 & 2021 Recycling Quantities Appendix 1: Annual Waste Quantities
An evaluation of recycling and composting programs, including waste diversion projections.	5.2 Municipal Solid Waste Disposal 6.1 Zero Waste Centre 6.3 Yard Trimmings Collection and Composting
A review of receiving environmental monitoring data with interpretation, including leachate flow data and leachate/drainage ditch levels suitably tabulated.	7.3 Water Quality Monitoring Program & Annual Review Appendix 6: 2021 Water Quality Monitoring Program Review Executive Summary Appendix 7: 2021 Weekly Leachate and Drainage Ditch Water Elevations
An evaluation of leachate generation control measures.	7.2 Leachate Generation Control Measures
An evaluation of the efficiency of the landfill gas management systems, including an estimation of the landfill gas generation rate, percent recovery and the actual	7.5 Landfill Gas Collection Efficiency

Reporting Requirement	2021 Annual Report Section(s)
rates/volumes of gas collected, utilized and flared.	
A list of operating problems and corrective actions taken.	8.5 Operating Problems & Corrective Actions
A summary of the public complaint and resolution log.	8.7 Public Complaint & Resolution Log

This report also meets the additional reporting requirements as per Section 10.6 of the BC *Landfill Criteria for Municipal Solid Waste, Second Edition* (MOE, 2016) by providing the information listed in Table 2.

Table 2: Additional Reporting Requirements as per the Landfill Criteria

Reporting Requirement	2021 Annual Report Section(s)
Total volume of waste discharged into the landfill for the year	Table 5: Inbound Material Quantities for 2020 & 2021 Appendix 1: Annual Waste Quantities
Operational plan for the next 12 months	2. Design & Operating Plans
Remaining site life and capacity	2.3 Remaining Capacity
Closure works completed	2.1 Fill Plan & Progressive Closure Status
Results of regular inspection for cover integrity, health of vegetation, undesirable plant species, burrowing animals, erosion, settlement, etc.	8.4 Site Inspections
Any changes from approved reports, plans and specifications	2. Design & Operating Plans
Compaction, waste to cover ratio, waste to road ratio and airspace utilization factor	2.2 Operational Efficiency
Operational and maintenance expenditures	8.6 Operational and Maintenance Expenditures

As of January 1, 2016, annual reports for high priority authorizations must include the MOE Annual Status Form. The Form for the Vancouver Landfill lists all OC conditions, all of which were met in 2021, and is included in Appendix 9.

2. Design and Operating Plans

Golder Associates Ltd. (Golder) completed the Design Plan (Golder, 2019a) and Operating Plan (Golder, 2019b) in early 2019. The Design Plan is a reference for landfill design and progressive closure, while the Operating Plan is a guide for day-to-day operation of the Landfill.

In September 2019, the City notified the MOE of the following updates to the Design Plan:

- The grade of the top of Phases 4 and 5 was decreased from 6% to 4% to have a more usable area post-closure;
- The drainage orientation for Phases 4 and 5 was changed from a crown in the middle draining north-south, to two crowns draining east-west; and
- The fill sequencing of Phase 5 South (Phase 5S) was placed ahead of Phase 5 North (Phase 5N) to facilitate directing clean stormwater from Phase 5 to a new pond that was constructed with the Phase 4 South (Phase 4S) closure in 2020.

Figures in the Operating Plan that referenced the final contours and filling sequence of Phases 4 and 5 were updated in April 2020 and August 2021 respectively. The MOE was notified of the updates in a letter issued in October 2021. The updated figures were:

- Sheet 004 from the Phase 4 Closure and Gas System Upgrades set of general drawings illustrates the updated Phase 4 final contours which supersedes the final contours on Figures 11 and 18 of the Operating Plan (Sperling Hansen Associates or SHA, 2020);
- Sheet S701 drawings provide the Phase 5 final contours and filling plan sequence including profiles and cross sections, which supersedes Figures 19 through 26 of the Operating Plan (SHA, 2021).

2.1. Fill Plan & Progressive Closure Status

Plan and profile views of the engineered fill plan, including projected phase closure dates, are shown in Figure 3.

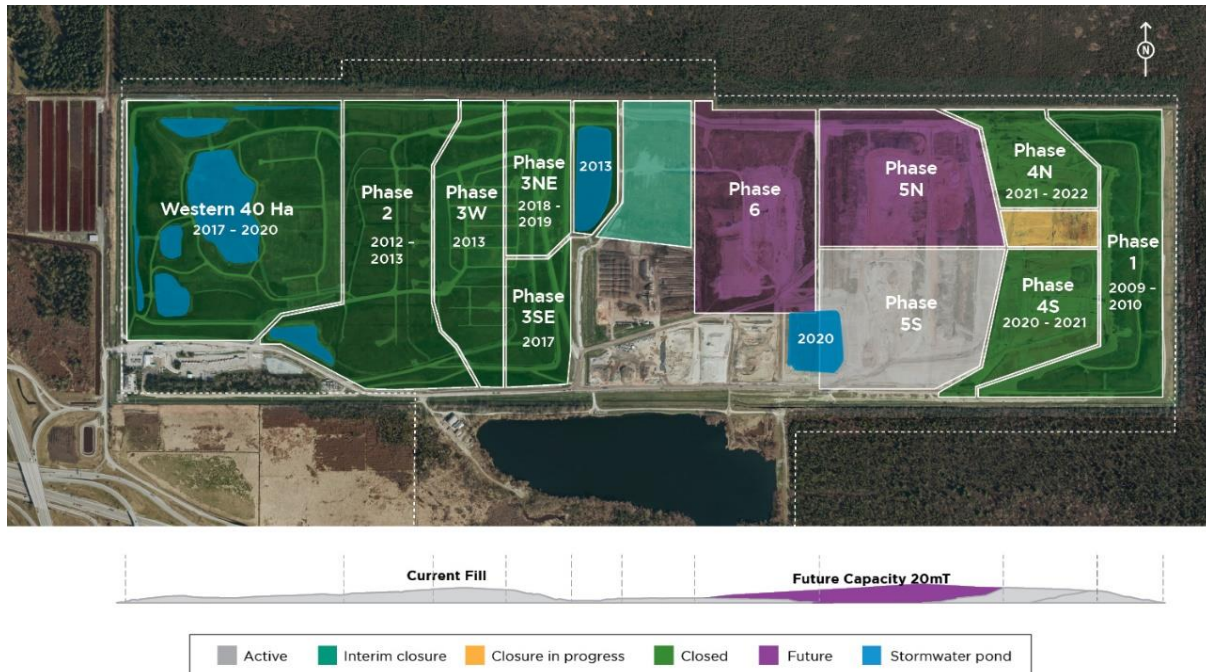


Figure 3: 2021 Landfill Fill and Progressive Closure Plan

A full time GPS Technician and one of the Landfill Engineers work closely with Superintendents and Operations staff in the active areas to ensure filling proceeds according to the intent of the engineered fill plan for each lift and phase.

Up until July, 2021, MSW filling occurred in Phase 4N and then moved into Phase 5S for the remainder of the year. Asbestos waste was disposed of in Phase 4N and 5S as well.

A summary of the operational plan for the next 12 months is as follows:

- Disposal of MSW in Phase 5S
- Expanding the landfill gas collection system in Phases 4 and 5
- Use of demolition material in Phase 5 for road construction
- Litter fencing on every lift

As of the end of 2021, several phases have been closed with engineered cover systems, including the Western 40 Hectares, Phases 1, 2, 3 and 4. A small portion, 4 ha, in Phase 4N was deferred to 2022 as detailed in Table 3.

Table 3: 2021 Progressive Closure Status

Area	Construction Timeframe	As of Dec 31, 2021			Completed by
		Area Closed	Additional Infrastructure Installed	Actual Spend	
Phase 1	2009-2010	14 ha	22 vertical gas wells and 1 horizontal gas collector; 9 stormwater discharge bridges	\$ 12M	CH2M Hill, Sperling Hansen Associates (SHA), Tyam Construction
	2012-2013	3.5 ha	Toe closure and ditch to divert stormwater to 2 southern discharge bridges only	included with Phase 2	RF Binnie Civil Engineering Consultants (Binnie), SHA, SCS Engineers (SCS), King Hoe Excavating (King Hoe)
Phase 2	2012-2013	19 ha	89 vertical gas wells and 12 horizontal gas collectors; 1 stormwater retention pond with 11,500 m ³ capacity	\$ 17.4M	Binnie, SHA, SCS, King Hoe
Phase 3W	2013	9.5 ha	13 vertical gas wells; 1 stormwater retention pond with 88,500 m ³ capacity (to serve all of Phase 3)	\$ 15.3M	Binnie, SHA, SCS, BD Hall Constructors (Hall)
Phase 3SE	2017 - 2018	9.7 ha	11 vertical gas wells	\$ 10M	Binnie, Golder, Hall
Phase 3NE	2018-2019	15.2 ha	33 vertical gas wells and 7 horizontal gas collectors	\$ 19.9M	Binnie, SHA, M2K
W40Ha	2017-2020	36.4 ha	27 vertical gas wells, 32 Draitube gas collectors; 6 stormwater retention ponds with 87,700 m ³ capacity	\$ 23.5M	Binnie, SHA, King Hoe
Phase 4S	2020	10.8 ha	19 vertical gas wells, 28 horizontal gas collectors; 1 stormwater retention pond with 100,000 m ³ capacity (to serve Phase 4 and future phases)	\$ 11.5M	King Hoe, SHA, SCS

Area	Construction Timeframe	As of Dec 31, 2021			Completed by
		Area Closed	Additional Infrastructure Installed	Actual Spend	
Phase 4N*	2021	4.7 ha	27 vertical gas wells; 6 horizontal gas collectors; 7 temporary vertical gas wells	\$8.8M	King Hoe, SHA, SCS
Total (ha)		122.8			
*Closure of the remaining 4 ha of Phase 4N is scheduled for 2022. ha = hectare (equal to 10,000 m ² or 2.47 acres)					

2.2. Operational Efficiency

Aerial mapping and analysis has been completed at the Landfill on an annual basis since 2000. The annual flight to generate contour data occurs around the beginning of April when weather permits, and the data are typically available within three months. AECOM Canada Ltd. (AECOM) is under contract to the City to complete annual data analysis from 2017 to 2021.

The purpose of the aerial mapping and analysis is to utilize the contour data from the previous and current years coupled with the tonnages of materials disposed and beneficially used to assess the following parameters:

- Landfill settlement
- Compaction density
- Air space consumption
- Waste to cover ratio and waste to other¹ materials ratio
- Remaining capacity
- Lifespan analysis

As per AECOM's *Vancouver Landfill Aerial Mapping Report* (AECOM, 2021b), the following operational efficiencies were achieved from April 8, 2020 to April 13, 2021, for the Phase 4 active area:

- Compaction density of 0.92 tonne/m³ for MSW. This value, also known as the effective density, is back-calculated using assumed densities from various geotechnical sources and survey volumes after accounting for settlement.
- Airspace utilization factor of 1.09 m³/tonne.
- Waste to cover ratio by volume of 4.11 to 1, and a waste to all other materials ratio by volume of 1.07 to 1 in Phase 4.

¹ Other refers to cover, road construction and other beneficial use materials.

2.3. Remaining Capacity

The 1999 Agreement between the City of Vancouver and the City of Delta defined the remaining capacity of the Landfill as of October 1, 1997 to be 20 million tonnes of MSW (City of Vancouver and The Corporation of Delta, 1999). The remaining capacity excludes any demolition waste disposed of in the Western 40 Hectares area. The remaining capacity of the Vancouver Landfill as of December 31, 2021 is 6,397,871 tonnes.

The 2021 *Vancouver Landfill Aerial Mapping Report* identified the remaining volumetric capacity for MSW as of April 7th until the final contours are achieved to be 8.43 million m³. This capacity is available in Phases 5 and 6. The volume is derived from taking the difference between the latest aerial contours (2021 in this case) and the final design contours in the 2019 Design Plan.

3. Closure and Post Closure Costs

The Landfill's OC requires the City to maintain a dedicated reserve fund sufficient to finance closure, post-closure and environmental contingencies related to the Landfill. The Solid Waste Capital Reserve (SWCR) was established to address these costs. In 2001, Council set the minimum balance of the SWCR at \$30 million and directed that the requirements for the SWCR be reviewed every five years. At the end of 2021, the closing balance of the SWCR was approximately \$68 million. This reflects a net increase of \$3.1 million from 2020, which is due to funded expenditures and offset by planned operational surpluses, interest revenue and Metro Vancouver pay-as-you-go contributions.

Every year, closure and post-closure costs are reviewed and updated with current available information. For the 2021 Landfill Liability, the 2019 Design Plan was used as the primary resource. The Net Present Value for closure and post-closure costs is \$112.7 million, down from \$113.6 million from 2020 as a result of 2021 closure expenditures.

According to the 1989 Tripartite Agreement (Greater Vancouver Sewerage and Drainage District, City of Vancouver and The Corporation of Delta, 1989), Metro Vancouver is responsible for closure and post-closure costs based on the proportion of regional waste in place at the Vancouver Landfill. The City of Vancouver is responsible to pay for closure and post-closure costs for Vancouver and Delta waste. At the end of 2021, 35.7% of the total waste in place at the Vancouver Landfill was regional waste, with the remaining 64.3% originating from Vancouver and Delta. This represents an increase of 1.4% in the proportion of regional waste since 2020, and corresponds to a current liability for the City of Vancouver of \$57.9 million.

4. Planned Improvements

4.1. Leachate, Surface Water Runoff and Stormwater Management

As filling progressed in Phase 5S in 2021, leachate collector extensions were installed as follows:

- On the east side of lifts 3 and 5 of Phase 5S, between October - December 2021.

In 2022, one leachate collector is planned for:

- The east side of lift 3 of Phase 5S starting in July 2022.

In September 2017, the City kicked off the 2017-2021 Water Quality Consulting & Stormwater Management Planning Project following award to AECOM. Major milestones achieved in 2021 are listed in the remainder of this section.

An action plan was developed and implemented to address the recommendations from the 2018 *Hydrogeology Review* (AECOM, 2018). Action items completed in 2021 included:

- Reviewed and updated the Leachate, Groundwater, Surface Water and Stormwater Monitoring and Sampling Manual (AECOM, 2021a) (five year review)
- Completed Stormwater Pilot Discharge Assessment to confirm infiltration capacity of the Dredge Pond
- Substantially completed installation of Remote Water Level Monitoring Stations at various ditch locations around the site to enhance measurement of cross gradients between ditches.

The remaining recommendations shall be either:

- Pursued as part of the Stormwater Management Plan (leachate collection system capacity evaluation, pump station assessment, berm upgrades); or,
- Included as part of the 2023 Hydrogeological Review (verify conductivity of sand aquifer, measure leachate levels in each phase, monitor piezometer transects).

The *Stormwater Management Plan* (AECOM, 2020) for the Vancouver Landfill was finalized in July 2020. The *Stormwater Management Plan* addresses the OC requirement that stormwater from above the engineered cover system in closed areas be directed outside of the leachate collection system (OC Section 2.8).

Recommendations of the *Stormwater Management Plan* that were undertaken in 2021 included routine stormwater monitoring, initiation of the pump station resiliency study (Phase 1) as well as completion of the stormwater pilot discharge assessment. The stormwater pilot discharge assessment involved discharging clean stormwater from Phase 1, Phase 2 and Phase 3 Ponds into the Dredge Pond to assess impacts on Dredge Pond water levels and quality. The tests were conducted during dry and wet weather conditions in the fourth quarter of 2020 (83,000 m³ diversion achieved) and during the first two months of 2021 (183,130 m³ diversion achieved). A summary of the findings were reported by AECOM (AECOM, 2021c).

4.2. Landfill Gas Collection

Implemented modifications and system upgrades undertaken in 2021 are summarized in Table 4.

Table 4: Implemented Modifications and System Upgrades in 2021

Milestone Date	Landfill Sub Area	Activity	Description
2021	Phase 5S	Drilled	5 vertical gas wells drilled on south wedge. They will be connected and commissioned in 2022.
		Installed	Drain tube gas collectors with 7 monitoring devices. They will be connected and commissioned in 2022.
		Installed	9 side slope gas collectors on the east slope. They will be connected and commissioned in 2022.
	Phase 4	Installed	1.1 ha of liner and all permanent piping for Lateral F and 4.3 ha of liner on Phase 4 North.
		Installed	0.6 ha liner (remaining portion) of the stormwater pond #4.
		Drilled and Commissioned	25 new vertical gas wells were connected and commissioned.
		Drilled	2 new vertical gas wells. They will be connected and commissioned in 2022.
		Drilled and Commissioned	7 new vertical gas wells.
		Installed and Commissioned	10 new horizontal gas collectors.
	Phase 3	Drilled	5 vertical gas wells in between high producing vertical gas wells. They will be connected in 2022.
	Phase 1	Re-Drilled and Commissioned	2 vertical gas wells are connected and functional.

Planned modifications and upgrades to the LFG collection system scheduled for 2022 are summarized in Table 5.

Table 5: Planned Modifications and Upgrades in 2022

Milestone Date	Landfill Sub Area	Activity	Description
2022	Phase 3	Commission	5 vertical gas wells.
	Phase 4 South	Re-Drill and Commission	4 vertical gas wells.
	Phase 4 North	Install	4 ha of closure liner.
		Install	Permanent gas conveyance system of 13 vertical gas wells.
		Install	1.2 ha of liner for temporary closure on south section of North-West slope.
	Phase 5 South	Install and Commission	9 lift 2 horizontal gas collectors.
		Install and Commission	9 side slope gas collectors.
		Commission	5 temporary vertical gas wells.
		Install and Commission	Lift 3 leachate collector, including 2 gas sample ports.
	Phase 5 North	Install and Commission	Lift 3 leachate collector, including 1 gas sample port.
	South Header	Install and Commission	Replace a 1100-metre section of the south header, including 10 condensate drain traps.
	Wellfield Upgrade	Install and Commission	Install up to 35 remote monitoring and auto-tuning devices on vertical gas wells and horizontal gas collectors.

4.3. Progressive Landfill Closure

Construction of the Phase 4 Closure and Gas Upgrades Project was awarded to King Hoe in early 2020. A total of 6.3 ha of liner construction in Phase 4S was completed in 2021 along with 4.5 ha of a new stormwater pond with a capacity of 100,000 m³ and 27 vertical gas wells. The remaining 1.1 ha of Phase 4S, 0.8 ha of the pond and 4.7 ha of Phase 4N were completed in 2021. In 2022, the southern portion of the temporary closure will be completed (1.2 ha). A further 4 ha of Phase 4N is deferred to 2022 due to delays in filling caused by COVID-19.

Progressive closure plans for 2022 to 2023 are summarized in Table 6.

Table 6: 2022-2023 Progressive Closure Plan

Area	Construction Timeframe	Area to be Closed	Additional Infrastructure Planned	Estimated Spend	To be Completed by
Phase 4N	2022	4 ha	None	\$ 8.5M	King Hoe, SHA, SCS

The design of Phase 5 will start in 2022. An update to the Design, Operations and Closure Plan (DOCP) will start in 2022 as well.

4.4. Landfill Facilities

Follow on work for the Landfill Entrance Improvement Project was completed in 2020 and included:

- Paving of several areas and roadways around the weigh scales; and
- Line painting around the entrance and in the Zero Waste Centre.

The following tasks were completed in 2021:

- Testing on the unattended lanes; and
- Signal light reprogramming.

RAM Engineering Ltd. was retained in 2021 to provide project management and engineering design as part of the Landfill Civil Works Project. Professional services to support various upgrades include:

- A new household hazardous waste area cover;
- Three bin canopies for the drop-off bays; and
- A new wheel wash is being explored.

4.5. Material Diversion

In 2021, the City considered a six-month mattress processing pilot at the Landfill. Mattresses are very bulky, low density and occupy a lot of valuable landfill airspace. An economic recovery model analysis was performed and three options were compared to better understand the logistics and associated monthly costs. However, with the MOE releasing the Extended Producer Responsibility (EPR) Five-Year Action Plan 2021-2026, which includes expanding mattresses into the category products of EPR initiatives, the City decided to put a mattress processing pilot on hold.

4.6. Landfill End Use

As per the terms of the 1999 Agreement between the City of Vancouver and the City of Delta (City of Vancouver and The Corporation of Delta, 1999), the two parties shall work together to establish the end use of the site for the post-closure period. In 2021, a consultant was retained to assist the City of Vancouver and City of Delta to develop suitable end use options for the site supported by stakeholder engagement and technical feasibility analysis as a Phase 1 in end use planning. The Phase 1 report is expected in fall 2022.

5. Waste Disposal

In addition to Vancouver and Delta, the Vancouver Landfill directly serves the communities of Richmond, White Rock, the University Endowment Lands and portions of Surrey under the terms of the 1989 Tripartite Agreement and 2010 *Integrated Solid Waste and Resource Management Plan* (Metro Vancouver, 2010). The remaining waste generated in the region was directed by Metro Vancouver to the Vancouver Landfill via the regional transfer stations (now referred to as recycling and waste centres), to the Waste-to-Energy Facility in Burnaby, and since 2017 to contingency disposal facilities outside of the region.

The Vancouver Landfill is authorized to accept up to 750,000 tonnes of waste each year. However, in November 2021, the MOE granted a temporary increase to the maximum annual authorized discharge rate to 825,000 tonnes for the 2021 calendar year (MOE, 2021d - see Section 5.3). The annual totals for 2020 and 2021 municipal solid waste, demolition waste, cover, road construction and closure materials received are provided in Table 7. The historical quantities are shown in Figure 4.

Table 7: Inbound Material Quantities for 2020 & 2021

Material	2021 Quantity (tonnes)	2020 Quantity (tonnes)
Waste Discharge		
Municipal Solid Waste	685,417	613,043
Bottom Ash	35,326	41,478
Demolition Material	29,635	44,138
Out-of-Region Flood Relief*	6,095	0
Cover Soil	357,783	490,582
Road Construction & Other Beneficial Use Materials		
Demolition hog	103,542	77,500
Wood waste	3,980	4,440
Crushed concrete	78,793	18,096
Purchased concrete & rock	30,229	53,549
Sand	79	1,812
Closure Materials		
Aggregate	55,367	68,363
Sand & Soil	494,335	494,422
Total	1,835,579**	1,907,423**

Note:

Cover soil, road construction & other beneficial use materials, and closure materials are not included in waste discharge quantities.

* Out-of-Region Flood Relief waste was authorized by the MOE in 2021.

** Totals may vary due to rounding errors.

In 2021, the total waste discharge was 756,472 tonnes, reflecting an increase of approximately 8% from 2020.

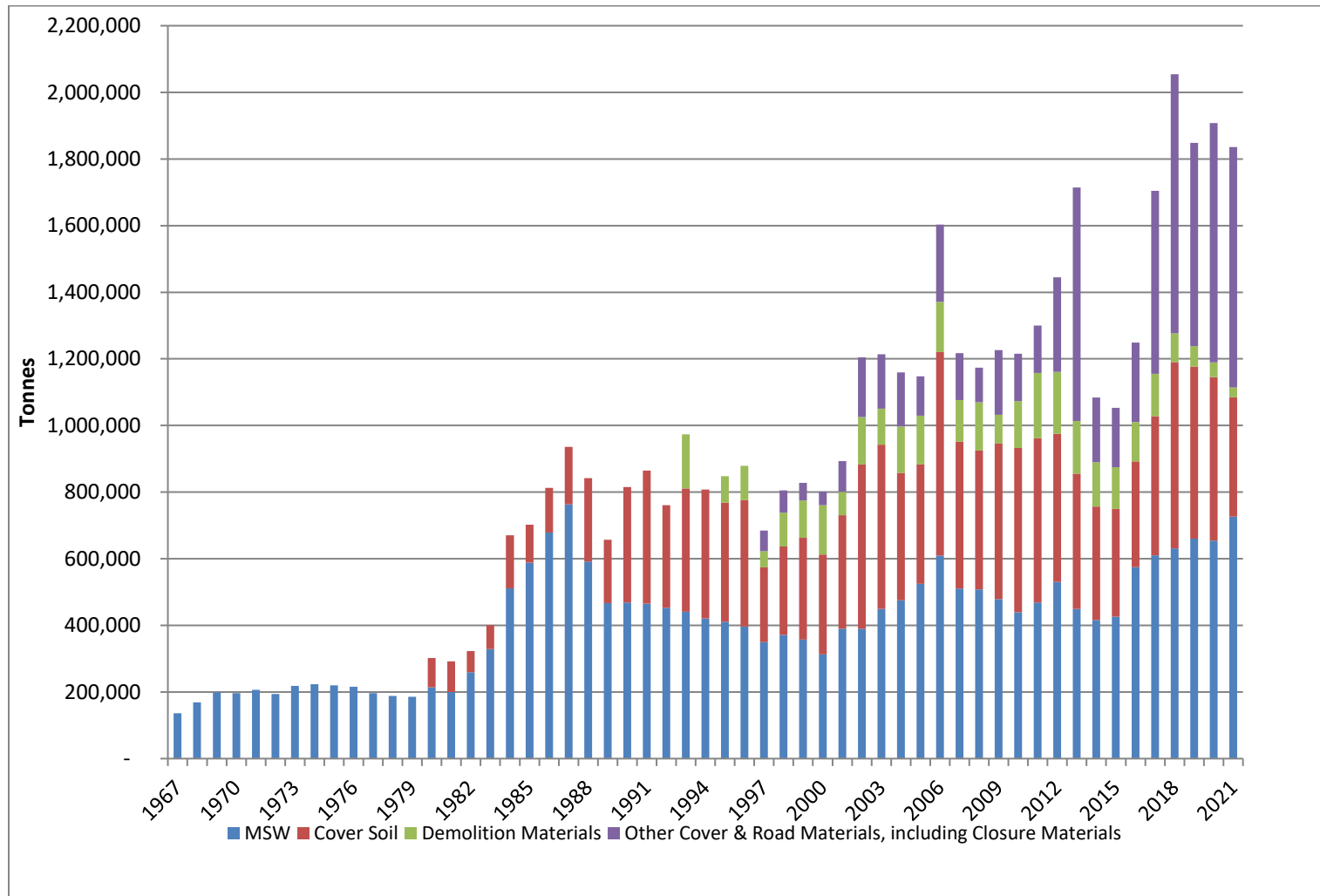


Figure 4: Historical Waste Quantities

5.1. Waste Composition

Metro Vancouver publishes waste composition study reports for the region, and the City of Vancouver contributes as a partner by coordinating waste audits at the VSTS. The data is combined with data gathered at the other regional facilities.

Metro Vancouver completed two waste composition studies in 2021 where one focused on multi-family waste, and the other on all sectors.

The 2021 Multi-Family Waste Composition Study was completed by Metro Testing and examined garbage, recycling and organics in multi-family residences throughout the region. Samples were collected directly from buildings, allowing for comparison of waste composition and disposal rates according to the following factors:

- Geographical Sub-region
- Building type (High-rise vs. Low-rise vs. Townhome)
- Ownership (Rented vs. Owned)

The 2021 Full-Scale Waste Composition Study was completed by Dillon Consulting and provided composition for the following sectors:

- Single-family Residential
- Multi-family Residential
- Commercial/Institutional
- Small Loads

Both of these studies are anticipated to be released at the end of April 2022. These studies, as well as those completed in previous years, are available on Metro Vancouver's website:

<http://www.metrovancouver.org/services/solid-waste/about/reports-resources/Pages/default.aspx>

5.2. Municipal Solid Waste Disposal

Waste disposed of at the Vancouver Landfill is either hauled directly to the Landfill, or transferred through the VSTS or one of Metro Vancouver's Transfer Stations.

In 2021, a total of 726,838 tonnes of municipal solid waste (refuse and bottom ash) was disposed of at the Landfill, primarily in Phase 4. Of this, 134,693 tonnes were transferred through the VSTS and 364,317 tonnes was transferred from the regional transfer stations.

Table A1 in Appendix 1 provides a breakdown of material type, origin and disposal location for 2021. Table A2 provides a breakdown of material type, origin and disposal location for 2020. Table A3 shows the breakdown by month of MSW, bottom ash, demolition material, cover material, road & other beneficial use materials, closure materials and yard trimmings for 2021. Details on some of these materials are included in the following sections.

The Landfill's OC restricts the type of waste discharged at the Landfill to typical MSW and other materials specifically authorized by the MOE. Asbestos waste may also be discharged in

accordance with the *Hazardous Waste Regulation* (MOE, 1988). All other Hazardous Waste is prohibited from disposal at the Landfill.

5.2.1. Asbestos Waste

A total of 12,752 tonnes of asbestos waste was disposed of in 2021 from commercial and residential customers, up from 9,508 tonnes in 2020.

Commercial asbestos waste is received Monday to Friday from 8:00am to 2:00pm for direct burial, while residential asbestos waste is received during regular operating hours in a dedicated bin in the Zero Waste Centre. Burials occur a minimum of 20 metres away from all other active areas, and include the placement of a minimum of 0.5 metres of material on the waste. An exposure control plan is in place that includes periodic exposure monitoring to confirm the risk of asbestos exposure to Staff is low. The definition of asbestos waste used in the Landfill's Asbestos Policy (City of Vancouver, 2016) follows the *Occupational Health & Safety Regulation* (BC Ministry of Labour, 1998). Commercial loads of asbestos waste have to meet the *Transportation of Dangerous Goods Regulation* (Transport Canada, 1985).

The used residential drywall pilot program at the Landfill started in September 2016 in alignment with a pilot program at two regional transfer stations, as a means of reducing illegal dumping and improper disposal of used drywall. It allows residents to deliver up to ten bags of used drywall, up to five times per year. A total of 768 tonnes of used residential drywall was received at the Vancouver Landfill in 2021, up from 667 tonnes in 2020. Used drywall from commercial customers is not accepted due to capacity constraints and the availability of alternative disposal options within the commercial sector.

5.2.2. Construction and Demolition Processing Residual Waste

Construction and demolition processing residual waste is the material that remains after construction and demolition waste has been processed to remove recyclable materials. In 2021, a total of 86,981 tonnes of this material was received from licensed transfer stations and material recovery facilities in the region. This quantity represents a significant increase when compared to the 11,215 tonnes received in 2020. Midway through 2021, quantities of this material increased substantially and the City made a decision to temporarily limit further acceptance in an effort to avoid exceeding the Landfill's 750,000 tonne annual discharge limit.

5.3. Other Authorized Waste

In November 2021, a provincial state of emergency was declared to support a coordinated response to the widespread flooding in BC. The MOE granted the Landfill a 10% maximum increase to the authorized discharge rate resulting in a temporary annual limit of 825,000 tonnes in 2021 (MOE, 2021d). Additional authorizations were received to accept both agricultural waste and out-of-region MSW (MOE, 2021b, c).

Other ongoing discharges authorized by the MOE prior to 2020 are those for Non-Recyclable Wastewater Treatment Plant (WWTP) Residuals, Non-Recyclable Drinking Water Treatment Plant (WTP) Residuals and Bottom Ash, all of which are generated by regional facilities. In 2018, the City received temporary authorization to accept Iona Grit Dump Solids for disposal until November 30, 2024 (MOE, 2018). In 2021, the City received temporary authorization to accept up to 120 tonnes of non-recyclable marine debris from the Haida Gwaii Marine Debris Clean-up Project (MOE, 2021a).

5.3.1. *Non-Recyclable Wastewater Treatment Plant Residuals*

As of 1998, the Landfill has been accepting grit from the Annacis Island and Lions Gate WWTPs, and since 2000 from Lulu Island and Iona WWTPs as well. Grit is primarily composed of materials that are denser than water and may include sand, pebbles, cinders, coffee grounds, seeds, cigarette filters and organic matter. Before grit was accepted at the Landfill, testing was conducted to confirm that it is not a Hazardous Waste. To minimize nuisance impacts, containers are tarped, drained and sealed at the WWTP to eliminate leakage during transportation to the Landfill.

In 2005, the Landfill began accepting sludge and scum screenings from Annacis Island WWTP on a trial basis. Sludge screenings are solids composed of hair, plastic debris, paper fibers and other finer materials. Scum screenings are floating materials such as toilet paper, waste paper products, plastics and other buoyant materials, which are generally combined with fat and grease. In October 2008, the MOE authorized disposal of WWTP residuals from the Annacis Island WWTP at the Landfill (MOE, 2008c).

In 2012, the MOE consolidated the authorizations for the disposal of non-recyclable WWTP residuals from any of the five regional WWTPs (MOE, 2012). In 2020, the City received a letter amendment to include 2,500 tonnes of digester solids originating from Metro's WWTPs in the 2012 authorization provided certain conditions are met. Digester solids are grit that has not been captured in upstream preliminary treatment system, and sludge generated during secondary treatment, which is mixed with sawdust prior to hauling to absorb excess liquid. As stipulated in the MOE amendment letter (MOE, 2020), the disposal of digester solids counts towards the allowable annual tonnage, and is reported as a separate line item in Table A1 in the Appendix.

As part of the 2012 authorization, the City and Metro Vancouver were required to develop a sampling and reporting program that meets the City's needs for operating the Landfill in compliance with the OC. In fulfillment of this requirement, Metro Vancouver completes a Waste Assessment Form for the Landfill on an annual basis to confirm that the WWTP residuals are not Hazardous Waste. Further, Metro Vancouver completes characterization sampling and reporting on a biennial basis.

The most recent *Grit and Screenings Characterization Study Sub-Report* was completed for Metro Vancouver and dated January 2021 (WSP, 2021). This report summarizes the 2019 sampling program results of the non-recyclable WWTP residuals disposed of at the Vancouver Landfill. The Iona MV Bin, which receives the residue from Metro Vancouver vacuum trucks, failed the paint filter test in 2019 thus indicating the presence of free liquids (WSP, 2021). In early 2021, the bin was decommissioned, and Metro Vancouver vacuum trucks used the grit bay where other trucked liquid wastes are discharged. All residuals continue to be classified as non-hazardous and are suitable for disposal by the Landfill. The next report is expected in April 2022.

In 2021, 3,447 tonnes of grit was buried as nuisance waste in Phases 4 and 5. Only 4 tonnes of sludge and scum screenings were received and buried with the remainder processed at the Waste to Energy Facility as a means of energy recovery. In 2021, no digester solids were received. The tonnage of grit, sludge and scum screenings and digester solids received is

reported as a separate line item (Sewage Treatment Plant Residuals) in Table A1 in Appendix A1.

5.3.2. Non-Recyclable Drinking Water Treatment Plant Residuals

In November 2009, the Landfill began accepting drinking WTP residuals from the Seymour Capilano Filtration Plant on a trial basis. The residuals consist of silt and sediment from the raw water reservoir and the coagulants added to bind that sediment together. In November 2011, the MOE authorized the ongoing disposal of WTP residuals as MSW at the Landfill (MOE, 2011). In 2021, approximately 1,812 tonnes WTP residuals were accepted at the Landfill.

5.3.3. Iona Grit Dump Solids

In August 2018, the MOE authorized the temporary disposal of Grit Dump Solids from a closed landfill on the Iona WWTP site until November 30, 2024 (MOE, 2018). The landfill was operational from approximately 1963 to 2000, historically used to dispose of material from the grit collection tanks of both the Iona and Lulu Island WWTPs, and authorized under permit PE-00023 (now Operational Certificate ME-00023) (MOE, 2004a). During the last year of operation (1999 to 2000), the landfill also accepted material from an “oily sludge farm” which consisted of petroleum hydrocarbon contaminated waste from refinery storage tanks. Material removal is required to allow for planned upgrades to the Iona WWTP and typically occurs during an eight to twelve week period in the summer and early fall each year. It was initially estimated there were approximately 40,000 to 65,000 tonnes of Grit Dump Solids that required disposal.

As stipulated in the 2018 MOE authorization letter, the disposal of Grit Dump Solids counts towards the allowable annual tonnage, and is reported as a separate line item in Table A1 in the Appendix. In 2021, the Landfill received 15,889 tonnes of Grit Dump Solids, for a cumulative total as of 2018 of 83,393 tonnes. Metro Vancouver advised there are approximately 2,000 tonnes of Grit Dump Solids remaining on the WWTP site for disposal at the Landfill in 2022.

5.3.4. Non-Recyclable Marine Debris

In February 2021, the City received a disposal request from the Misty Isles Economic Development Society for the disposal of up to 120 tonnes of non-recyclable marine debris from the Haida Gwaii Marine Debris Clean-up Project. The debris was to include crab traps, tires, chains, rope, bricks, blocks and old docks. The City received an authorization letter from the MOE (MOE, 2021a), dated August 17, 2021 to allow for disposal before the end of March 2022. No additional non-recyclable marine debris is anticipated in 2022.

The authorization letter requires that the annual report include the following:

- Tonnage: 6.4 tonnes in 2021
- Fill location: Phase 5
- Dates of discharge: December 15 and 16, 2021

The tonnage of non-recyclable marine debris received is reported as a separate line item (non-recyclable marine debris) in Table A1 in Appendix A1. A signed redacted copy of the waste

assessment forms (as required under the MOE authorization letter) is included in the Appendix 8.

5.3.5. Refuse from Out-of-Region (Metro Vancouver Regional District)

In November 2021, due to the heavy flooding in BC, the Landfill received refuse disposal requests from organizations outside the Metro Vancouver Regional District. The City received approval from the MOE in a letter (MOE, 2021b) dated November 18, 2021 to discharge refuse from out-of-region until the end of March 2022. Refuse from sources outside the region and the quantity of material received is reported on a separate line item (Out-of-Region) in Table A1 in Appendix A1.

5.3.6. Agricultural Waste

Also in response to the heavy flooding, the City worked with Canadian Food and Inspection Agency and the MOE to permit the discharge of cattle mortalities and associated agricultural waste from flood impacted areas at the Landfill. The MOE approved the City's request in a letter (MOE, 2021c) dated November 20, 2021. This authorization expired at the end of December 2021, and the quantity of material received is reported on a separate line item (Agricultural Waste) in Table A1 in Appendix A1.

5.4. Bottom Ash

The regional Waste-To-Energy Facility (WTEF) opened in 1988 in Burnaby, and the bottom ash was initially managed at the Coquitlam Landfill. In 2001, bottom ash was first accepted as subgrade material for an expansion of the Vancouver Landfill Composting Facility. From October 2017 to August 2019, bottom ash was redirected by Metro Vancouver for use in the construction of the new Coquitlam United Boulevard Recycling and Waste Centre in accordance with MOE approval. A total of 35,326 tonnes of bottom ash was disposed of in 2021, slightly lower than 2020.

5.5. Demolition Material

Demolition material is mainly wood waste with small amounts of soft construction material, which has to meet the minimum criteria for wood content of 80%. Drywall, asbestos, putrescible material and Hazardous Wastes are prohibited. In 2021, a total of 29,635 tonnes of demolition material was received at the Landfill, down from 44,138 tonnes in 2020. Most was used for preparation of roads, drainage and gas collection layers in Phases 4 and 5; the remaining material was landfilled.

5.6. Cover Materials

Cover soil for Landfill operations is excavation material generated by sewer, water and street construction activities in the Metro Vancouver region.

In 2021, the Landfill received a total of approximately 357,783 tonnes of soil. The material was distributed on site as follows:

- 68% was direct hauled to the soil stockpile area (see Figure 2);
- 12% was direct hauled to Phase 4 for cover; and

- 20% was direct hauled to Phase 5 for cover.

The soil stockpile area is managed by the on-site contractor, Poschner Construction 88 Ltd. (Poschner), who must maintain a minimum of 30,000 m³ of soil in the area at all times. Articulated ('Yuke') dump trucks are used to deliver soil to the active face on an as needed basis. Poschner installed a weighscale in the area in 2016. Soil usage data by fill location is considered for Annual Aerial Mapping.

5.7. Road Construction & Other Beneficial Use Materials

Road construction materials for temporary access roads on the active areas at the Landfill include purchased and recycled concrete, demolition (demo) hog and wood waste.

In late 2014, the City issued an Expression of Interest for the supply of clean concrete and asphalt directly from construction sites, and has since periodically brought in a crushing contractor for processing the material at the Landfill. Crushed material is used in closure works and for landfill operations. In 2021, there were two crushing events, one in March and the other in November. Approximately 78,800 tonnes of concrete and asphalt and 30,230 tonnes of purchased aggregate were received and managed in 2021.

Demo hog is ground construction wood waste received at a reduced fee from local wood waste processors for use as top dressing on tipping pads. A letter issued by the MOE in February 2008 (MOE, 2008a), confirms demo hog can be classified as a recyclable / beneficial use material and is not counted towards the annual authorized discharge limit in the OC. In 2015, the City issued a Letter of Interest and met with demo hog suppliers after revising the material specifications. Suppliers deliver demo hog on a rotating basis. Effective June 2019, a reduced rate was established for 'fine' demo hog, to reflect the additional processing costs required to reduce the size to meet the City Engineer's specifications. Fine demo hog is used to surface tipping pads, while both coarse and fine demo hog are used for road building and as a road base before placing rock for tipping pads. Approximately 103,540 tonnes of coarse and fine demo hog was received in 2021.

Since January 1, 2011, residential quantities of clean wood waste have been accepted at the Landfill at a reduced fee to encourage diversion. Starting September 2011, the types of wood accepted were expanded to include all wood waste free from fixtures. Wood waste is ground onsite and then used as road base and topped with demo hog. Residential quantities of clean wood waste have also been accepted at the VSTS since January 2011, and the material was comingled with food and green waste collected curbside for composting at private facilities. Approximately 3,980 tonnes of wood waste was received in 2021.

5.8. Closure Materials

Materials used for the construction of engineered cover systems in completed areas of the Landfill include:

- soil to contour the areas to achieve design elevations;
- a geomembrane liner as an impermeable barrier;
- aggregate to convey landfill gas and stormwater to collection systems below and above the liner, respectively; and,

- topsoil to support the growth of grass and future vegetation.

In 2021, closure contractors sourced approximately 55,370 tonnes of aggregate and 494,340 tonnes of soil and topsoil for the Phase 4 closure project.

6. Waste Reduction & Recycling Initiatives

6.1. Zero Waste Centre

The Zero Waste Centre (ZWC) offers a recycling area for large items not typically included in curbside collection programs (mattresses, scrap metal, white goods) and a number of Product Stewardship Program materials (household batteries, lead acid batteries, smoke alarms, tires, thermostats, used oil, used oil filters). In May 2014, the City expanded collection to include all forms of packaging and printed paper covered by the provincial Product Stewardship Program, and under contract to Recycle BC. In June 2018, the City began collecting Other Flexible Plastic Packaging on behalf of Recycle BC for their pilot project as detailed later in this section.

In 2019, as part of the Landfill Entrance Improvement Project, the City expanded the ZWC to manage existing material streams more effectively and plan and implement new programs. In December 2020, the Landfill formally starting accepting paint and household hazardous wastes that are part of the Product Care Association of Canada (Product Care) collection program. Customers bring program items to a sorting table where Staff will confirm if it is acceptable as part of the Product Care program. In 2021, bins were added to the ZWC for the collection of books.

Recycled quantities received are provided in Table 8. The total amount of materials recycled in 2021, including the tonnes associated with materials measured in litres and units, was 2,062 tonnes compared to 1,854 tonnes in 2020.

Table 8: Recycling Quantities for 2020 & 2021

Item	2021	2020	Units
Books	1.81	0	tonnes
Clothing	12.4	4.8	tonnes
Containers (Plastic, Metal, Paper) ¹	3.9	12.5	tonnes
Cooking Oil	1.8	1.2	tonnes
Drywall, new scraps only	88	23.7	tonnes
Electronics & Small Appliances ¹	159	180	tonnes
Fire Extinguishers	1.57	0.90	tonnes
	692	396	units
Glass Bottles & Jars ¹	4.0	5.9	tonnes
Household Batteries & Cell Phones ¹	1.2	1.4	tonnes
Lead Acid Batteries ¹	18.7	25.2	tonnes
Light Bulbs ^{1,2}	2.65	0.75	tonnes
	315	259	tonnes
Mattresses	12,636	10,394	pieces
Mixed Paper & Cardboard, Commercial	0	10	tonnes
Mixed Paper & Cardboard, Residential ¹	260	248	tonnes
Other Flexible Plastic Packaging	6.7	1.8	tonnes
Plastics Bags & Overwrap ¹	1.8	4.1	tonnes
Plastic Foam Packaging ¹	7.9	7.9	tonnes
Product Care Items (Paint, Aerosol, Pesticide, Solvent) ^{1,2}	49	22.9	tonnes
Propane Tanks	9,643	4,315	units
	9.2	8.2	tonnes
	230	242	tonnes
Refrigerators, Freezers & Air Conditioners	3,711	3,789	units
Scrap Metal (excluding Refrigerators, Freezers & Air Conditioners)	821	715	tonnes
Smoke Alarms ¹	3	2	boxes
Tires ¹	35.4	49	tonnes
	3,350	4,542	units
	2.9	0.8	tonnes
Waste Antifreeze ¹	2910	805	litres
	26.8	26.1	tonnes
Waste Oil ¹	30,150	29,380	litres
Waste Oil Filters ¹	1.7	0.8	tonnes
Total³	2,062*	1,854*	tonnes

Note:

¹ product stewardship program material

² abandoned or recovered from waste stream

³ includes tonnes calculated for those items measured in units, pieces, and litres. The conversion factors used were provided by Metro Vancouver and Product Stewards.

* Totals may vary due to rounding errors.

Additional details for select materials are as follows:

- Household batteries and cell phones were collected under the same program by Call2Recycle. However; cell phone total weights were not tracked by the vendor in 2021.
- As per Recycle BC's website², Other Flexible Plastic Packaging are types of film and flexible plastics that often include multiple layers of different types of plastic, making it more difficult to recycle. Collection of Other Flexible Plastic Packaging is part of a research and development project to determine how to best recycle this material. During this time, material that is unable to be recycled will be recovered and produced into engineered fuel.
- Commercial mixed paper and cardboard collection was discontinued as Recycle BC's post-collection depot service provider was able to provide extra bins for mixed paper and cardboard. Only residential materials are collected within the extra bins.

6.2. Disposal Bans

Since 2008, the City of Vancouver has enforced disposal bans in alignment with Metro Vancouver to reduce the amount of material being landfilled that could instead be recycled, and follow BC's *Recycling Regulation* (MOE, 2004b) (defines materials to be managed under provincial EPR Programs).

Materials banned from disposal as garbage at the Landfill are defined in the appendices of the City's *Solid Waste By-law No. 8417* (City of Vancouver, 2021) and mirror those which are banned in Metro Vancouver's *Tipping Fee Bylaw* (GVS&DD, 2021) in most cases.

The Disposal Bans are enforced by Metro Vancouver's Inspection Officers that randomly visit the City's disposal facilities. Disposal Ban Violation notices and surcharges are issued to those customers that dispose of banned materials in excess of the defined thresholds. Appendix 2 contains a complete list of materials that are accepted for recycling at the Landfill and those that are banned from disposal as garbage.

6.3. Yard Trimmings Collection and Composting

Since 1995, the Landfill has operated a composting facility for yard trimmings to divert organics from disposal. Major milestones in the history of organics diversion in the City are as follows:

- 2000 - City crews began collecting residential yard trimmings at the curbside for composting at the Landfill.
- 2006 - curbside collection was automated to reduce injuries to collection workers.
- 2013 - the City added food scraps to the curbside collection program for single family residents following a pilot that began 2010. However, since food scraps are not authorized for composting under the Landfill's Operational Certificate, commingled yard trimmings and food scraps from the curbside program are directed to a private composting facility in the region.
- January 2015 – the City bans food scraps from disposal as garbage.

² <https://recyclebc.ca/flexiblepackaging> accessed March 15, 2022

Yard trimmings delivered by customers to the VSTS and Landfill continue to be composted at the Landfill, in addition to the leaves collected from City Streets by City Crews. Since 2019, yard trimmings are delivered from two of the regional transfer stations (Maple Ridge and Langley), due to the closure of one of the commercial composting facilities in the region. In 2021, approximately 21,600 tonnes of yard trimmings were received, down from approximately 28,500 tonnes in 2020.

The Composting Facility includes a 4.2 ha paved surface, of which approximately one ha was paved in 2021 (West and North areas). The compost area also has a dual-shaft shredder, excavator, two front-end loaders and a windrow turner. A rental star screener was used since 2015, and in 2021, a new screener and a replacement excavator were purchased.

The static windrow composting method is used to process yard trimmings into finished compost. The feedstock is ground up and placed in windrows (piles) using front end loaders, then turned regularly to maintain optimal oxygen and temperature levels throughout. After a minimum of six months in windrows, the material is screened and stockpiled for curing and subsequent sale or donation.

Approximately 19,900 m³ of finished compost was distributed in 2021, compared to 7,500 m³ in 2020. Compost sales totaled 18,600 m³ of which approximately 330 m³ of compost was purchased at a reduced rate by Delta Farmers. The remaining 1,300 m³ was donated to the City of Delta and City of Vancouver residents during free compost campaigns.

Compost quality is compared to standards set out in the MOE's *Organic Matter Recycling Regulation* (MOE, 2002) based on the feedstock and composting method used. In 2020 and 2021, the compost met the standards for unrestricted distribution for all parameters listed in the Regulation. A summary of the compost quality in 2020 and 2021, and the standards for unrestricted use are provided in Table 9.

Table 9: Compost Quality for 2020 & 2021

Parameter	BC Standard mg/kg unless stated	2021 Mean Value mg/kg unless stated	2020 Mean Value mg/kg unless stated
Arsenic	13	5.4	5.1
Cadmium	3	0.5	0.5
Chromium	100	21.5	21.0
Cobalt	34	4.5	4.6
Copper	400	61.5	65.0
Lead	150	27.5	28.7
Mercury	2	0.1	0.1
Molybdenum	5	1.5	1.4
Nickel	62	15.2	16.2
Selenium	2	<0.50	<0.50
Zinc	500	171.5	162.7
Foreign Matter (%)	1	0.02	0.1

6.4. Diversion Projections

The 2010 *Integrated Solid Waste and Resource Management Plan* (ISWRMP) established future diversion targets, including an aspirational goal of 80% diversion by 2020. The Plan outlines initiatives for achieving these rates which include diverting demolition, landfill clearing and construction waste for recycling as well as food waste to composting and energy recovery.

As per the *2021 ISWRMP Biennial Report* (Metro Vancouver, 2022) produced by Metro Vancouver and dated January 2022, 64% of the materials generated in the region in 2020 were recycled or diverted from disposal. This diversion rate is the same as determined in the previous period (2018) as reported in the *2019 ISWRMP Biennial Report* (Metro Vancouver, 2020). The next ISWRMP report is anticipated to be completed in 2023.

7. Environmental Protection Programs

7.1. Leachate, Surface Runoff and Stormwater Management

Water management at the Vancouver Landfill is described using the following terminology:

- **Leachate** - produced by rainwater percolating through waste.
- **Surface Runoff** - rainwater that flows along the surface of areas of the Landfill (subject to the placement of daily or intermediate cover), and may be impacted by leachate.
- **Stormwater** - rainwater that is collected above the engineered cover system installed in closed areas of the Landfill. Stormwater is not impacted by leachate.

The Landfill site is underlain by compressed peat and a continuous layer of relatively impermeable clayey-silt, which is referred to as the natural soil barrier layer. Prior to the placement of waste in each landfill cell, a layer of demolition material was placed on top of the

peat. This provides the conduit for leachate to flow laterally to the double ditch system surrounding the Landfill footprint as shown in Figure 5. The layer of demolition material, natural soil barrier layer, and double ditch system are collectively referred to as the leachate collection system. The inner ditch collects leachate, while the outer ditch, more commonly known as the drainage ditch, collects clean water that runs off adjacent land. The drainage ditch is maintained at a higher level than the inner ditch to contain leachate in the inner ditch as shown in Figure 6. The leachate is then conveyed from the pump station located in the southwest corner of the Landfill through force mains to the Annacis Island WWTP under *Waste Discharge Permit SC-100168-FSA* (WDP) (GVS&DD, 2011).

In addition to leachate, surface runoff is routed to the inner ditch. An internal storage pond (linear pond 4) is used to reduce peak discharge to the sewer system. This pond has an approximate capacity of 65,000 m³ and is located north of the Phase 4 stormwater retention pond (Figure 5).

The Phase 2 and Phase 3 closure areas each have a dedicated pond for stormwater retention, which had a combined capacity of 100,000 m³ when constructed, but has reduced to 67,200 m³ due to settlement. Six retention ponds for clean stormwater in the Western 40 Hectares have a combined storage capacity of approximately 87,700 m³. The Phase 4 retention pond, which has an estimated capacity of approximately 100,000 m³, was constructed with Phase 4S closure.

Up until October 2020, stormwater was directed to the retention ponds then once the storm had passed, to the inner ditch. In October and November 2020, two stormwater discharge pilot tests were conducted (AECOM, 2021c). The purpose of the pilot tests was to assess whether the Dredge Pond could receive clean stormwater discharge from three of the on-site retention ponds (Phase 1, Phase 2 and Phase 3 ponds) without adversely affecting Dredge Pond water quality or causing off-site flooding events. The water quality from these three retention ponds was shown to be suitable for off-site discharge based on previous results of the stormwater monitoring program.

The two pilot tests conducted in 2020 resulted in approximately 81,040 m³ of stormwater being discharged to the Dredge Pond (outside the leachate collection system). The pilot was extended to March 2021 during which an additional 183,130 m³ of clean stormwater was diverted to the Dredge Pond during the first three months of the year. The pilot tests demonstrated that discharging clean stormwater from the three retention ponds to the Dredge Pond did not appreciably affect Dredge Pond water quality or result in any downstream flooding events. As such, the stormwater discharge pilot assessment was considered a success and eventually became a continued operational practice. As a result, it is estimated that in 2021, approximately 395,000 m³ of clean stormwater were diverted from the leachate collection system resulting in an approximate savings of \$610,000 in leachate conveyance and treatment costs.

The annual fees associated with leachate, surface runoff and stormwater management include a conveyance fee paid to Delta for the use of the sewer system, and an industrial discharge fee made up of capacity and usage components for the treatment of the leachate at the WWTP. The capacity and usage charges account for biological oxygen demand (BOD), total suspended solids (TSS) and flow. In 2021, the cost associated with leachate conveyance and treatment totaled \$3.64 million. Approximately 75% of this cost was associated with conveyance, which is slightly lower than last year.



Figure 5: Leachate, Surface Runoff and Stormwater Management

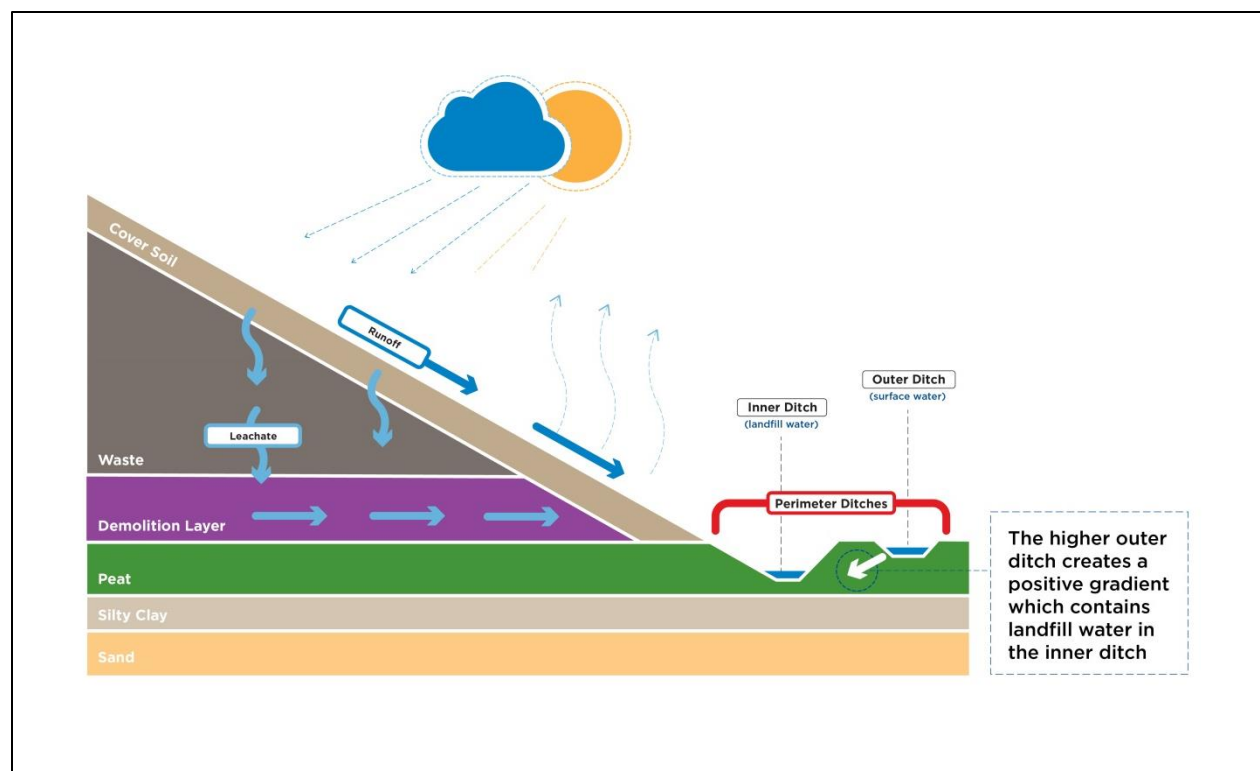


Figure 6: Leachate Collection System Cross-Section

Monthly leachate flow and precipitation data for 2021 are provided in Table 10.

Table 10: 2021 Leachate Flow Volumes and Precipitation

Month	Leachate Flow (m³)	Precipitation³ (mm)	Precipitation Volume (m³)	Ratio of Leachate Flow to Precipitation Volume
January ¹	498,223	164	369,225	135%
February ¹	243,402	100	224,325	109%
March ¹	139,689	46	102,600	136%
April ¹	73,483	25	56,475	130%
May	46,870	31	69,075	68%
June	50,487	28	63,000	80%
July ¹	47,042	1	1,575	2987%
August	44,752	36	81,900	55%
September	66,639	149	335,250	20%
October	174,589	140	315,900	55%
November	473,957	377	848,700	56%
December ¹	487,775	139	312,075	156%
Total²	2,346,908	1,236	2,780,100	84%

Notes:

¹ The high ratio of leachate flow to precipitation volume reported in select months can be due to the release of stored water that occurs when the landfill becomes saturated, and to the controlled release of clean stormwater from storage ponds in the winter months.

² The high ratio of leachate flow to precipitation volume is attributed to an increase in landfill surface area that has been closed with an engineered cover system, and overland flow from the outer drainage ditch to the inner ditch during significant rainfall events in winter.

³ Recorded at Delta Burns Bog Station 1102415.

A total of 2,346,908 m³ of leachate, surface runoff and stormwater was pumped to Annacis Island WWTP in 2021. Leachate from the Vancouver Landfill is considered dilute compared to other MSW landfills because of the high volume of surface runoff and stormwater from the closed areas that have historically been treated as leachate.

The average annual ratio of leachate discharge to precipitation volume has been on an upward trend since progressive closure started in 2009. This is likely attributed in part to an increase in the surface area of the Landfill that has been progressively closed as well as other water inputs to the leachate collection system that have yet to be characterized (inflows from outer ditch and groundwater capture).

7.2. Leachate Generation Control Measures

Leachate generation at the Landfill is controlled through a number of mechanisms, which include the following:

- Progressive closure of completed phases, with an impermeable geomembrane cover system installed to minimize infiltration and leachate generation. Hydroseeding reduces erosion and increases evapotranspiration. See Figure 7 for the cross-section of the typical final cover system.
- Dedicated linear ponds for leachate and surface runoff to control flows to the leachate pump station as well as stormwater retention ponds to reduce flows from closed areas to the pump station or Dredge Pond during significant precipitation events. See Figure 5 for pond locations.
- Use of daily and intermediate cover at the active face and keeping the active face as small as possible to minimize infiltration from precipitation.
- Erosion control measures on side slopes, such as swales and downchutes, to convey water to internal ditches.

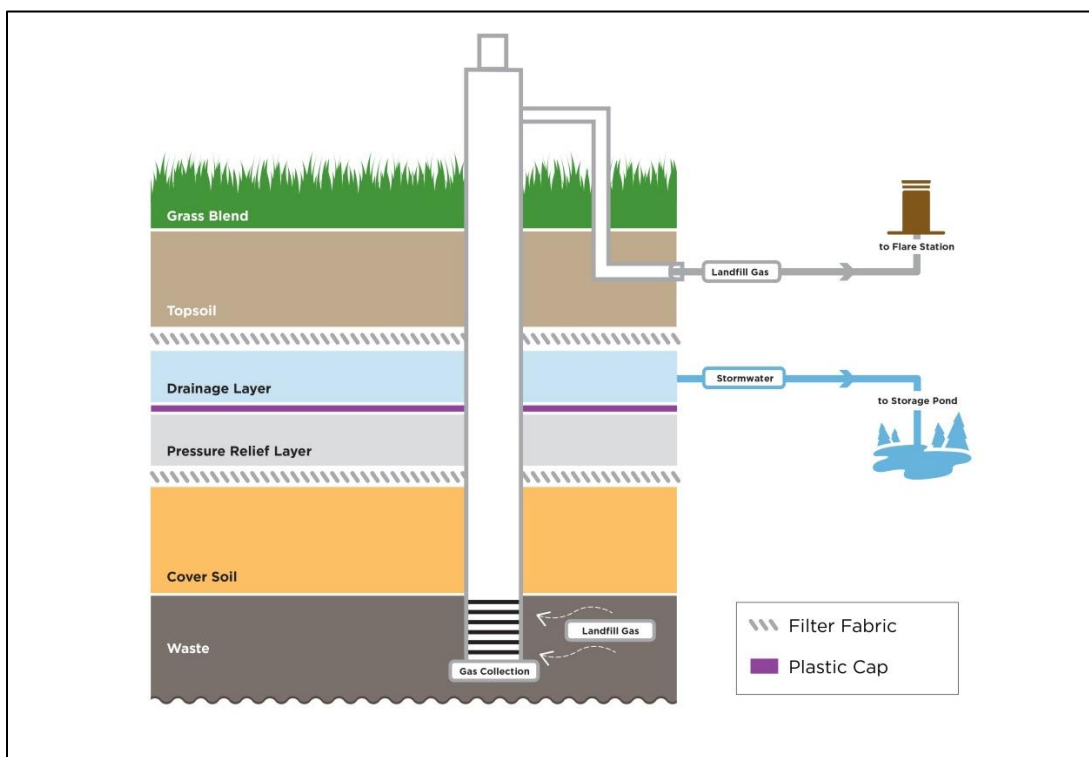


Figure 7: Final Cover System Cross-Section

7.3. Water Quality Monitoring Program & Annual Review

The Landfill OC requires regular sampling and analysis of leachate, and surface and ground waters in the vicinity of the Landfill, for the stations and parameters indicated. Leachate flow measurement and leachate/drainage ditch water level measurements are also required. The Landfill's WDP also requires regular sampling and analysis of leachate, in addition to leachate flow measurement. The Landfill Water Quality Monitoring Program (WQM Program) is in place to meet the above requirements and includes stormwater sampling as well. Sampling and data collection is completed by City Staff, according to the 2021 Leachate, Groundwater, Surface Water and Stormwater Monitoring and Sampling Manual prepared by AECOM.

In 2021, one leachate station, 13 surface water locations, 18 shallow groundwater wells and 20 deep groundwater wells were sampled quarterly by Landfill Staff. Shallow groundwater wells are screened in the peat aquifer and range in depth between 2.5 – 4 m, while deep groundwater wells are screened in the sand aquifer and range in depth between 6 – 9 m. Well and sampling locations are shown in Appendix 3. Additionally, a 24-hour composite sample representing the leachate pumped to Annacis Island WWTP was taken monthly. Samples were analyzed for the parameters listed in Appendix 4.

Consultants hired by the City have completed annual reviews of the WQM Program each year since 1999. As per the *City of Vancouver Landfill - 2021 Annual Water Quality Monitoring Report* (AECOM, 2022a) also known as the 2021 Review, the 2021 Landfill WQM Program meets or exceeds the requirements set out in the OC and WDP with respect to the number, type and locations of stations monitored, sampling frequency, water quality parameters, and detection limits with the following exceptions:

- Five surface water stations (Stations 43, 44, 45, 91 and 96) were not sampled during dry ditch conditions in the third quarter. City staff were also unable to sample Station 45 in the second quarter due to dry ditch conditions.

As part of the the 2017-2021 Water Quality Consulting & Stormwater Management Planning Project described in Section 4.1, AECOM conducted stormwater and surface water monitoring at the Landfill and surrounding area between September 2018 and April 2019. The objective of the program was to assess the feasibility of discharging stormwater outside of the leachate collection system as required by the OC and WDP. The December 2019 *City of Vancouver – 2018/19 Stormwater and Surface Water Monitoring Report* (AECOM, 2019) recommended that a regular monitoring program for stormwater be implemented, and include monthly sample collection from October to March each year. Sampling began in December 2019 and continued into 2021. Results from the sampling events are included in the 2021 Review.

The executive summary from the 2021 Review, including report recommendations, is included in Appendix 6. A tabulation of the leachate/drainage ditch levels is included in Appendix 7.

7.4. Landfill Gas Management System

The City began collecting and flaring LFG in 1991, with a small portion of the gas utilized for space and water heating on site. The City typically uses less than one percent of the collected LFG for on-site space heating for the administration and technical buildings. However, this discontinued in December because the heating units in the administration and technical trailer buildings were upgraded temporarily to propane in anticipation of Village Farms Clean Energy (VFCE) shutting down for plant upgrades.

The City began selling LFG for beneficial use of LFG in 2003 to Maxim Power Corporation (Maxim) for their combined heat and power cogeneration facility located southeast of the Landfill's blower-flare station. Village Farms International Inc. (VFI) purchased the assets of Maxim Power Inc. in July 2014. VFI operates the facility under the name Village Farms Clean Energy (VFCE).

The amount of LFG being flared has increased in the last two years (2020-2021) as VFCE prepares to switch their LFG usage to making renewable natural gas for sale to FortisBC.

Planning for two Renewable Natural Gas Facility (RNG) projects is underway, and their progress is detailed below.

7.4.1. Delta RNG

In October 2020, the City and Village Farms Clean Energy (VFCE) finalized an amendment to their 20-year agreement to extend the term to allow VFCE to construct upgrade their equipment at the Landfill to produce RNG off site for the Fortis pipeline and carbon dioxide for their greenhouses. The agreement extension is for a 20-year period and commences upon start-up and commercial operations of the Delta RNG project with an option to extend for an additional 5-year period. Design began in late 2020 and commercial operation is planned for Q1/Q2 2023.

7.4.2. FortisBC RNG

In 2018, FortisBC and the City reached an agreement for FortisBC to develop an upgrading plant at the Landfill to convert LFG to RNG for the FortisBC pipeline. This agreement was approved by the BC Utilities Commission in September 2019. In December 2021, FortisBC successfully selected their technical provider for the RNG facility project and awarded the balance of plant design work. Commissioning is planned in Q4 2023.

An overview of the LFG management system is shown in Figure 8, with the distribution of the vertical gas wells, horizontal gas collectors and DRAINTUBE³ gas collectors across the Landfill footprint shown in Figure 9.

³ DRAINTUBE is a geocomposite mat consisting of small diameter plastic pipes (<25mm in diameter) between layers of geocomposite material that is used for collecting landfill gas under the geomembrane cover and in the waste mass.

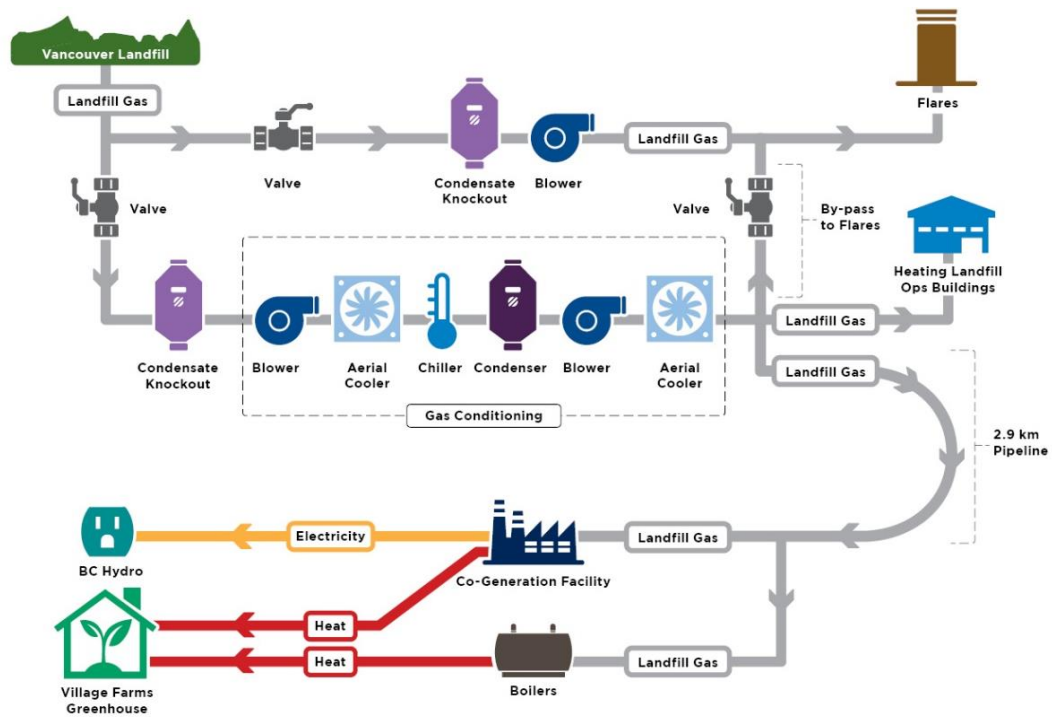


Figure 8: Landfill Gas Collection & Beneficial Use System



Figure 9: 2021 Landfill Gas Collection System

The total volume of landfill gas (LFG) collected in 2021 is reported in two ways in this section and Table 11:

1. As measured by individual meters; and,
2. On a normalized basis (to 50% methane by volume) as per the methodology used by the MOE in Section 3.2 of the 2010 *Landfill Gas Management Facilities Design Guidelines* (Conestoga-Rovers & Associates, 2010).

Table 11: 2021 Landfill Gas Collection and Beneficial Use

Date	Weighted Average Methane Content (% by vol.)	LFG to Utilization Facility (m ³)	LFG to Flare (m ³)	LFG to Building Heat (m ³)	LFG Captured for Period (m ³)
2021 Total (metered)	50.4	19,376,431	52,459,956	1,501,200	71,878,897
2021 Total (normalized to 50 percent methane)	50.0	19,529,309	52,873,859	1,513,044	72,446,012
2021 Daily Average	50.4	53,086	143,726	4,113	196,928
2021 Daily Average (normalized to 50 percent methane)	50.0	53,505	144,860	4,145	198,482

The total metered volume of LFG collected in 2021 equates to 24,541 tonnes of methane or 613,527 tonnes of carbon dioxide equivalents (CO₂e). It is equivalent to the emissions approximately of 133,375 vehicles over the period of a year.

In 2021, approximately 27% of the LFG collected was directed to beneficial use, and the remaining 73% was flared.

7.5. Landfill Gas Collection Efficiency

The 2021 Collection Efficiency (%CE) was 77.4% which exceeded the BC MOE's target of 75%. There was an increase in collection efficiency of 4.1% compared to 2020.

This increase in collection efficiency between 2020 and 2021 is due to the City's continued effort to maximize LFG collection through an aggressive capital works program constructing LFG infrastructure in a timely manner to collect as much gas as early as possible as well as operational improvements made in the landfill gas wellfield.

The landfill gas collection efficiency has been prepared in accordance with the requirements of the *Landfill Gas Management Regulation* (MOE, 2008b), and in accordance with the *Landfill Gas Management Facilities Design Guidelines*.

In 2021, new vertical gas wells, horizontal gas collectors, side slope gas collectors and Draintube gas collectors were installed. Refer to Section 4.2 for the complete breakdown of LFG infrastructure by phase.

In 2021, the City has also modified some operating procedures to increase collection efficiency including:

- The field monitoring (gemming frequency) of gas wells collecting at least 15 scfm of LFG and has at least 55% methane were increased to twice per month; and
- A pressure relief (PR) gas collector audit was conducted to search for alternate sources of LFG collection. This led to three PR gas collectors being added to the monthly field monitoring as they were found to be producing collectable gas.

Further details on LFG collection activities in 2021 can be found in the *2021 Annual Landfill Gas Report for the Vancouver Landfill* (City of Vancouver, 2022).

7.6. Landfill Gas Surface Emissions Monitoring Program

In 2015, the City hired Golder Associates Ltd. (Golder) to conduct surface emissions monitoring to determine the total methane emissions (flux) from the Landfill footprint with identification of general areas of higher emissions. The Airborne Matter Mapping method is used and it applies a mass balance approach by sampling the emission plume with a helicopter and using multiple sampling runs at different elevations.

In the first year of monitoring, the method identified the active area (Phase 3) to be the largest source of emissions, and a few other areas for intermediate soil cover repair. Measurements collected in 2016 and 2018 yielded similar results. In 2020, the active portion of Phase 4 was identified as the largest emission source. Three minor emission sources were also discovered in the W40 Ha area.

Additional flights have been postponed to 2023 to allow time for Phase 4 closure to be completed in order to assess any issues with closure.

7.7. Subsurface Soil Landfill Gas Monitoring

The purpose of subsurface soil gas monitoring is to monitor the subsurface migration of LFG beyond the LFG wellfield (closed and active filing areas) to onsite buildings.

In 2020, 18 subsurface soil gas monitoring probes were installed near the perimeter of the site in between the waste mass and the property boundary. Monthly monitoring began in March 2020.

Of the 18 probes, eight were found to have exceeded the 5% CH₄ LEL threshold at some point during the first year of monitoring. Attempts were made to mitigate this LFG soil gas migration by turning up the suction in vertical gas wells in the gas fields immediately adjacent to the gas probes. Frequent readings were taken, before and after LFG flow adjustments were made in the field. On analysis, it was found that altering the suction on the gas wells had no apparent effect

on subsurface gas migration. The main cause of changes (% CH₄) in gas migration was found to be changes in atmospheric pressure. As a result of this analysis, monitoring frequency was reduced to quarterly as of March 2021. To address the gas migration, consultants recommended the installation of two additional building methane monitors in 2022 at the Air Compressor trailer and Poschner (onsite contractor) works yard (see Section 7.8).

7.8. Building Methane Monitoring

In 2021, the City changed from Atlas Copco to Comcor to maintain the continuous combustible gas measurement equipment (building methane monitors) installed in 2016 throughout Landfill buildings. Since then, the building methane monitors have been calibrated quarterly and replaced once they exceeded their service-life. As of December 2021, there were a total of 34 building methane monitors installed and operational at the Landfill. Two additional monitors will be installed in 2022 at the Compressor trailer and Poschner (onsite contractor) works yard.

7.9. Landfill Gas Migration & Emissions Monitoring Program

The City has had a perimeter ambient air monitoring program since 2012 to monitor potential nuisance odour sources at the property boundary. Ambient air is monitored for total organic carbon (TOC) as methane (CH₄), and hydrogen sulfide (H₂S) at each station at heights of 10 cm and 200 cm above ground elevation.

At the start of 2021, there were 57 stations along the Landfill perimeter on the West, North, East and part of the South boundaries. During 2021, 19 new perimeter monitoring locations were added along the south boundary of the Landfill along the Dredge Pond to complete the loop of monitoring locations around the perimeter.

There were two detections, above the detection limit (50 ppm), on the western boundary for TOC (compared to none in 2020). This is due to the stations on the western boundary being moved closer to the perimeter.

There were 15 detections, above the detectable odour limit (3 ppb), for H₂S (compared to none in 2020). This was due to the new stations along the southern boundary of the landfill. Most of these were south of active filling areas and the flare station.

The City will further evaluate potential odour sources.

8. Operational Information

8.1. Nuisance Waste

In 1999, a database was created to track nuisance waste accepted at the Landfill. Nuisance waste is defined as material that requires special consideration, documentation, handling or disposal (such as direct burial). These materials typically originate from small businesses or light industry and are not classified as Hazardous Waste. The waste generator completes a Waste Assessment Form and submits it for review and approval by City staff. Waste Assessment Forms are entered into the database from which summary reports can be generated.

Nuisance waste also includes materials ordered for destruction by the Canadian Food Inspection Agency (CFIA). Deep burial is required to meet CFIA requirements and is often witnessed by a CFIA Officer.

Table 10 lists the types of nuisance wastes and quantities received at the Landfill in 2021. The tonnage of CFIA burials in 2021 was approximately 5,600 tonnes more than in 2020, mainly attributed to Japanese beetle soil. In addition, street sweepings also decreased by approximately 160 tonnes compared to 2020 due to more sweeping being done by City crews. Overall 2021 nuisance waste quantities dropped by 5,313 tonnes when compared to 2020 quantities, which represents a 65% decrease.

Table 12: 2021 Nuisance Waste Quantities

Material	2021 Quantity (tonnes)
CFIA burials	7,262
Street sweepings	568
Shellfish scrapings and shells	468
Other	372
Non-Compostable Food	99
Fish waste	39
Fish nets	32
Rope	25
Invasive Species	14
Marine Debris	6
Total	8,886

Note:

* Other includes expired cosmetics, grain sweepings, non-recyclable products (rubber, hose assemblies, pocket coil cores, stumps, ice paint, post sortation residue).

8.2. Bird Control & Counts

Birds, particularly gulls, are a nuisance at landfill sites. In large numbers, they create a negative image of landfills and scatter litter onto surrounding areas. Birds are also a potential aviation hazard. A formal program using birds of prey started in July 2001. The program includes the use of trained raptors (hawks) near the active face as a primary control method. The raptors discourage gulls and other birds from approaching the waste. Secondary control methods are used when trained raptors are not an option, such as when traffic is heavy or it is very windy or rainy. These methods include noise deterrents (stock or bull whips, pyrotechnics, whistles), visual deterrents (aerial projectiles, laser pointers, kites), and positioning the bird control vehicle close to the active area.

Pacific Northwest Raptors has been providing bird control service since January 2016 and is based on Vancouver Island.

In early 2018, the City began supporting the Hancock Wildlife Foundation in collaboration with Simon Fraser University for the Bald Eagle Tracking Alliance Project. The Project aims to better

understand the movements of bald eagles using tracking devices. Annual bald eagle counts are typically performed by the Hancock Wildlife Foundation (HWF); however, no counts occurred in 2021 due to the pandemic.

8.3. Household Hazardous Waste

Household hazardous wastes (HHW), such as paints, used oil, flammable liquids and pesticides, are banned from disposal at the Vancouver Landfill. However, residents periodically abandon or discard HHW in loads of refuse.

In 1993, a storage facility was set up at the Vancouver Landfill for abandoned HHW. The facility was upgraded in 1999 to provide a larger covered drop-off area and improved security. The facility consists of a fenced area where HHW waste is placed into boxes, drums, tub skids or a fireproof storage cabinet. Used oil is bulked by Staff into a steel double walled tank. Product stewards and a HHW contractor regularly remove and safely dispose of the waste. The facility was updated in 2019 to add more space as part of the Landfill Entrance Improvement Project.

In December 2020, the Landfill formally starting accepting paint and HHW that is part of the Product Care collection program. Customers bring program items to a sorting table where Staff will confirm if it is acceptable or not. As a result, the Landfill Zero Waste Centre depot is now an authorized collection depot for Product Care, and the City receives revenues for collection program materials. This partnership will provide increased residential recycling options and reduce the costs for HHW management.

In 2021, the total cost of contracted services for the removal and disposal of HHW not covered by stewardship programs was approximately \$25,400 compared to \$49,000 in 2020. Costs during 2021 were almost 50% lower than 2020, due to the implementation of the Product Care collection program. Note that City staff time to segregate and pack the materials is not included in the costs above.

8.4. Site Inspections

Formal site inspection activities beyond those conducted as part of environmental monitoring programs, are summarized in Table 13.

Table 13: 2021 Site Inspection Activities

Type of Inspection	Description	Findings & Action Taken (if applicable)
Site Tour	Conducted weekly by the GPS Technician and Superintendent to assess progress of filling, cover integrity, erosion, and settlement in active areas.	Any signs of erosion on side slopes are addressed promptly by Operations Staff at the direction of the Superintendent.
Workplace Inspections	Conducted monthly by representatives from the OH&S Committee and exempt Staff to verify compliance with the	Any deficiencies identified are logged and addressed as soon as practical with discussion

Type of Inspection	Description	Findings & Action Taken (if applicable)
	Landfill's Safety Management Program and <i>OH&S Regulation</i> .	following in the monthly OH&S Committee Meetings.
Vegetation Inspection	Site inspection conducted in January, March, September and December 2021 by City staff, with occasional support from landscaping contractor to identify invasive species and prepare a management plan. Monthly inspections for invasive plants completed by the landscaping services contractor in established naturescaping areas.	<p>Several different invasive plants are present in large numbers throughout the landfill closed areas.</p> <p>Attempts were made to remove Scotch Broom, chemically treat Japanese Knotweed and close the Western 40 Pond 1 and Pond 5 valves to allow flooding to suppress the growth of Reed Canary Grass. At the end of 2021, Himalayan Blackberries were partially removed from the Wildflower slope.</p> <p>In the naturescaping areas, multiple invasive plants were removed by hand as part of regular monthly maintenance tasks, including: Himalayan Blackberries, Creeping Buttercup, Teasel, Common Mullein, Reed Canary Grass and Common Butterfly Bush.</p>
Leachate Collection System Inspection	Conducted in advance of and during significant precipitation events by the Environmental Technician to ensure ditches and culverts are not obstructed by debris, leachate flow is unobstructed, and freeboard exists between water levels in the leachate and drainage ditches and crest of the intermediate berm.	Any accumulation of debris is managed promptly by Operations Staff.
Property Boundary Inspection	Conducted quarterly by Environmental Technician to monitor for litter so crews can be deployed for collection.	Contractor engaged to remove litter bordering the active areas. Typically performed in the first, second and fourth quarter.

8.5. Operating Problems and Corrective Actions

The operating problems and corrective actions taken in 2021 are detailed in Table 14.

Table 14: 2021 Operating Problems and Corrective Actions

Problem	Leachate Pump Station – Pump #4 Repairs
Description	In September 2021 when Pump #4 (the largest of four pumps within the leachate pump station) was undergoing preventative maintenance by the City waterworks crew, certain tests indicated there was an elevated risk of potential pump failure. At that point, a re-build kit was ordered and plans were made to extract and overhaul the pump once the kit arrived. However due to pandemic related supply chain challenges, the City was advised that it could take several weeks before replacement parts arrived. In mid-October 2021, Pump #4 experienced a motor failure and was no longer operational leaving the remaining three pumps to manage the high leachate flows anticipated in the fall and winter.
Corrective Action	The City notified the MOE and began implementing a contingency plan. The City contacted the pump vendor to remove Pump #4 from the wet well and take it to their shop for repairs. The pump required specialized parts from Europe which took approximately six weeks to arrive, fix and re-install. In the interim, the City installed temporary pumps to convey leachate from the inner ditches to the leachate storage pond (linear pond 4) to reduce peak flows at the pump station. The re-furbished pump was put back into service on November 26 and full pumping capacity was restored.
Problem	November Flooding
Description	<p>In mid-November, most of southern BC experienced successive periods of intense rainfall (termed atmospheric rivers) that resulted in severe flooding and led to a provincial state of emergency being declared. During this time, the water level in both the inner and outer ditches surrounding the Landfill rose and overtopped the berm at several locations.</p> <p>The floods also caused landslides and highway closures. As a result, transportation was impacted due to these road closures. Post collection service for recycling of foam and glass materials from Recycle BC were impacted as the processing facilities required highway transportation. In addition, mattress hauling to the Island was impacted as ferries were prioritized to bring in food supplies.</p>

Corrective Action	<p>The City notified the MOE and other stakeholders of the flood events at the Landfill. AECOM was retained to visit the site, collect water quality samples and assess potential impacts in areas where water over-topped the berm. (AECOM, 2022b). The City's contractor was instructed to activate the perimeter ditch pump network to draw leachate from the inner ditch and store it in linear pond 4. This was done in an effort to maintain an inward flow gradient from the outer to the inner ditch given that both ditches were hydraulically connected at some locations. The City continued to monitor and pump leachate over a three day period until ditch separation was restored. Once the leachate pump station was restored to full capacity in late November (pump #4 was repaired), ditch levels were restored to normal levels and the contingency pumping effort was significantly reduced.</p> <p>Recycle BC temporarily suspended accepting foam and glass materials from recycling depots. The City eased the disposal ban bylaw to allow customers who weren't aware of the temporary suspension to dispose of residential quantities of foam and glass as MSW. At the end of December and early January, Recycle BC announced they would resume collecting foam and glass materials respectively. Mattresses hauling was only suspended for two weeks, and resumed once highway roads were re-opened.</p>
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8.6. Operational and Maintenance Expenditures

The total spent in 2021 for operations and maintenance at the Landfill was approximately \$25 million, as detailed in Table 15. Total expenditures in 2021 were approximately 5% higher than in 2020 due to higher staffing and equipment costs in the ZWC, including the installation of an emergency shower in the HHW area.

Table 15: Operational and Maintenance Expenditures for 2020 & 2021

Item ¹	2021	2020
Salaries, Administration, Wages & Fringe Benefits	\$5,939,150	\$5,347,013
Vehicle & Equipment Rental	\$4,328,939	\$3,725,971
Insurance, Taxes, Loan Payments, Utilities, Building Maintenance, Permits & Landscaping	\$5,417,593	\$6,058,831
Recycling	\$437,401	\$317,671
Roads and Cover	\$1,754,044	\$1,502,619
Water Quality, Gas Management, Ditch Maintenance, Bird Control, Household Hazardous Waste Disposal, etc.	\$1,714,896	\$1,410,259
Consulting Projects (Leachate Upgrades, Gas, etc.)	\$179,810	\$153,298
Sewer and Soil Deposit Fees	\$4,437,908	\$4,589,487
Weighscales	\$797,985	\$736,689
Total	\$25,007,727	\$23,841,838

Note:

¹ Items do not include capital loan repayments and other cost allocations.

8.7. Public Complaint and Resolution Log

In 2021, the Landfill logged eight complaints, down from 24 received in 2020. The Public Complaint and Resolution Log for 2021 is available in Appendix 5.

More than one complaint was received on the following items:

- Customer feedback - Customers complained about the minimum transaction fees to dispose their garbage at the Landfill and frustration over no new commercial accounts being allowed at this time. Landfill staff reviewed and ensured they followed operational policies and procedures.
- Customer experience - Customers raised concern regarding communications by Staff, such that messaging could have been communicated in a more friendly and understanding manner. When a customer experience complaint is received, a Superintendent is in contact with the customer to gather information and the Staff member to resolve it.

8.8. Landfill Tours

Landfill Staff regularly provide tours of the Landfill for a variety of visitors, including school groups (kindergarten to university levels), special interest groups, industry associations & professionals, delegates from other countries, and members of the public. Visitors in groups bring their own vehicles for tours since the Landfill does not have a dedicated vehicle for this purpose.

Tours provide the opportunity to showcase how waste is responsibly managed to minimize environmental impacts, and how much work we still have to do as a society to reduce the amount of waste sent for disposal.

Due to the pandemic, Landfill Tours were suspended on March 11, 2020 and the City canceled the 2020 open house. In 2021, there were no Landfill Tours due to COVID-19 restrictions. Tours continue to be suspended until there is a sustained lifting of restrictions by the Province. The next open house will be planned following the conclusion of the COVID-19 restrictions.

References

AECOM Canada Ltd, (AECOM, 2018). *City of Vancouver Landfill – 2018 Hydrogeology Review*. Report prepared for City of Vancouver, December 20, 2018.

AECOM Canada Ltd, (AECOM, 2019). *City of Vancouver – 2018/19 Stormwater and Surface Water Monitoring Report*. Report prepared for City of Vancouver, December 31, 2019.

AECOM Canada Ltd, (AECOM, 2020). *City of Vancouver Landfill Stormwater Management Plan*. Report prepared for the City of Vancouver, July 17, 2020.

AECOM Canada Ltd, (AECOM, 2021a). *City of Vancouver Landfill – 2021 Leachate, Groundwater, Surface Water and Stormwater Monitoring and Sampling Manual*. Report prepared for the City of Vancouver, August 6, 2021.

AECOM Canada Ltd, (AECOM 2021b). *Vancouver Landfill Aerial Mapping Report April 8, 2020 – April 13, 2021*. Report prepared for City of Vancouver, December 16, 2021.

AECOM Canada Ltd, (AECOM, 2021c). *Stormwater Pilot Discharge Assessment*. Report prepared for City of Vancouver, October 25, 2021.

AECOM Canada Ltd, (AECOM, 2022a). *City of Vancouver Landfill – 2021 Annual Water Quality Monitoring Report*. Report prepared for City of Vancouver, March 31, 2022.

AECOM Canada Ltd, (AECOM, 2022b). *Perimeter Ditch Overflow Impact Assessment*. Report prepared for City of Vancouver, March 29, 2022.

BC Ministry of Environment, Lands and Parks, (MOE, 2001). *Operational Certificate MR-01611*. Issued October 31, 1973, Amended March 8, 2001.

<https://j200.gov.bc.ca/pub/ams/download.aspx?PosseObjectId=59566144>

BC Ministry of Environment, (MOE, 1988). *Hazardous Waste Regulation B.C. Reg. 63/88*. February 18, 1988. https://www.bclaws.gov.bc.ca/civix/document/id/crbc/crbc/63_88_multi

BC Ministry of Environment, (MOE, 2002). *Organic Matter Recycling Regulation B.C. Reg 18/2002*. February 5, 2002.

https://www.bclaws.gov.bc.ca/civix/document/id/crbc/crbc/18_2002

BC Ministry of Water, Land and Air Protection, (MOE, 2004a). *Operational Certificate ME-00023*. Issued April 2, 1958, Amended April 23, 2004.

<https://j200.gov.bc.ca/pub/ams/download.aspx?PosseObjectId=52071188>

BC Ministry of Environment, (MOE, 2004b). *Recycling Regulation B.C. Reg. 449/2004*. October 7, 2004.

https://www.bclaws.gov.bc.ca/civix/document/id/crbc/crbc/449_2004

BC Ministry of Environment, (MOE, 2008a). *Request for Consideration of Materials for Beneficial Use at the Vancouver Landfill – Demo Hog*. Letter prepared for the City of Vancouver, February 28, 2008.

BC Ministry of Environment, (MOE, 2008b). *Landfill Gas Management Regulation*. December, 2008.

<https://www2.gov.bc.ca/assets/gov/environment/waste-management/garbage/landfillgasmanreg.pdf>

BC Ministry of Environment, (MOE, 2008c). *Disposal of Greater Vancouver's Regional District's Sludge and Scum Screenings from the Annacis Island WWTP at the Vancouver Landfill*. Letter prepared for the City of Vancouver, October 21, 2008.

BC Ministry of Environment, (MOE, 2011). *Disposal of Water Treatment Plant Residuals from the Seymour-Capilano Filtration Plant at the Vancouver Landfill*. Letter prepared for the City of Vancouver, November 3, 2011.

BC Ministry of Environment, (MOE, 2012). *Disposal of Non-Recyclable Wastewater Treatment Plant Residuals from the Five Metro Vancouver Owned and Operated Wastewater Treatment Plants at the Vancouver Landfill*. Letter prepared for the City of Vancouver, June 29, 2012.

BC Ministry of Environment and Climate Change Strategy, (MOE, 2016). *Landfill Criteria for Municipal Solid Waste, Second Edition, British Columbia*. June, 2016.

<https://www2.gov.bc.ca/gov/content/environment/waste-management/garbage/landfills>

BC Ministry of Environment and Climate Change Strategy, (MOE, 2018). *Vancouver Landfill Operational Certificate MR-01611 Temporary Disposal of Iona Grit Dump Solids*. Letter prepared for the City of Vancouver, August 9, 2018.

BC Ministry of Environment and Climate Change Strategy, (MOE, 2020). *Amendment to Authorization to Discharge Non-Recyclable Residuals from Metro Vancouver's Wastewater Treatment Plants*. Letter prepared for the City of Vancouver, June 4, 2020.

BC Ministry of Environment and Climate Change Strategy, (MOE, 2021a). *Authorization to Discharge Non-Recyclable Marine Debris collected as part of the Haida Gwaii Marine Debris Clean-up Project*. Letter prepared for the City of Vancouver, August 17, 2021.

BC Ministry of Environment and Climate Change Strategy, (MOE, 2021b). *Authorization to Discharge Refuse from Sources Outside the Metro Vancouver Regional District*. Letter prepared for the City of Vancouver, November 18, 2021.

BC Ministry of Environment and Climate Change Strategy, (MOE, 2021c). *Authorization to Discharge Agricultural Waste resulting from the Provincial State of Emergency Declared November 17, 2021*. Letter prepared for the City of Vancouver, November 20, 2021.

BC Ministry of Environment and Climate Change Strategy, (MOE, 2021d). *Increase in Maximum Authorized Discharge Rate for 2021*. Letter prepared for the City of Vancouver, November 22, 2021.

BC Ministry of Labour, (1998). *Occupational Health and Safety Regulation B.C. Reg. 296/97*. September 8, 1997.

https://www.bclaws.gov.bc.ca/civix/document/id/crbc/crbc/296_97_multi

City of Vancouver, (2016). *Transfer & Landfill Operations Asbestos Waste Disposal Policy*. July 2016.

<https://vancouver.ca/files/cov/asbestos-policy-revised-july-2016.pdf>

City of Vancouver, (2021). *Solid Waste By-Law No. 8417*. December 8, 2021.

<https://bylaws.vancouver.ca/8417c.pdf>

City of Vancouver, (2022). *2021 Annual Landfill Gas Report for the Vancouver Landfill*. Report prepared for Ministry of Environment, March, 2022.

City of Vancouver and The Corporation of Delta, (1999). *Vancouver-Delta Agreement 1999*. September 21, 1999.

Conestoga-Rovers & Associates, (2010). *Landfill Gas Management Facilities Design Guidelines*, prepared for BC Ministry of Environment. March, 2010.

<https://www2.gov.bc.ca/assets/gov/environment/waste-management/garbage/designguidelinesfinal.pdf>

Golder Associates Ltd., (Golder, 2019a). *Design Plan, Vancouver Landfill, Delta BC*. Report prepared for City of Vancouver, March 14, 2019.

Golder Associates Ltd., (Golder, 2019b). *Operating Plan, Vancouver Landfill, Delta BC*. Report prepared for City of Vancouver, April 12, 2019.

Greater Vancouver Sewerage and Drainage District (GVS&DD, 2011) *Waste Discharge Permit SC-100168-FSA*. November 8, 2011.

Greater Vancouver Sewerage and Drainage District (GVS&DD, 2021). *Greater Vancouver Sewerage and Drainage District Tipping Fee and Solid Waste Disposal Regulation Bylaw No. 306, 2017* (most recently amended October 29, 2021). October 29, 2021.

http://www.metrovancouver.org/boards/Bylaws1/GVSDD_Bylaw_306_Consolidation.pdf

Greater Vancouver Sewerage and Drainage District, City of Vancouver and The Corporation of Delta, (1989). *Agreement between Greater Vancouver Sewerage and Drainage District and City of Vancouver and The Corporation of Delta* (also known as *Burns Bog Landfill Tripartite Agreement*). March 21, 1989.

Metro Vancouver, (2010). *Integrated Solid Waste and Resource Management Plan*. Plan prepared for the Ministry of Environment, July, 2010.

<http://www.metrovancouver.org/services/solid-waste/about/planning/Pages/default.aspx>

Metro Vancouver, (2020). *2019 Biennial Report, Integrated Solid Waste and Resource Management Plan*. January, 2020.

<http://www.metrovancouver.org/services/solid-waste/SolidWastePublications/2019ISWRMPBiennialReport.pdf>

Metro Vancouver, (2022). *2021 Biennial Report, Integrated Solid Waste and Resource Management Plan*. January 11, 2022.

<http://www.metrovancouver.org/services/solid-waste/SolidWastePublications/2021ISWRMPBiennialProgressReport.pdf>

SNC-Lavalin Inc., (2017). *Field Sampling and Quality Control Manual, Vancouver Landfill, Delta BC*. Report prepared for City of Vancouver, July 26, 2017.

Sperling Hansen Associates (SHA, 2020). *Phase 4 Closure & Gas System Upgrades Vancouver Landfill – Sheet 004 - General Drawings*, Drawings prepared for the City of Vancouver, April 13, 2020.



Sperling Hansen Associates (SHA, 2021). *Vancouver Landfill Phase 5 South and North Filling Plan – DOPC Updates*, Technical Memorandum, prepared for the City of Vancouver, August 4, 2021.

Transport Canada, (1985). *Transportation of Dangerous Goods Regulation*. January 17, 1985. <https://laws-lois.justice.gc.ca/PDF/SOR-2001-286.pdf>

WSP Consultants Canada Ltd. (WSP, 2021). *Grit and Screenings Characterization Study Sub-Report: Landfill Materials Only*. Report prepared for Metro Vancouver, January 2021.

Appendix 1: Annual Waste Quantities

Table A1: 2021 Material Summary by Source

Source	Waste Discharge				Cover	Road Construction & Other Beneficial Use					Closure		VLF Composting	
	VSTS MSW	VLF MSW	Total MSW	Demo	Cover Soil	Sand	Demo hog	Wood Waste	Crushed Concrete & Asphalt Grindings	Purchased Aggregate	Aggregate	Sand & Soil	VSTS Yard Trimmings	VLF Yard Trimmings
	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes
By Municipality	134,693	170,988	305,681										12,457	6,209
Vancouver Residential Collection	35,653	38	35,691											
Vancouver Public Works	5,494	12,475	17,969		253,442			10	916	12,386	4,718		1,186	3,730
Vancouver Commercial & Residential Drop-Off	59,341	35,245	94,586	9,284	14,069		23,054	756	15,848			36,427	10,799	564
Delta Residential Contractor		14,498	14,498											
Delta Public Works		5,426	5,426		50,332			7	8,089					89
Delta Commercial	376	12,909	13,285	2,960	14,993			123	999			15,096	11	55
Delta Residential Drop-Off	20	5,613	5,633					1,906					7	1,324
Richmond	30,436	36,139	66,575	1,389	17		66,460	429	1,093	10,680	16,366	68,364	282	142
UEL	2,261	84	2,345										19	2
Surrey	75	38,042	38,118	6,803	17,664	79	14,028	514	514	7,163		81,605	13	222
White Rock	4	420	424	233				109	189				2	56
Other Municipalities*	1,032	4,360	5,392	8,966	7,266			127	51,144		34,283	247,842	139	24
Out of Region		5,739	5,739										0.1	
Regional Waste Transfer		364,317	364,317											2,903
Coquitlam Resource Recovery Transfer		137,014	137,014											
North Shore Transfer Station Transfer		82,521	82,521											
Surrey Transfer Station Transfer		128,799	128,799											
Maple Ridge Transfer Station		9,076	9,076											1,507
Langley Transfer Station		6,907	6,907											1,396
Other Authorized Waste		56,839	56,839											
Bottom Ash		35,326	35,326											
Water Treatment Plant Residuals		1,812	1,812											
Sewage Treatment Plant Residuals		3,450	3,450											
Digester Solids														
Iona Grit Dump Residuals		15,889	15,889											
Non-Recyclable Marine Debris		6	6											
Agricultural Waste		356	356											
Totals	134,693	592,144	726,838	29,635	357,783	79	103,542	3,980	78,793	30,229	55,367	449,335	12,457	9,112
Total Materials to Vancouver Landfill												1,835,579		21,568

* Burnaby, City of Langley, City of North Vancouver, Coquitlam, District of North Vancouver, District of West Vancouver, Langley Township, Maple Ridge, New Westminster, Pitt Meadows, Port Coquitlam, Port Moody.

Note: Totals may vary due to rounding errors.

Appendix 1: Annual Waste Quantities

Table A2: 2020 Material Summary by Source

Source	Waste Discharge				Cover	Road Construction & Other Beneficial Use					Closure		VLF Composting	
	VSTS MSW	VLF MSW	Total MSW	Demo	Cover Soil	Sand	Demo hog	Wood Waste	Crushed Concrete & Asphalt Grindings	Purchased Aggregate	Aggregate	Sand & Soil	VSTS Yard Trimmings	VLF Yard Trimmings
	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes
By Municipality	131,253	80,291	211,544										12,760	10,025
Vancouver Residential Collection	37,702		37,702											
Vancouver Public Works	5,336	2,278	7,614		285,513			9	2,988	22,903			995	6,960
Vancouver Commercial & Residential Drop-Off	53,278	12,462	65,740	12,056	2,785		11,281	814	26		2,482	183,123	11,247	847
Delta Residential Contractor	10	14,012	14,022											
Delta Public Works		4,694	4,694		63,918			25	12,242					142
Delta Commercial	722	13,328	14,050	3,500	41,583	1,812	64	80	2,263	14,267	756	43	5	59
Delta Residential Drop-Off	23	5,449	5,472					2,148					9	1,441
Richmond	31,069	12,056	43,125	2,232	22		55,755	440	22	1,483	48,525	147,297	287	128
UEL	2,291	67	2,359					1					30	-
Surrey	74	11,871	11,945	9,924	83,266		10,400	661	51	14,897		45,557	9	346
White Rock	17	821	838	629				98	89			919	2	75
Other Municipalities*	731	3,252	3,983	15,797	13,495			163	417		16,599	117,484	176	28
Regional Waste Transfer		362,573	362,573											5,711
Coquitlam Resource Recovery Transfer		122,292	122,292											
North Shore Transfer Station Transfer		74,538	74,538											
Surrey Transfer Station Transfer		148,077	148,077											
Maple Ridge Transfer Station		10,042	10,042											3,254
Langley Transfer Station		7,624	7,624											2,457
Other Authorized Waste		80,404	80,404											
Bottom Ash		41,478	41,478											
Water Treatment Plant Residuals		1,517	1,517											
Sewage Treatment Plant Residuals		2,933	2,933											
Digester Solids		185	185											
Iona Grit Dump Residuals		34,285	34,285											
Non-Recyclable Marine Debris		5	5											
Totals	131,253	523,268	654,521	44,138	490,582	1,812	77,500	4,440	18,096	53,549	68,363	494,422	12,760	15,737
Total Materials to Vancouver Landfill												1,907,425	28,496	

* Burnaby, City of Langley, City of North Vancouver, Coquitlam, District of North Vancouver, District of West Vancouver, Langley Township, Maple Ridge, New Westminster, Pitt Meadows, Port Coquitlam, Port Moody.

Note: Totals may vary due to rounding errors.

Appendix 1: Annual Waste Quantities

Table A3: 2021 Material Summary by Month

	Waste Discharge					Cover, Road & Closure Materials			VLF Composting		
	VSTS	VLF	Total	Bottom Ash	Demolition Material	Cover Material	Road & Other Beneficial Use Materials	Closure Materials	VSTS Yard Trimmings	VLF Yard Trimmings	Yard Trimmings Total
Month	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes	tonnes
January	10,675	44,762	55,438	3,217	1,998	24,302	33,931	36,476	725	790	1,515
February	9,257	35,705	44,962	3,167	2,118	36,904	29,287	120,686	508	518	1,026
March	11,748	41,658	53,406	3,729	2,195	42,231	20,584	90,749	1,177	887	2,064
April	11,219	46,341	57,560	2,738	2,602	32,177	11,484	69,175	862	876	1,738
May	10,921	52,202	63,123	3,759	3,773	26,396	16,893	4,596	881	882	1,763
June	11,527	57,110	68,637	3,532	3,062	26,672	12,406	16,810	845	794	1,639
July	11,644	48,966	60,610	3,635	3,537	26,787	8,912	51,095	701	429	1,130
August	11,472	51,377	62,849	3,426	2,161	38,542	12,352	46,070	651	267	918
September	11,946	56,132	68,078	2,637	2,010	37,538	14,937	34,659	774	368	1,142
October	11,349	41,406	52,755	1,549	1,984	27,688	21,689	10,344	1,803	467	2,270
November	12,033	33,566	45,599	720	2,224	24,541	18,491	2,326	2,623	2,260	4,883
December	10,902	47,595	58,496	3,218	1,971	14,005	15,655	21,716	905	574	1,480
Totals	134,693	556,819	691,512	35,326	29,635	357,783	216,622	504,702	12,457	9,112	21,568
Total Materials to Vancouver Landfill								1,835,579			

Note: Totals may vary due to rounding errors.

Appendix 2: 2021 Recyclable and Banned Materials

Recyclable Materials – Accepted for FREE (Residential Only)

- | | |
|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| ✓ Antifreeze and empty antifreeze containers | ✓ Paper containers (tetra-packs, coffee cups) |
| ✓ Books | ✓ Plastic bags and overwrap |
| ✓ Cardboard (flatten) | ✓ Plastic containers (jars, jugs, bottles) |
| ✓ Cell phones | ✓ Printed paper and paper packaging (newspaper, magazines, catalogues, writing paper, paper bags) |
| ✓ Clothing | ✓ Propane tanks (maximum 4 disposable and 2 refillable) |
| ✓ Cooking oil | ✓ Scrap metal |
| ✓ Electronics, small appliances and power tools (max 5 large items) | ✓ Smoke and carbon monoxide alarms |
| ✓ Fluorescent light bulbs and tubes | ✓ Thermostats |
| ✓ Foam packaging (no foam peanuts) | ✓ Tires (passenger or light truck with or without rims; maximum of 10) |
| ✓ Glass bottles and jars | ✓ Used oil (maximum 15 litres), oil filters (maximum 3) and empty oil containers |
| ✓ Large appliances (refrigerators, freezers, air conditioners) | |
| ✓ Lead acid car and truck batteries | |
| ✓ Metal containers (cans, tins, foil, empty aerosol cans excluding spray paint cans) | |

Recyclable Materials – Accepted for a FEE

- ✓ Gypsum drywall, new scraps only (maximum level pick-up truckload)
- ✓ Food scraps (maximum 130 kg)
- ✓ Mattresses and box springs (maximum 8 pieces)
- ✓ Wood waste (includes painted, stained and treated wood, residential quantities)
- ✓ Yard & garden trimmings

Banned Materials

The lists of Banned Materials that follow are taken from City of Vancouver *Solid Waste By-Law No. 12849* in effect as of January 1, 2021.

Banned Hazardous and Operational Impact Materials (Schedule E)

The following wastes are prohibited from disposal at the Vancouver Landfill and Vancouver South Transfer Station:

1. Automobile bodies.
2. Refuse that is on fire, smoldering, flammable or explosive.
3. Hazardous Waste as defined in the *Hazardous Waste Regulation* (B.C. Reg. 63/88), with the exception of asbestos waste delivered to the Vancouver Landfill in accordance with the Asbestos Policy.
4. Propane tanks, with the exception of Propane Tanks delivered as recyclable materials;
5. Liquids or sludge.

6. Coated or uncoated wire and cable that exceeds either 1% of the total weight of the load or 1% of the total volume of the load.
7. Dead animals from personal or business activities.
8. Inert fill material including soil, sod, gravel, concrete and asphalt exceeding 0.5 cubic metres per load, with the exception of those materials meeting the City Engineer's specifications for landfill cover, road building, and closure.
9. Excrement, other than amounts of pet excrement that are double bagged and discarded with Municipal Solid Waste and that do not exceed either 5% of the total weight of the load or 5% of the total volume of the load.
10. Barrels, drums, pails or other large (205 litre or greater) liquid containers.
11. New or used gypsum (drywall), with the exception of residential used gypsum (drywall) delivered to the Vancouver Landfill in accordance with the Drywall Policy.
12. Mattresses, with the exception of Mattresses that are delivered in dedicated loads to the Vancouver Landfill for management as special handle waste requiring burial
13. Railroad ties or creosote treated wood.
14. Toxic Plants, with the exception of Toxic Plants that are double bagged and delivered in dedicated loads to the Vancouver Landfill for management as special handle waste requiring burial.
15. Personal hygiene products where the personal hygiene products make up more than 10% of the total weight of the load unless the personal hygiene products are double bagged in sealed plastic bags that are sufficiently durable to resist leaking or breaking during collection and disposal.
16. Any material that would cause undue risk of injury or occupational disease to any person at the Vancouver Landfill and Transfer Station or that would otherwise contravene the *Occupational Health and Safety Regulation* (B.C. Reg. 296/97) enacted pursuant to the *Workers Compensation Act*, as amended or replaced from time to time.
17. Any other material deemed by the City Engineer as unacceptable for disposal at the Vancouver Landfill or Vancouver South Transfer Station.

Banned Recyclable Materials (Schedule F)

1. Beverage containers identified in "Schedule 1 — Beverage Container Product Category" to the *Recycling Regulation* (B.C. Reg. 449/2004) of the *Environmental Management Act*.
2. Containers other than beverage containers made of:
 - i. Metal,
 - ii. Glass,
 - iii. Plastic identified by the SPI Code #1 (Polyethylene Terephthalate or PET) or SPI Code #2 (High Density Polyethylene or HDPE) or SPI Code #4 (Low Density Polyethylene or LDPE) or SPI Code #5 (Polypropylene or PP), or
 - iv. Composite materials to create rigid packaging consisting of paper and polyethylene (gable top cartons, frozen food boxes, ice cream cartons, and microwaveable dinner cartons) or paper, polyethylene and aluminum (aseptic cartons).
3. Recyclable Paper.
4. Corrugated Cardboard.
5. Yard Waste.
6. Food Waste.
7. Clean Wood Waste.
8. Expanded Polystyrene Packaging.

Banned Product Stewardship Materials (Schedule G)

The following materials included in the effective Product Stewardship Program product categories of the *Recycling Regulation* of the *Environmental Management Act*, are banned from garbage containers, and from disposal as garbage at the Vancouver South Transfer Station, and Vancouver Landfill:

1. The following materials pursuant to Schedule 2 – Residual Product Category to the *Recycling Regulation*:
 - Solvents and flammable liquids;
 - Pesticides;
 - Gasoline;
 - Pharmaceutical products and medications;
 - Oil, oil filters and oil containers;
 - Paint and paint containers;
 - Lead-acid batteries; and
 - Antifreeze and antifreeze containers;
2. Electronics and electrical products, including metal household and commercial appliance, as identified in Schedule 3 – Electronics and Electrical Products Category to the *Recycling Regulation*;
3. Tires pursuant to Schedule 4 – Tire Product Category to the *Recycling Regulation*.

Appendix 3: 2021 Water Quality Monitoring Location Plan



Appendix 4: 2021 Water Quality Monitoring Program Parameters

Surface Water

alkalinity as CaCO ₃	dissolved organic carbon	sodium, total & dissolved
aluminium, total	hardness as CaCO ₃	specific conductivity
ammonia	iron, total & dissolved	sulphate
arsenic, total	lead, total	zinc, total
cadmium, total	magnesium, total & dissolved	temperature*
calcium, total & dissolved	manganese, total & dissolved	turbidity
chloride	nickel, total	TSS
chromium, total	pH*	TOC
cobalt, total	true colour	VOCs
copper, total	phenols	
dissolved oxygen*	potassium, total & dissolved	

Groundwater

alkalinity as CaCO ₃	cobalt, dissolved	pH*
aluminium, dissolved	copper, dissolved	phenols
ammonia	hardness as CaCO ₃	potassium, dissolved
arsenic, dissolved	iron, dissolved	sodium, dissolved
cadmium, dissolved	lead, dissolved	specific conductivity
calcium, dissolved	magnesium, dissolved	sulphate
chloride	manganese, dissolved	temperature*
chromium, dissolved	nickel, dissolved	zinc, dissolved
		VOCs

Leachate Grab Samples

alkalinity as CaCO ₃	cyanide	potassium, total & dissolved
aluminium, total	dissolved oxygen*	sodium, total & dissolved
ammonia	hardness as CaCO ₃	specific conductivity
cadmium, total	iron, total & dissolved	sulphate
calcium, total & dissolved	lead, total	sulphide, total & dissolved
chloride	magnesium, total & dissolved	temperature*
chromium, total	manganese, total & dissolved	toxicity
cobalt, total	pH*	volatile organic compounds
copper, total	phenols, total**	zinc, total

Leachate Composite Samples

aluminium, total	copper, total	nickel, total
cadmium, total	iron, total	pH
chemical oxygen demand	lead, total	total suspended solids
chromium, total	manganese, total	zinc, total
cobalt, total	molybdenum, total	

* Field Data

** Total of 2,3,4,5 and 2,3,4,6 tetrachlorophenols and pentachlorophenols

Appendix 5: 2021 Public Complaint and Resolution Log

No.	Issue	Resolution
1	Customer phoned to make a complaint about an employee at the scales. The customer did not cross over the landfill scales during a second drop-off and acknowledged it was their fault. They claimed that the employee yelled at them and wanted a manager to address this.	The superintendent investigated the issue regarding the employee and later called the customer back to apologize. The superintendent expressed empathy towards the customer and acknowledged that the issue of re-entry may have come about due to miscommunication between scales and the recycling depot.
2	Customer posted feedback via a social media post. The post claimed a City of Vancouver Landfill employee displayed aggressive driving habits and used inappropriate language during an unpleasant exchange.	Upon further video investigation the Landfill determined the vehicle belonged to a City employee, but in a different department. The complaint was forwarded to the appropriate department for action. No callback was requested.
3	Customer stated the highway signage for getting to the Vancouver Landfill from Highway 99 is confusing and not clear enough for drivers.	The Vancouver Landfill does not have authority over highway signage. No follow up was requested from the customer.
4	Customer phoned and expressed they were frustrated because the Landfill scales were going to charge them to dispose of old tires. The customer said the information on the website needs to be amended because he drove to the Vancouver Landfill under the impression that tires were free to recycle and now they wasted their time.	Customer was contacted by a Landfill admin employee who clarified recycling material acceptance. The customer was told the Landfill website states that tires are accepted for free for recycling; however, free recycling is available for residential customers only. The Landfill does not provide this free service for commercial customers.
5	Customer complained that he was double charged at Landfill scales. When the customer made the first bill transaction they were sure the electronic card payment went through but the scale employee did not see the transaction go through. The customer then paid again. Upon looking at their bank statement, the customer discovered it was a double payment. They requested a call back to resolve this issue.	The customer was contacted by a City of Vancouver staff member who apologized for billing error. The customer was refunded the extra charged amount.
6	Customer phoned to complain that the City does not have a policy in place to reduce rates (e.g. \$5-10) for citizens who reside in apartments, as they do not have the same storage space as a homeowner. The customer complained that there is no incentive for people to do the right thing and that other citizens will end up dumping their garbage illegally.	The customer did not request a call back response. The City solid waste bylaw and website state there is a minimum fee charged during peak and non-peak periods. These fees also align with the regional Transfer Station minimum charges.

No.	Issue	Resolution
7	Customer was frustrated that the City is no longer able to create new accounts for commercial customers. The customer felt that there is no practical way for all their drivers to be able to pay each and every time they access the Landfill or Transfer Station. They requested that the commercial customer new account process be reviewed.	Transfer and Landfill credit account applications are no longer available. The department does not have the authorization to accept new applications.
8	Citizen called and reported their valuables may have been dumped at the Landfill in error.	The case was investigated by the Landfill staff; however, no items mentioned by the customer were located.

Appendix 6: 2021 Annual Water Quality Monitoring Report Executive Summary

AECOM Canada Ltd. (AECOM) reviewed historical data and interpreted leachate, groundwater, surface water and stormwater quality data collected by City of Vancouver (CoV) and AECOM staff between January 1, 2021 and December 31, 2021. This annual monitoring report presents the findings of the monitoring program review in accordance with the landfill Operational Certificate MR-01611 (OC). The requirements of the monitoring program and subsequent interpretation and reporting are specified within the OC and Waste Discharge Permit SC-100168-FSA (WDP). Section 3.5.2 of the OC requires that the annual report include a review and interpretation of the analytical data from receiving environment monitoring for the preceding year, and leachate flow data and leachate/drainage ditch levels. The WDP governs the discharge of leachate from the Vancouver Landfill. Leachate discharged from the landfill is conveyed through City of Delta (CoD) and Metro Vancouver forcemains to the Annacis Island Wastewater Treatment Plant.

Monitoring data included measurements of leachate flows and leachate quality at the leachate pump station near the southwest corner of the landfill. Groundwater elevations and groundwater quality were measured in the shallow and deep aquifers using a monitoring well network that surrounds the footprint of the landfill and are located immediately outside the perimeter ditch leachate collection system. Surface water elevations and surface water quality were measured in the perimeter drainage ditch surrounding the landfill footprint, in downstream drainage ditches, and in the Delta Irrigation Enhancement Project (DIEP) irrigation canal that is connected to the Fraser River. The Remote Water Level Monitoring System was commissioned in 2021. The new system continuously monitors water levels at 13 stations in stormwater ponds, and the inner and outer ditch in support of stormwater management at the landfill.

A routine stormwater monitoring program commenced in December 2019. Stormwater monitoring is not a requirement of the OC or the WDP. The purpose of the program is to monitor the quality of the stormwater from closed areas of the landfill to support discharge of stormwater outside the leachate collection system. Two pilot stormwater discharge tests were carried out in October and November 2020, which discharged clean stormwater from select closed and lined landfill phases to the Dredge Pond. Following the two pilot discharge events, stormwater continued to discharge to the Dredge Pond between December 2020 and March 2021. The Dry Weather Pilot, Wet Weather Pilot, and Extended Pilot discharged an estimated 267,430 m³ of stormwater into to the Dredge Pond over a period of 150 days.

The 2021 monitoring program met or exceeded the requirements of the OC and WDP with respect to the stations and media being monitored and the parameters being analyzed, with the exception of a few surface water monitoring stations when ditches were dry in late summer.

The monitoring program contained a quality assurance and quality control component which confirmed groundwater, surface water, leachate and stormwater quality data were acceptably precise and reliable. It also included a field sampling audit that confirmed the absence of issues that would materially affect the quality of data collected.

Flow Control System - Perimeter Ditch System

The perimeter ditch system consists of an inner leachate collection ditch and an outer surface water drainage ditch, which are separated by an intermediate soil berm. The outer drainage

ditch diverts natural surface runoff and shallow groundwater flow from Burns Bog around the landfill footprint. The inner leachate ditch collects the following waters, which are collectively referred to as 'leachate' once they reach the inner ditch:

- Leachate – Rainwater that is contaminated after the water percolates through waste.
- Surface Runoff – Rainwater that flows along other surfaces at the landfill such as intermediate cover areas (temporarily closed) and operational areas (i.e., entrance area buildings and scales) that may be impacted by leachate.
- Stormwater – Rainwater that is collected above the impermeable geomembrane in closed areas of the landfill. It is not impacted by leachate.

Water collected in the leachate ditch flows to the landfill's pump station before being transported offsite through the municipal sanitary sewer system. Water in the sanitary line is transported to the Annacis Island Wastewater Treatment Plant.

The purpose of the perimeter ditch system is to maintain an inward hydraulic gradient around the landfill footprint to ensure leachate is collected and conveyed to the leachate pump station. To achieve this, water levels in the leachate ditch are actively maintained at a lower elevation than the drainage ditch through pump station control. Water levels in the drainage ditch are reflective of natural inputs from the surrounding lands; however, a system of weirs is in place to increase retention of natural runoff and maintain higher water elevations adjacent to Burns Bog.

Based on regular monitoring of five staff gauges installed in the perimeter ditch system, the overall efficiency of the system was 90% in 2021. This is slightly lower than the overall containment efficiency in 2020 (94.2%) and the overall average efficiency from 1995 to present (93.1%). This is primarily due to the temporary ditch overflow event that occurred in November 2021 following an atmospheric river event that delivered over 139 mm of precipitation recorded between November 13 and 15, 2021. Although outward gradients were observed at select monitoring locations following intense storm events, the duration of the gradient reversal was limited and estimated groundwater flow velocities through the berm are very slow. Therefore, it is highly unlikely that leachate migrated through the berm separating the leachate and drainage ditches as a result of the temporary gradient reversal. In the future, the efficiency of the perimeter ditch system will be assessed using manual levels in conjunction with continuously monitored water levels at stations comprising the Remote Water Level Monitoring System.

Leachate Flow

The CoV maintained suitable flow measuring devices for the purpose of recording the volume of leachate discharged to the sanitary sewer each month as required under Section 3.2.2 of the OC. Although total precipitation in 2021 was 8% higher than that in 2020, the total volume of leachate discharged in 2021 was 2,346,908 m³, which was approximately 13% lower than that in 2020. The leachate and precipitation ratio in 2021 was 90.6%, which was noticeably lower than those in 2018-2020 and may reflect the benefits of the Stormwater Pilot Discharge program and the interim discharge strategy, which involves discharge of stormwater generated on Phase 1, Phase 2, and Phase 3 outside the leachate ditch and into the Dredge Pond. In the future, additional stormwater from the Western 40 ha and Phase 4 could also be diverted should water quality be acceptable. The lower leachate and precipitation ratio suggests that ongoing

stormwater management activities are effectively decreasing the amount of leachate reporting to the pump station. The monthly leachate flows in wet season (January-March and October-December) were 15.6% lower than those measured in 2020.

The highest daily leachate flow rate (34,712 m³/day) occurred on January 4, 2021. This is well below the maximum (under review) daily limit of 45,000 m³/day. Leachate discharge volumes remained in compliance with OC and WDP requirements during 2021.

Groundwater Flow

Two groundwater flow systems are present beneath the site. The shallow aquifer consists primarily of organic peat that extends from ground surface to approximately six metres depth, and is underlain by a thick permeable deep sand aquifer (known as the deep aquifer). The shallow and deep aquifers are separated by a low permeability silt/clay aquitard that varies in thickness from 1 to 7 metres. Water levels are monitored in both aquifers on a quarterly basis using a series of monitoring wells located around the perimeter of the landfill. The perimeter ditch system and Dredge Pond are important hydrologic features that influence groundwater levels and flow directions in both aquifers. Groundwater elevations fluctuated on the order of one metre seasonally. Groundwater flow directions were predominantly from northeast to southwest, which is consistent with previous years. Because topography is relatively flat, horizontal groundwater gradients and flow velocities in both the shallow and deep aquifers are relatively low.

Surface Water Flow

Regional surface water flows southwest from Burns Bog toward the perimeter ditch system. Surface water and shallow groundwater that enter the perimeter ditch system is carried around the landfill footprint and discharged into Crescent Slough from two connection points at the northwestern and southwestern corners of the landfill. Crescent Slough ultimately discharges to the Fraser River. The City of Delta intermittently opens a floodgate to allow river water to flow into the Delta Irrigation Enhancement Project canal for irrigation purposes on nearby agricultural lands. As a result, periodic surface water flow reversals have been observed under certain tidal, river discharge and operational scenarios. In late summer, portions of the perimeter ditch system on the north, east and southeast sides of the landfill cease to flow or become dry following prolonged periods of dry weather.

Leachate Quality Summary

Monthly leachate quality samples were collected from the approved sampling point at the leachate pump station in accordance with OC and WDP requirements. All samples were analyzed for the parameters stipulated in the OC and WDP. All leachate quality samples met applicable discharge criteria in 2021, except one (1) leachate grab sample that marginally exceeded HWR criteria for dissolved manganese. Despite this minor exceedance, overall leachate quality met the intent of the WDP because the annual mean manganese concentration was well below the HWR criteria.

Groundwater Quality

As per the OC, quarterly monitoring must be conducted on five shallow monitoring wells and seven deep monitoring wells. In 2021, the monitoring program included 18 shallow monitoring

wells and 20 deep monitoring wells. Quarterly groundwater quality samples were collected from the monitoring stations required by the OC. The remaining monitoring wells were also sampled on a quarterly basis, with the exception of three wells that were only monitored for water levels and field parameters. All samples were analyzed for the parameters stipulated in the OC.

Groundwater quality in the shallow aquifer is strongly influenced by bog water chemistry. Upgradient groundwater flowing from Burns Bog toward the landfill is naturally acidic and contains elevated concentrations of several constituents that are readily mobilized under acidic conditions. Deep groundwater chemistry appears to have minimal influence from Burns Bog and represents a compilation of upgradient sources. Water chemistry in both shallow and deep aquifers naturally evolves along the flow path, particularly in the shallow aquifer, as groundwater travels away from the bog hydrologic system. Professional judgment was used to assess the nature and degree of any water quality impacts that may have occurred due to leachate, road salt, runoff from neighbouring lands, and brackish waters from tidal fluctuations and municipal floodgate operations.

Groundwater quality results were tabulated and compared against applicable Contaminated Sites Regulation (CSR) standards. The shallow aquifer is not considered to be a drinking water aquifer due to the presence of organic soils. Primary leachate indicator parameters are considered to be ammonia, conductivity, and chloride. Secondary leachate indicator parameters include alkalinity and hardness. All of these parameters were used to assess any leachate impacts in consideration of background concentrations of leachate indicator parameters and the results of statistical trend analysis.

Similar to previous years, leachate impacted groundwater was contained within the landfill property.

Shallow Groundwater Quality

Background water quality in the shallow aquifer was similar to previous years and reflected natural water chemistry in Burns Bog. Shallow groundwater quality at all monitoring stations does not appear to be impacted by leachate, with one exception (54-2013).

Shallow groundwater quality at monitoring station 54-2013 (south of the landfill and northeast of the Dredge Pond) exhibited dilute leachate impacts. Based on the results of the 2018 Hydrogeology Review, groundwater quality at this location, immediately south and up to 40 metres outside of the perimeter ditch system, is impacted by dilute leachate. The impacts are relatively minor and are contained within the landfill property boundary due to net-inward hydraulic gradients from the bog towards the perimeter ditch system. Water quality at 54-2013 met all applicable CSR standards and appears to be stable for past five years. Further monitoring is planned during the next hydrogeology review (2023) to verify the extent of the impacts.

Shallow groundwater quality at 26-2013 appears to have returned to historically observed patterns by the fourth quarter of 2020. The temporary degradation in groundwater quality in 2020 was believed to be due to stormwater conveyance line upgrades between the Phase 2 Pond and the Dredge Pond and short-term hydraulic trap reversals induced by drier than usual weather in March 2020. The consistently elevated ammonia and conductivity in shallow groundwater wells along the southwestern property (wells 25-2019, 26-2013 and 50) are

attributed to the upwelling and mixing of deep groundwater, and not associated with leachate impacts due to low chloride concentrations.

Shallow groundwater quality data met CSR AW standards except for beryllium at well 79 during two of four sampling events. Exceedances at this well are inferred to be the result of naturally high background concentrations.

Shallow groundwater quality data met CSR IW standards except for aluminum at well 66 during one sampling event. This occasional exceedance is likely due to the impact from Burns Bog or surface runoff, and is not attributed to leachate impacts.

Deep Groundwater Quality

In 2021, deep groundwater quality at all monitoring stations does not appear to be impacted by leachate. Background water quality in the deep aquifer was similar to previous years and reflected natural water chemistry. Concentrations of leachate indicator parameters and other dissolved minerals are higher than those observed in the overlying shallow aquifer. Concentrations of select leachate indicator parameters at downgradient monitoring wells are slightly higher than upgradient of the landfill, which may be the result of off-site sources (i.e. road salt and tidal influences).

Deep groundwater quality data met the applicable CSR Irrigation Water Use (IW) standards, with the exception of chloride at well 23 and well 124 (located at the southwest corner of the landfill) and chromium at well 57. Chloride concentrations at wells 23 and 123 are inferred to be the result of DIEP Canal construction in 2013. Chromium is not considered an accurate indicator of landfill leachate impacts at the site due to the low concentrations of chromium in leachate.

Deep groundwater quality data met CSR AW standards, except for chromium at well 57. As mentioned above, localized chromium impacts are not associated with leachate.

Deep groundwater quality data met applicable CSR Drinking Water Use (DW) standards, with the exception of dissolved vanadium at background well 121 and downgradient wells 57 and 55-2013. Vanadium impacts are not considered an indicator of landfill leachate due to relatively low concentrations of vanadium in leachate and high natural background concentrations.

Surface Water Quality

As per the OC, quarterly monitoring and sampling must be conducted at eight surface water monitoring stations. In 2021, 13 surface water monitoring stations were monitored and sampled to confirm compliance with the OC.

In 2021, the surface water monitoring program exceeded the requirements stipulated in the OC based on the number of stations and parameters monitored. The only exceptions were associated with locations that could not be sampled in the summer when the ditch was dry or stagnant, which is consistent with previous years.

Surface water quality at monitoring stations located north, northeast, northwest, and south of the landfill does not appear to be impacted by leachate. Water chemistry at these locations is strongly influenced by naturally acidic surface water runoff and groundwater seepage from Burns Bog. Similar to previous years, pH, turbidity, total suspended solids and select metals concentrations exceeded BCWQG AW and IW criteria. Exceedances at these stations are

consistent with background water quality and are attributed to the naturally acidic water quality associated with Burns Bog.

Surface water quality at monitoring stations located southwest of the landfill do not appear to be impacted by leachate, with the exception of temporary and localized impacts at station 13 and 15 during November. Short-duration impacts were due to intense precipitation events and high tides that caused water levels to overtop the berm that separates the leachate and drainage ditches, which hydraulically connected the ditches for several days. Hydraulic containment was restored shortly thereafter, with inward gradients restored after three weeks. Similar to previous years, pH, turbidity, total suspended solids and select metals concentrations exceeded BCWQG AW and IW criteria. Water quality impacts at these locations are attributed to seasonal runoff from nearby agricultural fields and roadways and influences from the Fraser River.

Stormwater Quality

The purpose of the stormwater monitoring program is to characterize the quality of stormwater discharging from closed landfill phases to confirm if the water is suitable for discharge outside the leachate collection system. In 2021, the stormwater sampling program was expanded to incorporate additional sampling locations, including the following stations: Phase 4 Pond (144), Outer Drainage Ditch (45), Dredge Pond (34), and Downstream Property Boundary (134).

Based on 2021 results, stormwater quality from closed Phases 1, 2, 3, and Western 40 Pond 6 was similar to or better than water quality in nearby on-site and off-site receiving environments (e.g., Dredge Pond, Crescent Slough, and Centre Ditch). As such, stormwater from these locations were considered acceptable for discharge outside the leachate collection system. Stormwater from Phase 1, 2 and 3 were discharged to the Dredge Pond in 2021 and water quality in the Dredge Pond was not appreciably affected. Stormwater from Western 40 Pond 6 discharged into the leachate ditch because conveyance infrastructure capable of discharging stormwater beyond the leachate ditch was not yet available and water quality had not yet been demonstrated to be acceptable for discharge outside of the leachate ditch.

Stormwater quality from stations 107 (W40-P4) and 144 (Phase 4) exhibit water quality that is not suitable for discharge outside the leachate collection system at this time. Water quality impacts are likely associated with recent closure activities and water quality is expected to improve with time.

Based on the findings of the 2021 Water Quality Monitoring Program Review, the following recommendations were made, and are presented with ongoing recommendations from previous years.

2021 - Water Quality Monitoring Program		Status
2021-1	Leachate, groundwater, surface water and stormwater monitoring (i.e., water level monitoring and sampling) should be conducted as per the recommended 2022 Water Monitoring Program as outlined in Appendix G of this report.	New
2021 - Water Quality Monitoring Program		Status
2021-2	Further evaluation of the elevated chloride and conductivity along the southwest property boundary should be conducted during the next hydrogeology review (2023) to verify the hydraulic gradients and impacts associated with municipal ditch network and the Delta Irrigation Enhancement Project canal.	New
2020 - Water Quality Monitoring Program		Status
2020-2	Water quality modelling should be conducted during the next hydrogeology review to assess the effects on leachate quality as a result of diverting stormwater outside the leachate ditch and predict what parameters might have future Waste Discharge Permit compliance issues, if any.	On-going
2020-3	Water levels and water quality in well 26-2013 should be closely monitored following installation of the remote water level monitoring system to confirm the persistence of the hydraulic trap.	On-going
2020-5	Further monitoring in the vicinity of station 54-2013 should be conducted during the next hydrogeology review (2023) to verify that the extent of the impacts.	On-going
2019 - Monitoring Network		Status
2019-2	Inactive monitoring Wells 19 and 20 should be decommissioned once access to the property south of the landfill is granted.	On-going
2019 - Water Quality Monitoring Program		Status
2019-5	Well 70 should continue to be sampled as part of the routine monitoring program until sufficient data is collected from the 2019 replacement well (Well 125) to determine if they exhibit similar water quality. It is anticipated that over two years of quarterly data is sufficient and a water quality comparison between well 70 and well 125 should be conducted as part of the 2022 Annual Water Quality Monitoring Report. If it is concluded that Well 125 is a suitable replacement for OC Well 70, then CoV should request the change to the OC. Once ENV approves the change, the well should be decommissioned in accordance with the BC <i>Groundwater Protection Regulation</i> .	On-going

Appendix 7: 2021 Weekly Leachate and Drainage Ditch Water Elevations

City of Vancouver Landfill - 2021 Annual Water Quality Monitoring Report

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Table 6-3. Vancouver Landfill Weekly Leachate and Drainage Ditch Water Elevations

Date	SG1		Flow Direction	SG2		Flow Direction	SG3		Flow Direction	SG4		Flow Direction	SG5		Flow Direction
	L1 m	D1 m		L2 m	D2 m		L3 m	D3 m		L4 m	D4 m		L5 m	D5 m	
Top of Gauge Elevation (masl) ³	1.38	1.03		1.32	1.04		2.34	2.42		NA	2.30		0.91	1.42	
2021-01-04	-0.09	0.4	inward	0.04	0.41	inward	0.94	1.06	inward	0.76	1.15	inward	0.29	0.55	inward
2021-01-06	0.11	0.37	inward	-0.08	0.41	inward	0.94	1.05	inward	0.66	1.14	inward	0.05	0.55	inward
2021-01-07	-0.25	0.19	inward	0.32	0.38	inward	-	-	-	0.63	1.09	inward	-	-	-
2021-01-08	-0.32	0.13	inward	-0.12	0.32	inward	0.7	1.03	inward	0.65	1.09	inward	0.21	0.45	inward
2021-01-11	-0.45	-0.05	inward	-0.18	0.28	inward	0.64	0.99	inward	0.6	1.03	inward	-0.07	0.4	inward
2021-01-12	-0.14	0.34	inward	0.02	0.37	inward	0.74	1.03	inward	0.68	1.13	inward	0.16	0.52	inward
2021-01-13	-0.41	0.29	inward	-0.18	0.39	inward	0.87	1.24	inward	0.64	1.09	inward	-0.05	0.5	inward
2021-01-14	-0.42	0.08	inward	-0.2	0.34	inward	-	-	-	0.61	1.05	inward	-	-	-
2021-01-15	-0.45	0	inward	-0.2	0.3	inward	0.62	1.01	inward	0.6	1	inward	-0.12	0.41	inward
2021-01-20	-0.5	-0.14	inward	-0.21	0.2	inward	0.58	0.96	inward	0.67	0.94	inward	-0.16	0.28	inward
2021-01-22	-0.49	-0.14	inward	-0.23	0.19	inward	0.58	0.93	inward	0.57	0.92	inward	-0.17	0.24	inward
2021-01-29	-0.5	-0.14	inward	-0.23	0.2	inward	0.56	0.93	inward	0.56	0.92	inward	-0.18	0.25	inward
2021-02-03	-0.45	0.06	inward	-0.2	0.32	inward	0.59	1.02	inward	0.58	1.03	inward	-0.11	0.44	inward
2021-02-05	-0.45	-0.01	inward	-0.21	0.28	inward	-	-	-	0.58	1.03	inward	-	-	-
2021-02-10	-0.5	-0.15	inward	-0.23	0.19	inward	0.51	0.94	inward	0.53	0.91	inward	-0.22	0.1	inward
2021-02-18	-0.4	-0.14	inward	-0.25	0.2	inward	0.52	0.93	inward	0.55	0.91	inward	-0.17	0.2	inward
2021-02-23	-0.4	-0.15	inward	-0.25	0.2	inward	-	-	-	0.55	0.91	inward	-	-	-
2021-02-26	-0.38	-0.14	inward	-0.23	0.2	inward	0.53	0.9	inward	0.54	0.9	inward	-0.2	0.19	inward
2021-03-01	-0.35	-0.14	inward	-0.2	0.23	inward	-	-	-	0.54	0.9	inward	-	-	-
2021-03-03	-0.36	-0.14	inward	-0.21	0.19	inward	0.5	0.92	inward	0.53	0.9	inward	-0.15	0.2	inward
2021-03-15	-0.38	-0.15	inward	-0.26	0.1	inward	0.45	0.81	inward	0.5	0.84	inward	-0.15	0.05	inward
2021-03-18	-0.45	-0.15	inward	-0.25	0.02	inward	0.45	0.79	inward	0.5	0.84	inward	-0.16	0.05	inward
2021-03-26	-0.52	-0.16	inward	-0.26	0.15	inward	0.45	0.82	inward	0.5	0.88	inward	-0.29	0.02	inward
2021-03-31	-0.52	-0.16	inward	-0.29	0.18	inward	0.44	0.82	inward	0.48	0.86	inward	-0.3	-0.02	inward
2021-04-12	-0.5	-0.15	inward	-0.3	0.15	inward	0.4	0.78	inward	0.46	0.81	inward	-0.35	-0.05	inward
2021-04-14	-0.52	-0.14	inward	-0.28	0.16	inward	0.45	0.77	inward	0.46	0.8	inward	-0.36	-0.05	inward
2021-04-16	-0.5	-0.15	inward	-0.26	0.14	inward	-	-	-	-	-	-	-	-	-
2021-04-19	-0.56	-0.15	inward	-0.3	0.13	inward	0.4	0.74	inward	0.45	0.77	inward	-0.37	-0.03	inward
2021-04-26	-0.58	-0.16	inward	-0.3	-0.15	inward	0.39	0.72	inward	0.45	0.71	inward	-0.37	-0.05	inward
2021-05-07	-0.55	-0.16	inward	-0.29	-0.18	inward	0.38	0.66	inward	0.44	0.77	inward	-0.38	-0.06	inward
2021-05-10	-0.56	-0.17	inward	-0.29	-0.17	inward	0.39	0.64	inward	0.45	0.65	inward	-0.37	-0.07	inward
2021-05-13	-0.6	-0.17	inward	-0.3	-0.16	inward	0.39	0.64	inward	0.45	0.65	inward	-0.37	-0.08	inward
2021-05-21	-0.61	0.08	inward	-0.3	-0.1	inward	0.39	0.61	inward	0.47	0.64	inward	-0.4	0.11	inward
2021-05-26	-0.6	0.08	inward	-0.3	-0.07	inward	0.4	0.6	inward	0.47	0.61	inward	-0.4	0.15	inward
2021-06-04	-0.6	0.02	inward	-0.3	-0.15	inward	0.4	0.55	inward	0.46	0.55	inward	-0.35	0.05	inward
2021-06-10	-0.6	0.09	inward	-0.3	-0.16	inward	0.39	0.55	inward	0.45	0.55	inward	-0.35	0.11	inward
2021-06-15	-0.57	0.15	inward	-0.3	-0.12	inward	0.38	0.5	inward	0.48	0.56	inward	-0.39	0.2	inward
2021-06-23	-0.61	0.12	inward	-0.29	-0.17	inward	0.4	0.49	inward	0.45	0.48	inward	-0.36	0.08	inward
2021-07-05	-0.51	0.15	inward	-0.26	-0.19	inward	0.4	0.48	inward	0.46	0.46	outward	-0.3	0.19	inward
2021-07-16	-0.56	0.18	inward	-0.27	-0.21	inward	0.39	0.48	inward	0.45	0.45	outward	-0.32	0.2	inward
2021-07-23	-0.55	0.14	inward	-0.27	-0.22	inward	0.39	0.48	inward	0.43	0.45	inward	-0.34	0.17	inward
2021-07-30	-0.57	0.04	inward	-0.29	-0.23	inward	0.4	0.48	inward	0.43	0.45	inward	-0.34	0.1	inward
2021-08-04	-0.54	0.18	inward	-0.27	-0.23	inward	0.4	0.48	inward	0.43	0.45	inward	-0.36	0.1	inward
2021-08-13	-0.55	0.18	inward	-0.3	-0.21	inward	0.4	0.48	inward	0.43	0.45	inward	-0.34	0.2	inward
2021-08-18	-0.58	0.18	inward	-0.32	-0.22	inward	0.4	0.48	inward	0.43	0.45	inward	-0.34	0.2	inward
2021-08-27	-0.53	0.03	inward	-0.28	-0.2	inward	0.41	0.47	inward	0.43	0.45	inward	-0.22	0.06	inward
2021-09-03	-0.48	0.02	inward	-0.28	-0.18	inward	0.42	0.47	inward	0.5	0.45	outward	-0.12	0.02	inward
2021-09-09	-0.55	-0.06	inward	-0.29	-0.24	inward	0.43	0.47	inward	0.43	0.45	inward	-0.35	-0.04	inward
2021-09-21	-0.4	-0.18	inward	-0.2	-0.23	outward	0.42	0.47	inward	0.48	0.45	outward	-0.26	-0.04	inward
2021-09-30	-0.19	-0.16	inward	0.15	-0.05	outward	0.62	0.47	outward	0.66	0.56	outward	0.13	-0.04	outward
2021-10-08	-0.36	-0.18	inward	-0.15	-0.21	outward	0.44	0.47	inward	0.5	0.45	outward	-0.22	-0.11	inward
2021-10-14	-0.33	-0.18	inward	-0.12	-0.24	outward	0.45	0.45	neutral	0.5	0.45	outward	-0.17	-0.1	inward
2021-10-22	-0.16	-0.16	neutral	0.1	-0.04	outward	0.3	0.7	inward	0.64	0.88	inward	0.22	0.15	outward
2021-10-26	-0.17	-0.17	neutral	0.08	-0.06	outward	0.3	0.79	inward	0.62	0.84	inward	0.06	0.22	inward
2021-11-01	-0.18	-0.16	inward	0.02	-0.09	outward	0.28	0.85	inward	0.62	0.89	inward	0.05	0.2	inward
2021-11-05	-0.08	-0.06	inward	0.17	0.16	outward	0.3	0.99	inward	0.75	0.98	inward	0.32	0.44	inward
2021-11-19	0.59	0.24	outward	0.7	0.47	outward	0.89	1.04	inward	0.95	1.05	inward	0.86	0.55	outward
2021-11-22	0.58	-0.05	outward	0.68	0.38	outward	0.86	0.97	inward	0.89	0.98	inward	0.75	0.45	outward
2021-11-28	0.2	0.32	inward	0.45	0.43	outward	0.94	1.06	inward	0.98	1.09	inward	0.74	0.58	outward
2021-12-01	0.09	0.31	inward	0.4	0.41	inward	0.47	1.07	inward	0.97	1.1	inward	0.62	0.57	outward
2021-12-09	-0.17	-0.12	inward	0.1	0.17	inward	0.27	1	inward	0.82	0.97	inward	0.49	0.41	outward
2021-12-15	-0.27	-0.12	inward	0.06	0.23	inward	0.26	1.02	inward	0.82	1.05	inward	0.48	0.44	outward
2021-12-20	-0.24	-0.12	inward	0.01	0.23	inward	0.26	1.01	inward	0.79	0.99	inward	0.46	0.46	outward
Summary Statistics															
Mean	-0.388	-0.022		-0.136	0.073		0.489	0.764		0.570	0.794		-0.090	0.194	
Standard Deviation	0.245	0.170		0.235	0.228		0.177	0.231		0.144	0.239		0.332	0.208	
Number of Measurements			359			63			57			62			57
Outward or No Flow			2			11			1			7			9
Outward Flow Percentage			0.6%			17.5%			1.8%			11.3%			15.8%
Average Outward Flow	9.37%														

Note:

1) All measured data are converted to geodetic elevations.

2) Stations L1 and D1 are measured on daily basis (week days).

2) Gauge elevation was surveyed in March 2021

Indicates outward gradient flow direction

Appendix 8: 2021 Non-Recyclable Marine Debris Waste Assessment Forms

NP6756

VANCOUVER LANDFILL WASTE ASSESSMENT FORM

2907

CITY OF VANCOUVER **Transfer & Landfill Operations**
PHONE: 604.606.2700 **EMAIL: landfilloperations@vancouver.ca**

Instructions: **Note:** The City of Vancouver reserves the right not to accept any waste material.
 1. Complete Section 1 of this form and return to the Landfill by email to landfilloperations@vancouver.ca.
 2. Landfill Staff will review the form and either: approve and return it by email, request additional information, or suggest other disposal options.
 3. If the form is approved, have the carrier complete Section 2 and bring a copy of the approved form with each shipment.

Section 1: Generator

Company Name: Misty Isles Economic Development Society Phone: [REDACTED]
 Address: 138 Bay Street City & Postal Code: [REDACTED]
 Contact Person: [REDACTED] Phone: [REDACTED]
 Waste Description: Marine Debris Waste Weight: 9560 Kg
 Packaging type (e.g. box, bag): Super sacks within 40-yard containers Total No. Shipments: 3-4 bin loads

Is this material under destruction orders from a government agency (CFIA, Agriculture Canada, etc.)? no
 * If YES, will an inspector be accompanying the load for burial? no

Generator's Declaration: "I certify that the waste material is fully and accurately described above and is not a Hazardous Waste" as defined in the Hazardous Waste Regulations to the Environmental Management Act (or any successor legislation). I further certify that such waste material is not unacceptable waste, as defined on the City of Vancouver Prohibited Materials list and that it will be packed in proper condition for transport. I certify that to the best of my knowledge the waste material is suitable for disposal at a sanitary landfill, and I acknowledge that I remain responsible for ensuring compliance with all laws and by-laws applicable to the packaging, transport and disposal of the subject waste material. I hereby agree to indemnify and save harmless the City of Vancouver, its officials, officers and employees, from all claims liability, penalties, fines, judgements, costs and expenses of every kind, including as may arise from any finding of negligence on the part of the City of Vancouver, its officials, officers and employees, which may result in the disposal of the subject waste or from any failure to comply with all by-laws, statutes and regulations relating to the waste disposal in respect of which this application is made.

I represent that I am authorized to give the representations, assurances and indemnities set out above to the City of Vancouver.*

Name: [REDACTED] Title: End of Life Coordinator
 Signature: [REDACTED] Application Date: 11/30/21

Section 2: Carrier (to be completed by hauler at time of shipment to Landfill)

Company Name: GFL City & Postal Code: COQ
 Address: 70 GORDON DRIVE Phone: [REDACTED]
 Vehicle License: [REDACTED]
 Shipment Number (1, 2, 3, etc.): [REDACTED]

Carrier's Declaration: "I declare that I have received the GOODS listed above for delivery in accordance with the Shipper's instructions."

Name: [REDACTED] Signature: [REDACTED]

Section 3: City of Vancouver (to be completed by Landfill Staff prior to shipment to Landfill)

Shipper to notify Landfill prior to shipping: no Database entry complete: no
 Special handling at Landfill: Accept at GARBAGE RATE
 No. of shipments to be accepted: 4 Shipments acceptable up to: Dec 31 2021
 Approved by: [REDACTED] Phone: [REDACTED]
 Signature: [REDACTED] Date Approved: Dec 7 2021

Date Received at Landfill _____ **Net Weight of Load** 10730 kg

DEC 16 2021

Version: January 7, 2020

NP6756

ENTERED

VANCOUVER LANDFILL WASTE ASSESSMENT FORM

2907



Transfer & Landfill Operations
PHONE: 604.606.2700

EMAIL: landfilloperations@vancouver.ca

Instructions:

Note: The City of Vancouver reserves the right not to accept any waste material.

1. Complete Section 1 of this form and return to the Landfill by email to landfilloperations@vancouver.ca.
2. Landfill Staff will review the form and either: approve and return it by email, request additional information, or suggest other disposal options.
3. If the form is approved, have the carrier complete Section 2 and bring a copy of the approved form with each shipment.

Section 1: Generator

Company Name: Misty Isles Economic Development Society Phone: [REDACTED]
Address: 138 Bay Street City & Postal Code: [REDACTED]
Contact Person: [REDACTED] Phone: [REDACTED]
Waste Description: Marine Debris Waste Weight: 9560 Kg
Packaging type (e.g. box, bag): Super sacks within 40-yard containers Total No. Shipments: 3-4 bin loads

Is this material under destruction orders from a government agency (CFLA, Agriculture Canada, etc.)? no
* If YES, will an inspector be accompanying the load for burial? no

Generator's Declaration: "I certify that the waste material is fully and accurately described above and is not a Hazardous Waste" as defined in the Hazardous Waste Regulations to the Environmental Management Act (or any successor legislation). I further certify that such waste material is not unacceptable waste, as defined on the City of Vancouver Prohibited Materials list and that it will be packed in proper condition for transport. I certify that to the best of my knowledge the waste material is suitable for disposal at a sanitary landfill, and I acknowledge that I remain responsible for ensuring compliance with all laws and by-laws applicable to the packaging, transport and disposal of the subject waste material. I hereby agree to indemnify and save harmless the City of Vancouver, its officials, officers and employees, from all claims liability, penalties, fines, judgements, costs and expenses of every kind, including as may arise from any finding of negligence on the part of the City of Vancouver, its officials, officers and employees, which may result in the disposal of the subject waste or from any failure to comply with all by-laws, statutes and regulations relating to the waste disposal in respect of which this application is made.

I represent that I am authorized to give the representations, assurances and indemnities set out above to the City of Vancouver."

Name: [REDACTED] Title: End of Life Coordinator
Signature: [REDACTED] Application Date: 11/30/21

Section 2: Carrier (to be completed by hauler at time of shipment to Landfill)

Company Name: OP City & Postal Code: COQ
Address: 70 GARDEN AVE Phone: [REDACTED]
Vehicle License: [REDACTED]
Shipment Number (1, 2, 3, etc.): [REDACTED]

Carrier's Declaration: "I declare that I have received the GOODS listed above for delivery in accordance with the Shipper's instructions."

Name: [REDACTED] Signature: [REDACTED]

Section 3: City of Vancouver (to be completed by Landfill Staff prior to shipment to Landfill)

Shipper to notify Landfill prior to shipping: no Database entry complete: no
Special handling at Landfill: Accept at GARBAGE RATE
No. of shipments to be accepted: 4 Shipments acceptable up to: Dec 31 2021
Approved by: [REDACTED] Phone: [REDACTED]
Signature: [REDACTED] Date Approved: Dec 7 2021

Date Received at Landfill: DEC 16 2021 Net Weight of Load: 2390 kg

Version: January 7, 2020

DEC 15 2021

P 75168

ENTERED
DEC 15 2021

VANCOUVER LANDFILL WASTE ASSESSMENT FORM

2907



Transfer & Landfill Operations
PHONE: 604.606.2700

EMAIL: landfilloperations@vancouver.ca

Instructions:

Note: The City of Vancouver reserves the right not to accept any waste material.

1. Complete Section 1 of this form and return to the Landfill by email to landfilloperations@vancouver.ca.
2. Landfill Staff will review the form and either: approve and return it by email, request additional information, or suggest other disposal options.
3. If the form is approved, have the carrier complete Section 2 and bring a copy of the approved form with each shipment.

Section 1: Generator

Company Name: Misty Isles Economic Development Society
Address: 138 Bay Street
Contact Person: [REDACTED]
Waste Description: Marine Debris
Packaging type (e.g. box, bag): Super sacks within 40-yard containers

Phone: [REDACTED]
City & Postal Code: [REDACTED]
Phone: [REDACTED]
Waste Weight: 9560 Kg
Total No. Shipments: 3-4 bin loads

Is this material under destruction orders from a government agency (CFIA, Agriculture Canada, etc.)? NO

* If YES, will an inspector be accompanying the load for burial? NO

Generator's Declaration: "I certify that the waste material is fully and accurately described above and is not a Hazardous Waste" as defined in the Hazardous Waste Regulations to the Environmental Management Act (or any successor legislation). I further certify that such waste material is not unacceptable waste, as defined on the City of Vancouver Prohibited Materials list and that it will be packed in proper condition for transport. I certify that to the best of my knowledge the waste material is suitable for disposal at a sanitary landfill, and I acknowledge that I remain responsible for ensuring compliance with all laws and by-laws applicable to the packaging, transport and disposal of the subject waste material. I hereby agree to indemnify and save harmless the City of Vancouver, its officials, officers and employees, from all claims liability, penalties, fines, judgements, costs and expenses of every kind, including as may arise from any finding of negligence on the part of the City of Vancouver, its officials, officers and employees, which may result in the disposal of the subject waste or from any failure to comply with all by-laws, statutes and regulations relating to the waste disposal in respect of which this application is made.

I represent that I am authorized to give the representations, assurances and indemnities set out above to the City of Vancouver.

Name: [REDACTED] Title: End of Life Coordinator
Signature: [REDACTED] Application Date: 11/30/21

Section 2: Carrier (to be completed by hauler at time of shipment to Landfill)

Company Name: GFL
Address: 70 GOLDEN DRIVE City & Postal Code: COQUITLAM BC V3K 6R5
Vehicle License: [REDACTED] Phone: [REDACTED]
Shipment Number (1, 2, 3, etc.): [REDACTED]

Carrier's Declaration: "I declare that I have received the GOODS listed above for delivery in accordance with the Shipper's instructions."

Name: [REDACTED] Signature: [REDACTED]

Section 3: City of Vancouver (to be completed by Landfill Staff prior to shipment to Landfill)

Shipper to notify Landfill prior to shipping: no Database entry complete: no
Special handling at Landfill: Accept at GARBAGE RATE
No. of shipments to be accepted: 4 Shipments acceptable up to: Dec 31 2021
Approved by: [REDACTED] Phone: [REDACTED]
Signature: [REDACTED] Date Approved: Dec 7 2021

Date Received at Landfill DEC 15 2021

Net Weight of Load 2090 kg

Appendix 9: 2021 Annual Status Form



Annual Status Form

AUTHORIZATION NUMBER: 1611

AUTHORIZATION TYPE: Municipal Waste

LEGAL AUTHORIZATION HOLDER NAME: City of Vancouver

AUTHORIZED PERSON NAME: Mike Budzik

AUTHORIZED PERSON SIGNATURE: Mike Budzik

SIGNATURE DATE: March 23, 2022

I understand that it is an offense to mislead a government official, and I declare that all of the information presented is accurate and true.

CONDITION NUMBER	CONDITION DESCRIPTION	COMPLIANT (Yes/No/ND)	ACTION TAKEN	ANNUAL REPORT SECTION(S)
1.1.1	The discharge [of refuse to a sanitary landfill from sources within the Greater Vancouver Regional District and other sources specifically authorized by the Regional Waste Manager] is authorized for the full term of the Greater Vancouver Regional Solid Waste Management Plan, dated July 1995. The solid waste management plan must be amended to authorize the discharge beyond this term.	Yes	N/A	Vancouver Landfill Overview
1.1.2	Maximum authorized rate of discharge is 750,000 tonnes per year	Yes	N/A	5. Waste Disposal
1.1.3	The characteristics of the discharge shall be typical municipal solid waste and other materials as specifically authorized by the Regional Waste Manager. Asbestos waste may be discharged in accordance with the <i>Special Waste Regulations</i> .	Yes	N/A	5. Waste Disposal
1.1.4	Waste shall not be discharged within a buffer zone as identified in Section 2.9. Putrescible and household waste shall not be discharged into water. The burning of waste is prohibited.	Yes	N/A	2. Design and Operations Plan
1.1.5	The authorized works common to this section and Sections 1.2, 1.3 and 1.4 are a locking gate to control access by the public, a weigh scale and fire protection equipment, approximately located as shown on attached Site Plan A.	Yes	N/A	
1.1.6	The authorized works specific to this section are those associated with a landfill operation and include berms, covering material, surface water diversionary works, environmental monitoring systems, leachate collection/pumping works and a landfill gas management system consisting of existing and future collection works, a blower/flare station and gas utilization works, approximately located as shown on attached Site Plan B.	Yes	N/A	7. Environmental Protection Programs; 8. Operational Information

Authorized Person Initial: MB

Date: March 23, 2022

CONDITION NUMBER	CONDITION DESCRIPTION	COMPLIANT (Yes/No/ND)	ACTION TAKEN	ANNUAL REPORT SECTION(S)
1.1.7	The location of the point of discharge is Lot 9, Section 5 and 6, New Westminster District, Plan 38013. Discharge within the area identified as the "100 Acre Reserve", approximately as shown on Site Plan B, is restricted to construction and demolition waste in accordance with the approved closure plan required in Section 2.8	Yes	N/A	2. Design and Operations Plan
1.2.1	The characteristics of waste [at the landfill transfer station facility] are the same as set out in Section 1.1.3	Yes	N/A	6. Waste Reduction and Recycling Initiatives
1.2.2	The authorized works are those associated with a transfer station and include a paved access area and roll off bins, approximately located as shown on attached Site Plan C.	Yes	N/A	6. Waste Reduction and Recycling Initiatives
1.2.3	The location of the facilities is Lot 9, Section 5 and 6, New Westminster District, Plan 38013.	Yes	N/A	Vancouver Landfill Overview
1.3.1	The type of materials which may be managed at this facility [recycling depot and household hazardous waste storage facility] are typical recyclable materials and household hazardous waste.	Yes	N/A	6. Waste Reduction and Recycling Initiatives
1.3.2	The authorized works are those associated with a recycling depot and household hazardous waste storage facility and include roll off bins, recycling containers, a secure (fenced) storage area and storage shed for household hazardous waste, approximately located as shown on attached Site Plan C.	Yes	N/A	8. Operational Information; 6. Waste Reduction and Recycling Initiatives
1.3.3	The location of the facility is the same location as set out in Section 1.2.3.	Yes	N/A	Vancouver Landfill Overview
1.4.1	The type of waste that may be composted [at the composting facility for organic wastes from sources within the Greater Vancouver Regional District and other sources as specifically authorized by the Regional Waste Manager] is restricted to fruit and vegetable waste, typical yardwaste and Christmas trees.	Yes	N/A	6. Waste Reduction and Recycling Initiatives
1.4.2	The authorized works are those associated with a composting facility and include an impermeable pad, a stationary grinding plant, and windrow turning equipment, approximately located as shown on attached Site Plan A.	Yes	N/A	6. Waste Reduction and Recycling Initiatives
1.4.3	The location of the facilities is the same location as set out in Section 1.2.3.	Yes	N/A	Vancouver Landfill Overview
2.1	In the event of an emergency which prevents compliance with a requirement of this operational certificate, that requirement will be suspended for such time as the emergency continues or until otherwise directed by the Regional Waste Manager.	Yes	N/A	
2.2	Inspect the authorized works regularly and maintain them in good working order. Notify the Regional Waste Manager of any malfunction of these works.	Yes	N/A	8. Operational Information
2.3	Inspect the property boundaries regularly and notify the Regional Waste Manager of any visual evidence of environmental impacts on adjacent properties	Yes	N/A	8. Operational Information
2.4	Provision of fencing, site access, vehicle safety barriers, surface water diversionary works, firebreaks and on site restoration as required, shall be carried out to the satisfaction of the Regional Waste Manager.	Yes	N/A	

Authorized Person Initial: AMB

Date: March 23, 2022

CONDITION NUMBER	CONDITION DESCRIPTION	COMPLIANT (Yes/No/ND)	ACTION TAKEN	ANNUAL REPORT SECTION(S)
2.5	In preparation for the placement of putrescible waste, construct a base cell consisting of an approximate 3 metre lift of demolition and construction waste covered with a minimum 0.15 metre layer of suitable cover material. Firebreaks shall be incorporated into each cell in such quantity and manner as to prevent fires from becoming an environmental or safety hazard. Putrescible and household waste shall not be discharged in the base cell. For the purpose of this section, suitable cover consists of soil, utilized in accordance with Section 2.7 or other material as deemed acceptable by the Regional Waste Manager.	Yes	N/A	7. Environmental Protection Programs
2.6	All waste shall be placed in cells of a size acceptable to the Regional Waste Manager. The working face shall be confined to the smallest practical area. Waste shall be discharged in layers of 0.6 metres or less and compacted to the smallest practical volume. Intermediate cover, consisting of a minimum 0.30 metre of suitable cover material shall be applied as the filling proceeds. Side slopes shall be a maximum of 1:3 (vertical: horizontal). During non-discharge hours, the working face shall be covered with a tarp or other measures to the satisfaction of the manager to provide vector and litter control. The working face shall be covered with a minimum of 0.15 metres of suitable cover material once a week. The manager may vary the frequency of covering when freezing conditions adversely affect normal operation.	Yes	N/A	5. Waste Disposal
2.7	Urban park quality soil may be utilized for berm construction, intermediate and final cover, top dressing and landscaping. Soil with any substance with a concentration exceeding the lowest applicable numerical standard for urban park land may only be used for internal berms or intermediate cover. The utilization or discharge of special waste soil is prohibited.	Yes	N/A	5. Waste Disposal
2.8	Submit a closure plan for the area identified as the "100 acre reserve", ..., to the Regional Waste Manager by December 31, 2001 for approval. For the remainder of the landfill, the operational certificate holder shall apply final cover to any area of the landfill, which will not receive any further waste. Final cover shall be applied within one (1) year of completing the subject area. Final cover shall consist of a minimum of 1.0 metre of low permeability (<1 x 10 ⁻⁵ cm/s) compacted soil (or equivalent) cap plus a minimum of 0.15 metre of topsoil and suitable vegetative cover. Final cover shall be sloped to promote surface water runoff. Surface water runoff shall be directed outside of the leachate collection system.	Yes	N/A	2. Design, Operations and Progressive Closure Plan; and 4. Planned Improvements
2.9	Maintain a buffer zone along the north, east and south perimeters of the site, approximately as shown on Site Plan B and as follows: a minimum of 50 metres wide along the west half of the northern boundary and 30 metres wide along the balance of the northern boundary; and a minimum of 50 metres wide along all remaining boundaries. The buffer zone along the southern boundary of the site shall include a minimum fifteen (15) metre wide natural or landscaped screen.	Yes	N/A	Vancouver Landfill Overview

Authorized Person Initial: MB

Date: March 23, 2022

CONDITION NUMBER	CONDITION DESCRIPTION	COMPLIANT (Yes/No/ND)	ACTION TAKEN	ANNUAL REPORT SECTION(S)
2.10	Post a sign, to the satisfaction of the Regional Waste Manager, at the entrance of the landfill site with the following current information: site name, owner and operator, contact telephone number and address for the owner and operator, telephone number in case of emergency, hours of operation, materials and wastes accepted for recycling and landfilling, prohibited materials and wastes, and tipping fees.	Yes	N/A	
2.11	Take all reasonable measures necessary to prevent fires from occurring at the site. Provide and maintain fire fighting equipment and materials to the satisfaction of the Regional Waste Manager. The operational certificate holder is responsible for complying with all municipal fire safety requirements. In the event of a landfill fire, immediately notify the local fire department, the Provincial Emergency Program and the manager.	Yes	N/A	8. Operational Information
2.12	Take measures to minimize leachate generation, including but not limited to, providing effective covering and surface water runoff. Measures taken, their effectiveness and any proposed measures shall be detailed in the annual report. The leachate collection works shall be maintained in accordance with sound engineering principles as supported by qualified personnel.	Yes	N/A	7. Environmental Protection Programs
2.13	Submit a report to the Regional Waste Manager by April 30, 2001 detailing measures taken to minimize odours and greenhouse gas emissions and their effectiveness. The annual report shall include a description of measures taken and the beneficial results accomplished by these measures, any revisions to the implementation schedule and any new measures planned for the coming year.	Yes	N/A	7. Environmental Protection Programs
2.14	The amount of compostable materials and finished compost accumulated at the facility shall be limited to the maximum which can be properly managed at the site.	Yes	N/A	6. Waste Reduction and Recycling Initiatives
2.15	The amount of recyclable materials and household hazardous waste accumulated at the facility shall be limited to the maximum which can be properly managed at the site	Yes	N/A	6. Waste Reduction and Recycling Initiatives
2.16	Conduct a hydrogeological assessment to determine the following: hydrogeological impact of continuing extraction of sand and water from the dredge pond and its effect on leachate management; the natural attenuation properties of the peat and silt layers in the long term; the effect of additional height of waste on the horizontal hydraulic conductivity of the demolition layer (base cell); and they hydrogeological impact of current operating practices. Take into consideration recommendations of the hydrogeological study completed in September 1995. Review and update the hydrogeological assessment every five years with the first review prior to December 31, 2005. Incorporate actions recommended in this review and subsequent reviews into the revised design and operating plan. Hydrogeological assessments and reviews shall be conducted by a qualified professional licensed to practice in the province of BC.	Yes	N/A	4. Planned Improvements
2.17	Register a covenant or other legal notification not later than 6 months following the subdivision of the property described in Section 1.1.7, that the property was used for the purpose of waste disposal as a charge against the title to the property.	Yes	N/A	

Authorized Person Initial: MB

Date: March 23, 2022

CONDITION NUMBER	CONDITION DESCRIPTION	COMPLIANT (Yes/No/ND)	ACTION TAKEN	ANNUAL REPORT SECTION(S)
2.18	Operate the authorized facilities in accordance with a design and operating plan certified by a qualified professional. Review the plan on an annual basis. Any revisions to the plan shall be submitted as part of the annual report.	Yes	N/A	2. Design, Operations and Progressive Closure Plan
2.19	Accrue, during the lifetime of the landfill, a dedicated reserve fund sufficient to finance closure, post-closure and environmental contingencies related to the landfill. Include a minimum post closure period of twenty (25) years and how the fund will be accrued in the design and operations plan. Update estimated costs of closure and post-closure activities annually and incorporate into the annual report. Should estimated costs increase, increase the rate of the accrual accordingly.	Yes	N/A	3. Closure and Post Closure Costs
2.20	Submit a closure plan for the sanitary landfill and landfill transfer station facility at least six (6) months prior to the closure of the landfill for approval. Incorporate the required information.	Yes	N/A	
2.21	Submit a site profile to the Regional Waste Manager not less than 10 days prior to decommissioning the authorized facilities.	Yes	N/A	
3.1	Record the quantity, in tonnes, of waste received at the landfill, recycling and composting facilities. Record the quantity and destination of recyclable materials and mature compost removed from these facilities.	Yes	N/A	5. Waste Disposal; and 6. Waste Reduction and Recycling Initiatives
3.2.1	Maintain leachate, surface water and groundwater monitoring stations, approximately located as shown on the attached Site Plan D, and as outlined in Table 1. Obtain grab samples at each station and analyze for each parameter at a frequency as indicated in Table 2. Take care in sampling, storing and transporting the samples to adequately control temperature and avoid contamination, breakage, etc.	Yes	N/A	7. Environmental Protection Programs
3.2.2	Provide and maintain a suitable flow measuring device and record the volume of leachate discharge to sanitary sewer each month.	Yes	N/A	7. Environmental Protection Programs
3.2.3	Establish and maintain a minimum of four (4) water level monitoring stations and record once per month the water level elevation in the leachate and drainage ditches at each station.	Yes	N/A	7. Environmental Protection Programs
3.3.1	Sampling and flow measurement shall be carried out in accordance with the procedures described in "British Columbia Field Sampling Manual for Continuous Monitoring plus the Collection of Air, Air-Emission, water, Wastewater, Soil, Sediment and Biological Samples", 1996 Edition, or by suitable alternative.	Yes	N/A	7. Environmental Protection Programs
3.3.2	Analyses are to be carried out in accordance with procedures described in the latest version of "British Columbia Environmental Laboratory Manual for the Analysis of Water, Wastewater, Sediment and Biological Materials, (March 1994 Permittee Edition)", or by suitable alternative.	Yes	N/A	7. Environmental Protection Programs
3.3.3	All data analysis required to be submitted by the permit shall be conducted by a laboratory acceptable to the Regional Waste Manager. Provide the laboratory quality assurance data, associated field blanks, and duplicate analysis results along with the submission of data required under section 3.2.	Yes	N/A	7. Environmental Protection Programs

Authorized Person Initial: MB

Date: March 23, 2022

CONDITION NUMBER	CONDITION DESCRIPTION	COMPLIANT (Yes/No/ND)	ACTION TAKEN	ANNUAL REPORT SECTION(S)
3.4	Maintain the following information and records, current and suitably tabulated, at the landfill office for inspection: copy of Operational Certificate MR-01611; training procedures and personnel training records; contingency plans and notification procedures; current design and operating plan; inspection records from staff and regulatory agencies; hydrogeological, geotechnical and landfill gas assessments; incoming waste, and soil records; records of recyclable materials shipped off site; environmental monitoring results and interpretations; and annual operating and monitoring reports for the previous year.	Yes	N/A	
3.5.1	Maintain data of analyses and records of waste and recyclable material quantities for inspection. Submit data of analysis suitably tabulated, to the Regional Waste Manager for the previous three months. The reporting period ends Mar 31, Jun 30, Sept 30 and Dec 31. All reports shall be received by the manager within 31 days of the end of the reporting period.	Yes	N/A	
3.5.2	Prepare an annual report which shall include a compendium of data submitted under Section 3.5.1, in addition to: a review and interpretation of the analytical data from receiving environment monitoring for the preceding year; waste, recyclable material and compost records; leachate flow data and leachate/drainage ditch levels suitably tabulated; an evaluation of leachate generation control measures; an evaluation of the efficiency of the landfill gas generation rate, percent recovery and the actual rates/volumes of gas collection, utilized and flared; revised closure/post closure costs and amount of funds currently available; revised design and operating plan and planned improvements; identification of operating problems and corrective actions taken; an evaluation of the recycling and composting programs including waste diversion projections; and public complaint/resolution log for the landfill. Submit report to the Regional Waste Manager on or before Mar 31 of the following year.	Yes	N/A	

Authorized Person Initial: MB

Date: March 23, 2022