REPORT

Golden Landfill Design, Operations and Closure Plan Update

Golden, BC

Submitted to:

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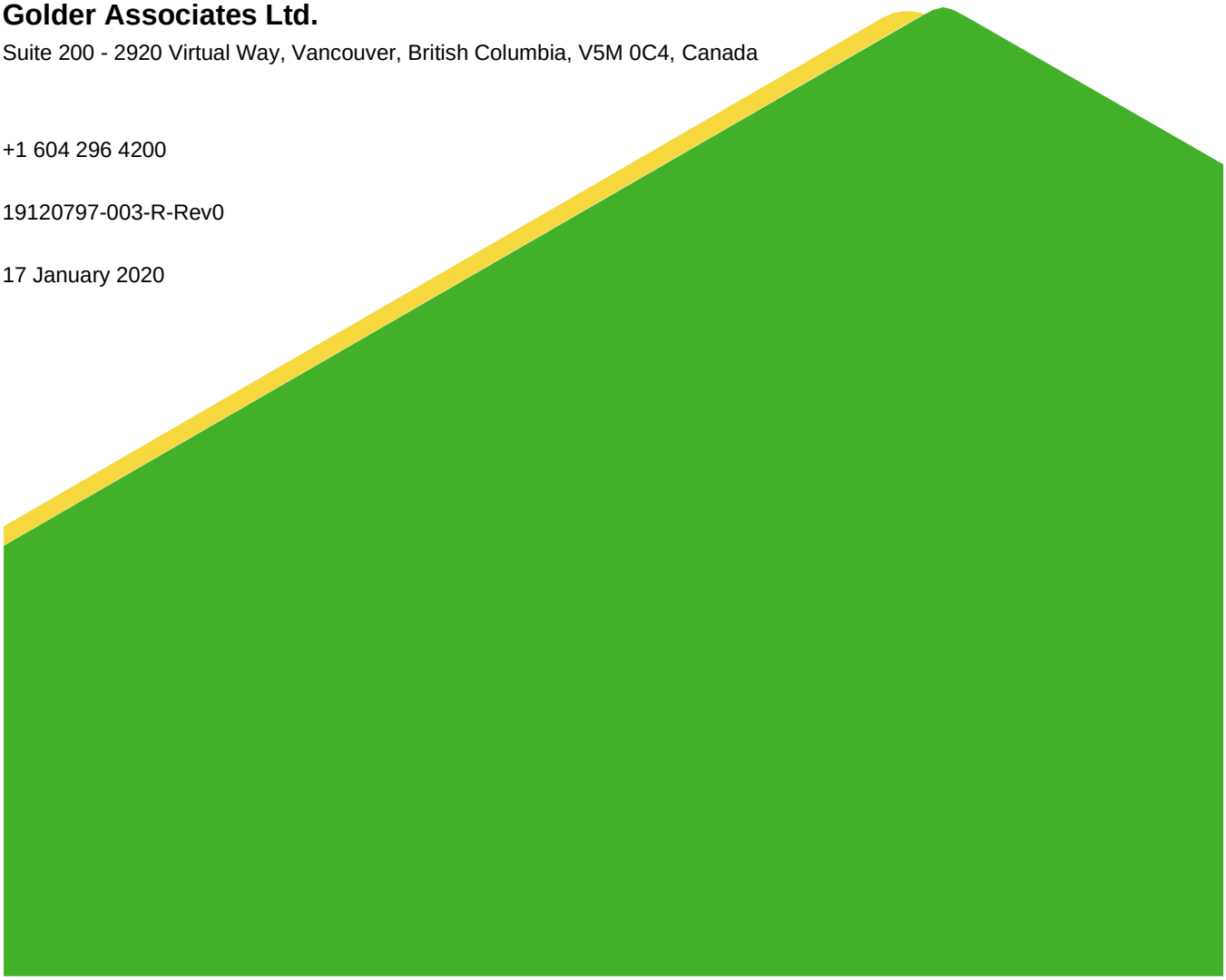

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1.0 INTRODUCTION

1.1 Background Information

Golder Associates Ltd. (Golder) has prepared this updated Design, Operations and Closure Plan (DOCP) for the Golden Landfill (Landfill or Site) located in the Columbia Shuswap Regional District (CSRD). This updated DOCP is based on the previous Design and Operations Plan (D&O Plan) prepared by Golder in 2013, Golder's observations during site visits on 14 March and 28 May 2019, and a review of the following information:

- *Golden Landfill Design and Operations Plan* (Golder, 13 December 2013)
- Operational Certificate 17006 (Ministry of Environment and Climate Change Strategy, amended 31 October 2019)
- Ministry of Environment Documents (Summary of 2017 Site Inspection, 2018 CSRD Response Letter and Environmental Impact Assessment Review by the Ministry dated 24 September 2018)
- Golden Landfill Annual Reports for 2015 to 2018 (Columbia Shuswap Regional District)
- *Annual Environmental Monitoring Report, Golden Refuse Disposal Site, Golden, B.C.* (Summit Environmental Consultants Inc. - Three reports 2011 to 2013)
- *Golden Landfill Design and Operations Plan* (EBA Engineering Consultants Ltd., November 2007)
- *Conceptual Model, Preliminary Numerical Model and Contaminant Inventory. Town of Golden, B.C., Aquifer Protection Plan* (Golder, March 2006)
- *Solid Waste Management Alternative Disposal Strategy Report* (XCG Consultants Ltd., 10 January 2013)
- *Landfill Gas Generation Assessment Report for the Golden Landfill* (Conestoga-Rovers & Associates, June 2012)
- *Supplemental Landfill Gas Generation Assessment – Golden Landfill* (GHD Ltd, 21 June 2017)

This DOCP update supersedes all D&O Plans previously prepared for the Site. Since it is an update and not an entirely new plan, many elements of the 2013 D&O Plan are incorporated in this document. The purpose of this DOCP is to outline the recommended approach to developing, operating and eventually closing and maintaining the Landfill throughout the post-closure period. This document incorporates the provisions of the Site's Operational Certificate (OC 17006) and certain sections of the BC Landfill Criteria for Municipal Solid Waste (2016).

1.2 Regulatory Requirements

The Landfill has been operating since the early 1970's. The first permit for the Landfill was issued to the Town of Golden in 1974 (EBA, 2007). It allowed waste disposal, controlled burning, and deposition of septic tank waste. The Landfill permit was then reportedly transferred to the CSRD between the late 1970's (CSRD, 2012) and 1986 (EBA, 2007).

Design and operations of the Landfill should conform with the general requirements outlined in the following regulations or criteria, which are described in more detail in the subsequent sections:

- Operational Certificate 17006 amended 31 October 2019 – Compliance is mandatory.
- Ministry of Environment Environmental Management Act – Compliance is mandatory.
- BC MOE Landfill Criteria for Municipal Solid Waste (Landfill Criteria, June 2016) – This document represents good practice.
- BC MOE Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills – This document represents good practice.
- BC Water Quality Standards and Guidelines – These standards and guidelines are used to assess quality of the groundwater at the Site.
- BC MOE Landfill Gas Management Regulation, brought into force on 1 January 2009 – Compliance is mandatory.
- CSRD Solid Waste Management Plan (2009 to 2029).
- WorkSafe BC – Compliance is mandatory.

1.2.1 Operational Certificate

Operational Certificate 17006 was issued on 5 May 2003 and last amended on 31 October 2019 (see Appendix A). It specifies that the maximum quantity, final Landfill footprint, and Landfill profile must comply with the approved D&O Plan. It also requires that the Landfill D&O Plan be reviewed and updated as needed at least once every five years. This DOCP update is prepared to address this requirement. The OC also sets requirements for the following:

- Emergency procedures.
- Public health, safety, and nuisance.
- Groundwater and surface water quality.
- Landfill gas (LFG) management.
- Waste compaction and coverage.
- Permitted waste types.
- Site access.
- Dust and litter control.
- Monitoring.
- Reporting.
- Closure plans.

1.2.2 Environmental Management Act

The Environmental Management Act was brought into force on July 8, 2004. It provides a regulatory framework to protect human health and the quality of water, land and air in BC. Part 3 of the Act (Municipal Waste Management) is of particular relevance to the Landfill because it defines municipal solid waste (MSW) and contains mandatory administrative requirements for managing facilities accepting MSW and recyclable materials.

1.2.3 Landfill Criteria for Municipal Solid Waste

The Landfill Criteria for Municipal Solid Waste (the Landfill Criteria or Criteria) were issued by the BC Ministry of Environment and Climate Change Strategy (MoE&CCS) in 1993 and were last updated in 2016. The Criteria outline recommended design, operation and closure practices for MSW landfills. The requirements of the Criteria are not mandatory or legally binding but are intended to be taken into consideration when setting the enforceable standards specified in Solid Waste Management Plans, permits and operational certificates.

1.2.4 Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills

The Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills were prepared by the MOE to assist landfill owners and operators to design and implement an environmental monitoring program meeting the recommendations in the Landfill Criteria. The guidelines address groundwater, surface water, leachate, Landfill Gas (LFG), and ambient air quality monitoring.

1.2.5 British Columbia Water Quality Standards and Guidelines

The following provincial water quality standards and guidelines apply within BC:

- BC Contaminated Sites Regulation (CSR; BC Reg. 375/96 O.C. 1480/96, including amendments up to B.C. Reg. 116/2018, 24 January 2019. EMA [SBC 2003]) Schedule 3.2 Generic Numerical Water Standards.
- BC Water Quality Guidelines (BC WQGs) for the protection of aquatic life, which apply to receiving surface waters and comprise working and approved guidelines (BC ENV 2017a; BC ENV 2018b).

The water quality standards that are applicable to this Site are discussed in the Golden Landfill Environmental Monitoring Plan (Golder, 2019).

1.2.6 Landfill Gas Management Regulation

The Landfill Gas Management Regulation, which applies to landfills that accept MSW for disposal on or after 1 January 2009, requires that assessment of landfill gas (LFG) generation be carried out for landfills that contain 100,000 tonnes or more of MSW, or receive 10,000 or more tonnes of MSW per year for disposal after 2008. For the Landfill to comply with this regulation, an initial LFG assessment report, prepared by a qualified professional, must have been submitted to the MOE no later than 1 January 2011. If the assessment indicates that the Landfill would generate 1,000 tonnes or more of methane in the calendar year immediately preceding the calendar year of the assessment, an LFG management facilities design plan will need to be prepared for the Landfill.

The most recent LFG generation assessment was conducted by GHD in 2017. The results are described in Section 3.5.

1.2.7 Solid Waste Management Plan (2009 to 2029)

The CSRD Solid Waste Management Plan (SWMP) describes the CSRD's key commitments with various parties (other municipalities, First Nations, adjacent Regional Districts, and National Parks) to manage and reduce solid wastes in the CSRD over a 5-year period (2009 to 2013).

The SWMP describes a strategic framework that efficiently categorizes policies according to the core strategies consistent with the 6Rs Waste Management Hierarchy (Rethink, Reduce, Reuse, Recycle, Recover, and Manage Residuals), which encourages CSRD waste managers to think about ways to help reduce the environmental impact of their waste management decisions. The SWMP also outlines the approach that the CSRD uses to measure the performance of its programs and policies.

In 2015, the CSRD conducted a review and update of the 2009 plan. The purpose of the update was to enhance the guiding principles, vision and goals that were established in 2009 and evaluate progress made in implementing the SWMP recommendations.

1.2.8 WorkSafe BC

WorkSafe BC provides the applicable health and safety requirements associated with institutional, commercial and industrial operations including the operation of solid waste management facilities such as the Golden Landfill.

2.0 SITE CONDITIONS

2.1 Physical Settings

The Landfill is located at 350 Golden-Donald Upper Road approximately 2 km northeast of Golden, BC (see Figure 1). According to the OC, the legal description of the Landfill is “Subdivision 12 of Section 18, Township 27, Range 21, West of the 5th Meridian, Kootenay District.” The Site is developed on a bench above the Kicking Horse River. It is approximately 1.3 km north of the Kicking Horse River and about 2.4 km east of the Columbia River. The approximate latitude-longitude, and UTM NAD83 co-ordinates of the centre of the Site are as follows:

- Latitude: 51º18’37”, longitude: 116º56’58”.
- UTM co-ordinates: 503400E, 5684200N (zone 11).

The Landfill property occupies a plan area of 16 hectares (ha). The current waste footprint is located at the southwest corner of the property and covers an approximate area of 4.3 ha. Some buried waste exists outside the current waste footprint as shown when excavations at the north end of the site revealed burnt waste residuals which are believed to date back to when the site was used as a forestry dump site.

The Landfill generally slopes down to the southwest towards the Kicking Horse River. It drops from elevation 955 m (above sea level) at its northeast corner, to elevations of about 925 to 930 m along the northwest southeast diagonal of the Site, at average grades varying from 25 to 40%. The topography becomes distinctly flatter from the northwest-southeast diagonal to the southwest corner of the Landfill. It drops from elevations of about 925 to 930 m at the diagonal, to elevation 913 m at the southwestern extent of the waste footprint, at an average grade of 5%. This flatter portion of the Landfill property is about 120 m higher than the Kicking Horse River. The Landfill is surrounded by natural terrain vegetated with trees and grass.

Based on Golder’s 23 May 2019 site visit, as well as the topographical survey and aerial photograph obtained by Harrier Aerial Surveys on 13 June 2019 (Figure 2 and Figure 3, respectively), the Landfill comprises the following key operational areas:

- An entrance gate off of Golden-Donald Upper Road;
- A split-level retaining wall with roll off bins that is used as a public drop off area;
- A share shed, recycling area and a vehicle scale adjacent to the public drop off;
- Separate stockpiles to the east of the scale house for metals, refrigerators and freezers, roof shingles, mattresses and concrete.
- A lock-block enclosure for the storage and sale of compost;
- A secure compound for the temporary storage of household hazardous waste;
- Separate stockpiles of dimensional lumber and yard and garden waste north of the active filling area;
- A stockpile of hydrocarbon impacted soil;
- A series of poles that support litter control netting along the south edge of the Landfill;
- An active filling area at the southwest corner of the property which is currently at an elevation of 928 m; and
- On-site borrow areas along the eastern half of the Site.

The Landfill is accessed via Golden-Donald Upper Road branching from Highway 1. This road ascends at approximately 5% average grade to the north over 900 m, from Highway 1 to the Landfill entrance on its east side. Once entering the Landfill, this road branches to the following roads:

- A road heading north that turns to the east after about 80 m. This road loops around the public drop off / recycling area and leads to the weigh scale.
- A road heading south from the weigh scale that extends up to the top of the active filling area. This road provides access to the active face as well as the dimensional lumber and yard and garden waste stockpiles.
- A road heading southeast from the weigh scale and then north to the area where the stockpiles of metals, concrete, etc. are located.
- A road heading directly south from the Site entrance gate. This road extends along the east and south toe of the Landfill.

2.2 Climate

The Landfill is located in an area with a relatively dry climate, with hot summers and moderate winters. The climate normals from 1981 to 2010 for the Golden Airport (ID 1173210) from Environment Canada indicate that the average temperature at the Site is 5.1ºC. The coldest month is January, with an average daily minimum temperature of -11.5ºC. The warmest month is July, with an average daily maximum temperature of 24.5ºC.

The general area where the Landfill is located receives an average annual precipitation of 467 mm. Most of this precipitation occurs as rainfall (325 mm), with the remainder as snowfall. Average monthly precipitation varies from 24.1 mm in February to 51.1 mm in November.

2.3 Hydrology

Existing site drainage features are shown in Figure 2. There is a ravine located at the northeast corner of the Site. This ravine is usually dry but does convey runoff during spring melt and intense precipitation events. When present, some of the runoff conveyed by this ravine flows overland (i.e. not in an established channel) towards the south end of the site where it is conveyed by a ditch at the toe of the southern Landfill slope. This ditch conveys the flow to the southwest corner of the Landfill where it terminates at a small infiltration pit.

The remainder of the overland flow ends up in the area between the existing landfill area and the eastern slope from which borrow material is excavated. This water flows west through two culverts below Landfill access roads and continues along the south edge of the public drop off area towards a small infiltration pit adjacent to the Landfill entrance. There is an additional ditch that conveys runoff from the north portion of the Site to the main ditch at the upstream end of the second culvert crossing.

Outside of the Landfill property, runoff that collects in the drainage ditches along Golden-Donald Upper Road flows to the south for about 1.3 km and discharges to the Kicking Horse River. Another surface watercourse exists approximately 180 m south of the Site. This watercourse flows to the southwest for about 1.1 km and discharges to a catch basin near Station Avenue.

2.4 Geology

The Landfill is underlain with ablation till to the east and ice-contact materials to the west, both of which primarily comprise silt, sand and gravel. The soil on the east side of the Site tends to be siltier and contain coarse, ice-contact deposits. Surficial deposits vary across the Site. On the east side, dense, gravelly sand and silty till-like deposits are present. These deposits are estimated to have low hydraulic conductivity and tend to restrict groundwater recharge and inflow to the Landfill. Clean, bedded sand and gravel alluvial deposits are present on the south side of the Landfill. These materials are estimated to be moderately permeable.

Limestone was encountered at a depth of 34 m below ground surface in borehole MW-6D put down on the west side of the Landfill by Summit in 2009. The bedrock underlying the Site was mapped as Cambrian to Ordovician (439 to 570 million years old) rocks of the McKay Group (Summit, 2011). This group consists of limestone, limestone conglomerate, shale, and associated meta-sedimentary rocks.

2.5 Hydrogeology

2.5.1 Regional Hydrogeology

Golder developed a conceptual hydrogeological model for the Town of Golden (including the area of the Landfill) as part of groundwater protection planning work (Golder 2006). Based on this model, regional groundwater flows occur in the surficial deposits (i.e., sand and gravel), and in the bedrock strata that surround and underlie the surficial deposits. The upland areas are typically groundwater recharge areas, and the Columbia River valley is the regional discharge area. Groundwater infiltrating the bedrock in the upland areas migrates downward, and then laterally into the surficial deposits that occur in the river valley, via fractures in the bedrock. Groundwater flow in the main sand and gravel aquifer is relatively slow and generally from southeast to northwest, along the Columbia River valley; however, lateral inflow also occurs (Golder 2006).

The ENV Water Resources Atlas (Province of BC 2019) has mapped one unconfined sand and gravel aquifer (No. 456) in Golden at the confluence of the Kicking Horse River and the Columbia River. Previous work by Golder indicates that there are three generally laterally continuous, sand and gravel deposits that make up the regional aquifer system (Golder 2006). The deeper water-producing strata are interlayered with finer-grained strata that act as aquitards. Most of the groundwater supply wells in the area that are completed in unconsolidated material are installed beneath confining layers and are protected from potential impacts to groundwater quality from surface activities. Based on previous publicly available groundwater protection work completed for the Town of Golden, the Landfill lies to the north, outside of the extent of Aquifer No. 456 and outside of the time-of-travel capture zones and buffer zones for municipal wells No. 4 and No. 6 (Golder 2006).

2.5.2 Local Hydrogeology

A detailed description of the Site hydrogeology is provided in the recently completed hydrogeological characterization report by Western Water Associates Ltd (WWAL 2019a). Below is a summary of some of the information from the report.

The ENV Water Resources Atlas (Province of BC 2019) does not report an aquifer beneath the Landfill. Based on well records for drilling completed at the Site, the unconsolidated deposits are thicker in the southwest area of the Landfill (115 m at MW18-11) and thinner toward the north, with bedrock outcropping at the eastern edge of the Site. Drilling records indicate that the unconsolidated materials in the area of the Landfill are largely unsaturated; however, there are areas where saturated conditions were encountered e.g. MW09-06 (WWAL 2019a).

The saturation level of shallow unconfined sediments in the area of the Landfill will be strongly controlled by groundwater recharge from precipitation and surface water loss to ground. WWAL inferred that the majority of recharge to groundwater from precipitation infiltrating the Landfill will migrate downward to the bedrock surface.

Groundwater flow in bedrock aquifers can be complex and less predictable than flow in unconsolidated materials since fracture orientation and density are important factors. With the available information it is difficult to assess the groundwater flow paths and travel times for transport of leachate constituents from the Landfill. Based on data from four monitoring wells installed in the bedrock, groundwater flow at the site is from northeast to southwest (WWAL 2019a). The steeply dipping bedrock at the southern boundary makes it difficult to estimate the groundwater flow direction and gradient immediately downgradient of the Landfill, and it is uncertain how and where leachate-affected groundwater migrates through the bedrock aquifer and discharges to Aquifer No. 456 (WWAL 2019a).

2.6 Groundwater Chemistry

The hydrogeological characterization and analysis of environmental monitoring data for the Landfill have been completed by Western Water Associates Ltd who are the CSRD's qualified professional monitoring and characterizing groundwater quality. To summarize the hydrogeological characterization (WWAL 2019a) and most recent environmental monitoring annual report (WWAL 2019b) contained within the 2018 Annual Operations and Monitoring Report (CSRD 2019):

- Western Water Associates Ltd. estimated the potential mass loading of chloride from the Landfill to Aquifer 456 of on the order of 394 mg/day which was estimated to represent less than 1% of the annual chloride contained in the aquifer. As a result, they infer that the Landfill is not contributing to measurable water quality degradation within Aquifer No. 456 (WWAL 2019a).
- Exceedances of drinking water guidelines/standards for arsenic, lithium, strontium, fluoride, iron, manganese, and cobalt observed at the historically-monitored wells, the two new monitoring wells installed at the Landfill in 2018, and the five additional domestic wells sampled in 2018 are interpreted by WWAL to be naturally-occurring within the bedrock (WWAL 2019a).
- Domestic wells DWM-1B and DWM-4, which are located upgradient of the Landfill, are not interpreted to be impacted by the Landfill (WWAL 2019a).
- There is the potential that groundwater beneath a portion of the neighboring property exceeds the groundwater quality standards based on chloride and nitrate exceeding applicable drinking water guidelines/standards at MW18-10, which is located at the south boundary of the Site and installed in bedrock to a depth of 36.4 m below grade (WWAL 2019a).
- Groundwater quality at MW09-6S, located near the western boundary and installed in overburden to a depth of 34.5 m below grade, shows evidence of groundwater quality impact from Landfill leachate. Concentrations of chloride and nitrate appear to have decreased since 2009 (WWAL 2019b).
- Based on one sample collected since it was drilled, groundwater quality at MW18-11, which is installed in bedrock to a depth of 146.3 m below grade, does not appear to be impacted by Landfill leachate (WWAL 2019b).

- Based on soil sampling conducted at the neighboring property to the south of the Site in 2018, no impact on soils from off-site surface water runoff were detected (WWAL 2019b).
- During spring freshet and high precipitation periods, surface water may flow onto, through and off the Landfill site, and there is evidence that this flow has at times been impacted by the Landfill (BC ENV 2018a).

2.7 Landfill Gas

The Landfill presently does not have an on-site active landfill gas management system. Landfill gas has been monitored on a regular basis near the western property boundary since 2013. The two monitoring locations are GP-6D / 6S (Deep and Shallow) and GP 7D / 7S. These monitoring locations are soil gas probes installed immediately adjacent to groundwater monitoring wells MW09-06 and MW09-07.

The methane concentrations observed at these two locations have ranged between 0 and 0.2 percent since monitoring was initiated in 2013. These values are below the Lower Explosive Limit (LEL) for methane which is equivalent to 5 percent methane by volume referenced in the Landfill Gas Management Facilities Design Guidelines (March 2010) issued by BC MoE.

3.0 SITE DESIGN CRITERIA

3.1 Waste Origin and Control

The Landfill is authorized to receive waste and recyclables from the CSRD and its environs. In 2018, the Landfill serviced a population of 6,856 (CSRD, 2018). Table 1 summarizes the annual waste tonnages to the Landfill from 1982 to 2018. Annual tonnages to the Landfill from 1982 to 1997 were provided in CRA's landfill gas generation assessment report (CRA, 2012). Based on these waste quantities, the total amount of MSW disposed of in the Landfill to 2018 is estimated to be approximately 190,000 tonnes.

Table 1: Annual Disposal Quantities (1982 to 2018)

Year	Quantity (tonnes MSW)	Year	Quantity (tonnes MSW)	Year	Quantity (tonnes MSW)
1982	4,668	1995	5,311	2007	6,241
1983	4,730	1996	5,382	2008	4,655
1984	1,793	1997	5,396	2009	5,552
1985	1,858	1998	5,595	2010	4,912
1986	4,922	1999	4,820	2011	4,994
1987	4,913	2000	5,227	2012	6,282
1988	4,950	2001	5,829	2013	4,417
1989	4,988	2002	5,476	2014	5,054
1990	5,027	2003	5,115	2015	4,387
1991	5,065	2004	5,281	2016	5,494
1992	5,103	2005	5,869	2017	5,019
1993	5,172	2006	6,085	2018	9,200
1994	5,241				

The Landfill was previously surveyed on 16 August 2013 and most recently on 13 June 2019. The amount of airspace consumed between these two dates is 69,000 m^3. The amount of material disposed at the Landfill over this same timeframe is estimated to be approximately 33,500 tonnes. Over these six years, the overall airspace utilization factor of waste (tonnes of MSW divided by total airspace consumed inclusive of cover materials) at the Landfill was calculated to be approximately 0.48 tonnes/m^3. This value is lower than the values estimated in 2012 and 2013 which were 0.61 and 0.55 tonnes/m^3 respectively.

Waste that is acceptable for disposal at the Landfill is typical MSW, defined in the Environmental Management Act as one of the following:

- Refuse that originates from residential, commercial, institutional, light industrial, demolition, land-clearing or construction sources.
- Refuse specified by a manager to be included in a waste management plan.

According to the OC, disposal of the following wastes is prohibited at the Landfill:

- Soils with constituent concentrations that exceed industrial land use standards;
- Hazardous wastes, except those approved for landfill disposal in the Hazardous Waste Regulation;
- Biomedical wastes;
- Bulk liquids and semi-solid wastes, which contain free liquids, as determined by USEPA Method 90954 Paint Filter Liquids Tests, Test Methods for Evaluating Solid Wastes-Physical/Chemical Methods (EPA Publication No. SW-8460); and
- Appliances, equipment, or any material containing or releasing ozone-depleting substances.

The OC was recently amended (31 October 2019) to restrict the type of contaminated soil that can be received at the site (see Appendix A). The quality of soil accepted at the site shall be below industrial land use standards whereas prior to the amendment, soils that were less than Hazardous Waste standards could be accepted. Contaminated soil that can be accepted may be disposed of by monofilling, co-disposal with other wastes, or use as a refuse cell berm or cover material. It cannot be used as final cover material. Asbestos may be accepted if it complies with the restrictions outlined in Section 3.3 of the OC.

Tetra Tech carried out a waste characterization study for the Landfill in 2018, of which the waste originated from the following three sectors:

- Residential curbside collection
- Residential self-haul
- Industrial, commercial, and institutional

Of the waste sampled in Tetra Tech's study, compostable organics, paper and plastic constituted the largest proportions, accounting for about 36%, 21% and 20% respectively of the total mass of the sampled waste.

The CSRD currently has diversion programs in place that divert the following materials from the Landfill: metals, asphalt shingles, concrete / brick / porcelain, ozone depleting substances (ODS) units (e.g. fridges and freezers), propane tanks, automotive batteries, mattresses and reusable items. The landfill also operates a Recycle BC depot. The CSRD may add or remove diversion programs at the Landfill from time to time depending on factors such as resource availability and market conditions.

3.2 Setback

The 5 May 2003 OC permitted a 15 m buffer zone between the Landfill and the property boundary, and the Landfill was filled accordingly. As such, there are areas with waste within 15 to 50 m of the property line that will remain in place as part of this Plan. The 29 August 2012 version of the OC increased the buffer zone by requiring a minimum 50 m distance between the limit of waste and the property line. The requirement in the 29 August 2012 OC of 50 m distance between placement of waste and the property line has been used to develop the current filling plan for the Landfill.

3.3 Slope Stability

Slopes with grades varying from 25 to 40% are present in the borrow excavation area along the eastern half of the Site. These slopes consist of gravelly sand and silty till-like deposits and did not show obvious indicators (e.g. stress cracking, scarps, bulging) of slope instability during Golder's 28 May 2019 site visit, except for shallow gullies inferred to be formed by concentrated surface water flow on these slopes during heavy rainfall events. The stability of the borrow excavation slopes is expected to change with excavation operations. All slopes over 2 m height and not specifically shown on the drawings to be steeper (e.g. 2:H:1V temporary waste slopes on Figures 4 and 5) should target a 33% or flatter grade. If steeper slopes are desired, a geotechnical engineer should provide an opinion on the stability of the particular slope.

Landfill slopes were covered with intermediate soil cover and appeared to be stable during our site visit.

3.4 Surface Water Management

Surface water management works are to be designed to achieve the following objectives (Landfill Criteria, 2016):

- Convey and direct surface water runoff away from the active operating area within the landfill footprint to minimize surface water contact with waste.
- Minimize potential for on-site erosion and sediment loading to downstream water courses.
- Control peak flows from the Landfill to minimize the downstream flood risk
- Prevent surface water run-on onto the landfill footprint.

Section 5.2 presents the recommended surface water management plan for the Landfill.

3.5 Landfill Gas Generation Potential

In 2017, GHD Ltd estimated the potential landfill gas generation from the Landfill using a first-order kinetic model (see Appendix B). GHD's results over the five-year assessment period (2016 to 2021) indicated that methane generation would be approximately 202 tonnes per year in 2016 and 223 tonnes per year in 2021. These values are below the 1,000 tonne per year methane generation threshold that triggers the requirement to develop a Landfill Gas Management Facilities Design Plan under the Landfill Gas Management Regulation.

3.6 Leachate Generation Potential

Leachate generation was assessed using the US EPA Hydrologic Evaluation of Landfill Performance (HELP) model (version 3.07). A 20-year simulation was run using historical climate data that had been adjusted to reflect average annual temperature and precipitation data collected at the Golden Airport climate station. The following summarizes the HELP model results:

- Average annual precipitation over the 20-year simulation was 466 mm per year.
- Average annual leachate generation was estimated to be approximately 187 mm per year during active operations.
- About 167 mm per year of leachate would be generated from the Landfill capped with a soil final cover comprising 0.15 m of topsoil underlain by 0.6 m of barrier soil having an assumed hydraulic conductivity of 1×10^{-5} cm/s.
- About 0.06 mm per year of leachate would be generated from the Landfill capped with a geomembrane final cover, consisting of the following layers (from top to bottom):
  - 0.15 m of topsoil cover for vegetation;
  - 0.3 m gravel drainage layer;
  - Geomembrane final cover; and
  - 0.3 m sand/gravel LFG collection layer.

Additional information regarding the HELP model results is presented in Section 5.1. As part of the detailed design of the final cover on future waste at the Landfill (e.g., implementing progressive Landfill closure), a more detailed assessment, including sampling and laboratory testing of the soil to assess the reasonableness of the HELP model parameters, may be warranted.

3.7 Leachate Containment

The Landfill Criteria state that any new phases of a landfill be developed with a base liner that consists of a primary high-density polyethylene (HDPE) membrane and a secondary compacted clay liner or geosynthetic clay liner (GCL). An exemption to this base liner requirement may be considered if all three of the following apply:

- The MSW disposal rate is less than 5,000 tonnes of waste per year and the total waste capacity of landfill is less than 100,000 tonnes;
- The landfill is located in a very remote area where there is no practical waste disposal alternative less than 100 kilometers away; and
- The landfill receives less than 500 mm of precipitation annually

The Golden Landfill does receive less than 500 mm of precipitation per year and the nearest alternative disposal option (Revelstoke Landfill) is located over 100 km away. However, the average annual disposal rate exceeds 5,000 tonnes per year and the amount of waste already is place is estimated to be 190,000 tonnes. Golder therefore recommends that future phases of Landfill development be constructed with an engineered base liner and leachate collection system to align with the Landfill Criteria.

4.0 LANDFILL DEVELOPMENT AND FILLING PLAN

4.1 Design Approach

As discussed in Section 3.7, Golder recommends that future Landfill phases be lined in accordance with the Landfill Criteria. This has an effect on the overall development of the Landfill, compared with the 2013 DOCP. The recommended overall design approach is to excavate into native soils to obtain intermediate and final cover soils and to prepare the excavated surface so that the design bottom-of-landfill grades are achieved. A portion of the excavated soils will need to be stockpiled (for use later as intermediate and final cover) so that the lining system can be installed. The amount of space available to stockpile soils on site is limited, so the CSRD has indicated that the design approach should be to reduce the amount of soil excavation required to facilitate liner construction as opposed to maximizing soil excavation and the corresponding landfill airspace that could ultimately be achieved.

4.2 Final Landfill Configuration

The conceptual design final closure contours of the Landfill are shown in Figure 7. These conceptual closure contours were developed based on the recent 13 June 2019 topographical survey and the guidelines for final contours in the Landfill Criteria. The completed Landfill will have side slopes of 3H:1V (3 Horizontal to 1 Vertical) and a top platform that slopes down at a 10% grade from the central crest. The conceptual design shows benches spaced vertically every 15 to 20 m. Some roads are shown as lines and are not reflected in the contours. The top platform will have a peak elevation of 961 m and will have a plan area of approximately 2.3 ha. The ultimate waste footprint will be approximately 7.3 ha.

The completed Landfill will have a 10 m wide access road (including an inside ditch) that starts near the northwest corner of the footprint and winds its way to the top of the Landfill. The grade of the road is shown at an 8% grade which is the guideline for commercial traffic listed in the Landfill Criteria. This road, along with additional mid-slope ditches, will divide the Landfill surface slope into smaller drainage catchments to enhance surface runoff control. The mid-slope ditches generally provide a 15 to 20 m elevation difference between ditches or benches. This is slightly higher than the 15 m vertical separation guideline presented in the Landfill Criteria but is considered acceptable given that the annual precipitation in the area is low but sufficient enough to support vegetation. The access road should be constructed with a cross-fall (super-elevation) of approximately 2% down to the inside drainage ditch to enhance drainage off the road surface.

A comparison of the new design closure contours with the proposed base contours indicates that the remaining airspace capacity of the Landfill is approximately 835,000 m^3 (including MSW and cover materials). The Landfill is estimated to have an approximate service life of 60 years (closure in 2080) based on the following assumptions:

- The refuse disposal rate will be 0.75 tonnes/person/year which is representative of the disposal rate observed over the past five years.
- The Landfill service population will correspond with BCStats population projection for Golden from 2013 to 2036 and will increase by 0.5% annually thereafter. This annual rate of population increase is similar to the average rate of annual increase in the last 10 years of the BCStats population projection (2027 to 2036).
- The airspace utilization factor will be 0.55 tonnes/m^3 which is the average between that observed from 2013 to 2019 (0.48 tonnes/m^3) and the values calculated in 2012 and 2013 (0.61 and 0.55 tonnes/m^3 respectively). It is important to note that Landfill lifespan estimates are sensitive to the airspace utilization factor. For example, if the long-term airspace utilization factor were 0.5 instead of 0.55 tonnes/m^3, the Landfill lifespan would decrease by approximately 5 years.

The Landfill capacity and lifespan estimated above is less than those presented in previous D&O plans. This is due to the required transition to an engineered liner design. Normal practice is to install a liner on a subgrade sloped at 3H:1V or less. In this instance, establishing these 3H:1V slopes along the east half of the Landfill site means that the available waste footprint will be smaller than what could be achieved by filling over the existing ground. A steeper liner slope is possible, to slightly increase the airspace; however this introduces constructability issues.

Golder estimates that the Landfill will receive about 430,000 tonnes of waste between 2019 and the projected closure in approximately 2080.

4.3 Filling Plans

The 2013 D&O Plan presented a filling strategy based on the assumption that the Site would continue to operate as a natural attenuation landfill. However, as discussed in Sections 3.7 and 5.1, it is now recommended that any new phases of the Golden Landfill be developed with an engineered liner and leachate collection system to align with the Landfill Criteria. As a result, the final contours and filling strategy presented in the 2013 D&O Plan have been modified.

Table 2 presents the estimated airspace, waste capacity and lifespan of each of the five proposed phases of Landfill development. Figure 4 shows the projected conceptual Phase 1 Landfill contours. Until about the end of 2027, filling will be confined to the existing waste footprint at the southwest corner of the property, with the top elevation of Phase 1 projected to be at approximately 935 m and a top surface platform area of roughly 5,000 m^2. Access will be provided along the bench road that starts at the north end and wraps around the west and south slopes at an 8% grade. Figure 4 also shows the conceptual Phase 2 site preparation contours. In order to prepare this area, road access to the diverted material stockpile area located east of the scale house will have to be shifted further north by cutting a road into the bank. The total amount of soil cut required for Phase 2 site preparation is estimated to be 20,000 m^3.

Figure 5 shows the conceptual Phase 2 fill contours. Phase 2 will be filled to a crest elevation of 944 m. Access will be provided along the same road that was used for Phase 1. Prior to the completion of Phase 2 (prior to approximately 2039), the scale house, public drop off area and diverted material stockpiles will need to be relocated to allow for construction of the Phase 3 liner.

Figure 6 shows the conceptual site preparation contours for the northern portion of the site. The north slope will be cut at 3H:1V down to a 10 m wide bench at elevation 925 m. The Phase 3 liner will be constructed below this bench and will extend west towards a toe berm that will be established over the current public drop off area. This berm will also serve as an access route to the Phase 1 bench road. This berm will require approximately 10,000 m^3 for soil fill. The amount of soil cut associated with the northern half of the site is approximately 112,000 m^3.

Figure 7 shows the conceptual final contours and the proposed progressive closure strategy. Both the liner slopes and landfill side slopes are intended to have benches, which are depicted on these conceptual design drawings as dashed lines rather than contours cut into the slope.

Prior to any further development, the ravine at the northeast corner of the site will be blocked off and diverted around the site (see Section 5.2).

Table 2 presents the progressive closure area, and the estimated closure cost for each phase in 2019 dollars, based on proportionate progressive closure area, a final cover design consisting of locally-available low-permeability soil, and the total estimated closure costs (Table 7: Estimated Closure and Post-Closure Costs).

Table 2: Projected Filling Sequence from 2019 to Closure

Phase	Projected Completion Year	Approximate Available Airspace (m^3)	Approximate Available Capacity (tonnes)	Progressive Closure Area (m^2)	Closure Cost (2019$)
1	2027	103,000	52,900	17,600	$1,280,800
2	2039	147,000	75,700	8,000	$582,200
3	2045	85,000	43,600	4,500	$327,500
4	2067	300,000	154,000	6,300	$458,500
5	2080	200,000	102,000	36,600	$2,663,500

4.4 Filling Details

The Landfill is developed using a hillside or an above-grade modified area fill method. At each stage of Landfill development (i.e., each platform), an access road brings waste-transport vehicles to the active face. Waste placement in the active filling area is then carried out using the area method. In this method, the active platform is first divided into strips. Waste is then filled in a strip-by-strip manner, with the waste in the first strip properly compacted and covered with intermediate cover before the second strip is developed. The width of strips should be kept to approximately 15 to 20 m to enhance efficiency in the placement and compaction of waste. The surface of a complete strip may be graded flat, if necessary to provide a level platform for unloading large waste vehicles. However, it would be beneficial from a drainage perspective to provide a cross-grade of about 2 to 3% generally down to the southwest to promote flow of surface water off the strip. The general concept of landfilling in a strip on the active platform is described below and illustrated in Figure 8:

1) An access road is built to the location and elevation of the starting point of a strip.

2) Areas near the strip are properly prepared and graded to promote flow of runoff away from the active face. If required, surface water diversion ditches or berms should be constructed near the active face.

3) Strips are filled in a generally southeast-northwest direction, with cross-grades generally down to the southwest to promote drainage of surface runoff during fill placement.

4) The active face is covered with a suitable daily cover (metal plates) at the end of each working day. This daily cover is removed when active filling commences on the following day.

5) Areas that will not accept new waste for 30 days or more are covered with a suitable intermediate cover.

The waste in each strip is placed in maximum 3 m thick lifts (2.7 m of MSW and 0.3 m of intermediate cover). In each lift, the waste is spread and compacted on the operating face in maximum 600 mm thick layers, with approximately three to five passes of the landfill compactor over each layer. The working face should be kept as small as is practical. The daily operating face should be kept to a width of approximately 6 to 10 m and a slope of about 4H:1V, with a small exposed face. This facilitates control of odour, birds, vectors, and litter. In addition, the areas adjacent to the active face should be graded to divert runoff from the MSW at the working face.

As final Landfill elevations are achieved in each phase of the operation, final cover will be placed over the area that will not receive additional waste and the surface will be vegetated for erosion control. The suitable plant growth material could be topsoil, or a manufactured growth medium comprising mineral soil and an organic component well mixed before application.

When filling of each lift is taking place, the outside edge should be completed with an initial slope of about 2.6H:1V to allow for some post-construction settlement. The actual amount of settlement that may occur depends on compaction of the waste, the waste composition, and the age and thickness of waste underlying the edge. Some adjustment of the final slope may be required to achieve an overall slope of 3H:1V at closure.

4.5 Materials Inventory

Table 3 summarizes the estimated quantities of major materials required for Landfill construction from 2019 until its closure in about 2080, assuming a 0.75 m thick soil final cover system and a total waste footprint of 7.3 ha. It is anticipated that the topsoil to be used in the final cover will be composed of mineral soil with organic amendments (e.g., biosolids). Intermediate cover will consist of a 2:1 mix by volume of mineral soil and wood chips. The metal plates may require periodic replacement.

Table 3: Estimated Quantities of Major Materials Required for Landfill Development

Item	Material	Estimated Quantity
Daily Cover	Metal Plates	200 m^2
Intermediate Soil Cover	Mineral Soil	130,000 m^3
	Wood Chips Ground On-site	65,000 m^3
Mineral Soil Final Cover	Mineral Soil	43,800 m^3
Topsoil for Final Cover	Mineral Soil with Organic Amendments	10,950 m^3

The amount of mineral soil available from soil excavation / site preparation activities associated with the provision of a liner construction is estimated to be approximately 131,000 m^3. Of this total amount, approximately 10,800 m^3 may be required for the Phase 3 toe berm. This leaves a balance of 120,200 m^3 available for Landfill operations. Based on the quantities in Table 3, it is estimated that the majority of mineral soil for the intermediate could be obtained from the required site preparation activities. The remaining intermediate cover and final cover soils would have to be obtained from on-site borrow areas established outside the waste footprint or from off-site sources; however these other sources of material will not be required until between about 2045 and 2080.

5.0 ENVIRONMENTAL PROTECTION

5.1 Groundwater Protection – Leachate Management

The existing Landfill is categorized as a natural control landfill that does not have a low permeability liner or a leachate collection system below the waste. Hence, it is intended to protect its surrounding environment from potential impacts of leachate primarily by its small size, its relatively low leachate generation potential due to climatic conditions, the presence of an unsaturated zone of soil greater than 1.2 m above the groundwater table (as per the OC), and the use of appropriate operating and closure procedures at the Site.

The updated Landfill Criteria identifies the installation of an engineered liner and leachate collection system for any of the following three landfill development scenarios:

1) a new landfill;

2) lateral expansion of an existing landfill beyond the approved waste footprint; or

3) a new landfill phase that extends the limit of waste within the approved waste footprint

Therefore, it is recommended that future development phases of the Golden Landfill be provided with an engineered lining and leachate collection system. It is recommended that the existing landfill (Phase 1) continue to be utilized until site preparation and liner construction for Phase 2 are complete.

The proposed leachate management strategy is presented on Figures 4 and 6. The CSRD has confirmed that given the limited space available, any excavation required to construct a lining system should be minimized since stockpiling large amounts of soil for future use will be challenging. The Phase 2 footprint will be established by grading the exposed borrow face that is located east of Phase 1 (see Figure 4). This face will be graded at a 3H:1V slope up to elevation 955 m and will require some compacted soil fill at the toe of the slope. There may be the potential for groundwater to seep out of these slopes if snow melt and precipitation that infiltrates upgradient of the Landfill encounters layers of low permeability soil or rock that force the groundwater to flow laterally towards the cut slope. This issue should be considered as part of detailed design. The base of the Phase 2 footprint will be graded downward to the north at a 2% slope to promote leachate to flow towards the collection sump.

During Phase 2 operations, the vehicle scale, public drop off area and diverted materials stockpiles will need to be re-located to allow for Phase 3 site preparation. Phase 2 is estimated to reach capacity by the year 2039.
The base of the Phase 3 footprint will be graded at a 2% slope to promote drainage to a leachate collection sump located at the north end of the lined footprint. The eastern portion of the Phase 3 liner will be installed along a 10 m wide bench. A berm will be constructed along the west edge of the footprint to establish the western limit of the liner. The crest of this berm will connect the bench road that was established along the Phase 1 and Phase 2 side slopes.

Excavation for Phase 3 will occur as cover soil is excavated during Phase 2 operations. Excavation of Phases 4 and 5 will occur during Phase 3 operations. The grading for Phases 4 and 5 will involve cutting back the slopes to the north to a 3H:1V grade. The 3H:1V slope will be vertically subdivided by establishing a bench road at a nominal elevation on 945 m to allow for staged liner construction. Phase 5 will be the final stage of liner construction.

The liner system itself should be constructed on a prepared subgrade and should consist of (from bottom to top) an underdrain to control groundwater seepage, a geosynthetic clay liner, a 60 mil textured HDPE geomembrane, and an above-geomembrane leachate collection layer. The leachate collection layer would include materials to protect the geomembrane, a high permeability drainage layer, leachate collection pipes, and a sump. Leachate that enters the sump will be conveyed through a pipe by gravity to a manhole located near the landfill entrance.

The CSRD will have to hold discussions with the Village of Golden to determine whether it is possible to discharge leachate to the Village's sanitary sewer system. If not, the CSRD will have to develop some means of leachate re-circulation or on-site treatment.

Preliminary estimates of leachate generation were developed using the US EPA Hydrologic Evaluation of Landfill Performance (HELP) model. The HELP model is a tool used to estimate the water balance associated with a landfill. A 20-year simulation was run using historical climate data that had been adjusted to reflect average annual temperature and precipitation data collected at the Golden Airport climate station. The results are presented in Table 4 below.

Table 4: HELP Model Results

Water Balance	Active Operations	Final Cover - Clay	Final Cover - Membrane
Precipitation (mm)	466	466	466
Evapotranspiration (mm)	278	210	271
Runoff (mm)	0	89	62
Final Cover Drainage (mm)	n/a	n/a	133
Leachate (mm)	189	167	Negligible
Peak Monthly Leachate (mm)	50	30	Negligible

In the short term, Phase 2 will be the first portion of the landfill where leachate is collected. Based on the HELP model results presented above, it is estimated that average annual leachate generation from the 1.3 ha catchment will be approximately 2,460 m^3/year or 0.08 L/s. The peak monthly flow rate is estimated to be 0.24 L/s during the month of May. There is some uncertainty regarding these estimates since many other factors can influence leachate generation including moisture content of the incoming waste and the extent of exposed liner that has yet to be covered with MSW.

In the longer term when Phase 5 is in active operation and the previous four phases have been closed, average annual leachate generation from the 4.3 ha catchment will be approximately 7,480 m^3/year or 0.24 L/s. The peak monthly flow rate is estimated to be 0.44 L/s during the month of October. This is based on an active catchment area of 1.3 ha and a closed catchment area of 3.0 ha.

Leachate composition and strength is likely to vary over the life of the facility. Table 5 provides some information that has been gathered from the literature and other sources in order to provide some preliminary sense of what leachate quality may be like. This information includes leachate quality data that has been measured at the CSRD's Salmon Arm Landfill.

Table 5: Leachate Quality Data

Parameter	New Landfill[1] (less than 2 years)		Mature Landfill[1] (greater than 10 years)	Salmon Arm Landfill[2]
	Range (mg/L)	Typical (mg/L)	Range (mg/L)	Range (mg/L)
BOD_5	2,000-30,000	10,000	100-200	<6-440
TOC	1,500-20,000	6,000	80-160	22.5-83.2
COD	3,000-60,000	18,000	100-500	57-870
TSS	200-2,000	500	100-400	4-342
Organic Nitrogen	10-800	200	80-120	4.2-86.4
Ammonia Nitrogen	10-800	200	20-40	0.08-56.4
Nitrate	5-40	25	5-10	<0.01-62.2
Total Phosphorus	5-100	30	5-10	0.05-1.05
Ortho Phosphorus	4-80	20	4-8	n/a
Alkalinity as $CaCO_3$	1,000-10,000	3,000	200-1,000	255-975
pH	4.5-7.5	6	6.6-7.5	7.7-8.9
Total Hardness as $CaCO_3$	300-10,000	3,500	200-500	310-523
Calcium	200-3,000	1,000	100-400	11.5-161
Magnesium	50-1,500	250	50-200	29.7-88.8
Potassium	200-1,000	300	50-400	n/a
Sodium	200-2,500	500	100-200	51.6-452
Chloride	200-3,000	500	100-400	62-438
Sulfate	50-1,000	300	20-50	4.5-52.1
Total Iron	50-1,200	60	20-200	0.08-10.7

[1] Table 11-13, *Integrated Solid Waste Management*, Tchobanoglous, et al., 1993
[2] Appendix C, *2017 Environmental Monitoring Report – Salmon Arm Refuse Disposal Facility (MR-05479)* Western Water Associates Ltd, April 2018

Transitioning to a lined disposal facility will increase capital and operational costs as well as reduce the Landfill's ultimate capacity. The preliminary capital cost estimate associated with the first stage of liner development (Phase 2 of the Landfill) is presented on Table 6.

Table 6: Phase 2 Liner and Leachate Collection System Capital Cost Estimate

Item	Units	Qty	Unit Price	Price	Total
Fixed Cost - Mobilization, Bonding, etc	LS	1	$150,000	$150,000	$150,000
Phase 2 Liner					$642,000
Final Grading	m^2	13,000	$5	$65,000	
Bedding Layer	m^2	13,000	$10	$130,000	
Underdrain Gravel	m^3	1,950	$50	$97,500	
Perforated Underdrain Pipe and Surround	m	150	$60	$9,000	
Solid Underdrain Pipe Trench	m	150	$100	$15,000	
Geosynthetic Clay Liner	m^2	13,000	$15	$195,000	
60 Mil HDPE Textured Membrane	m^2	13,000	$10	$130,000	
Phase 2 Leachate Collection					$408,000
Geotextile Cushion	m^2	13,000	$4	$52,000	
Gravel Drainage Layer	m^3	3,900	$50	$195,000	
Perforated Pipe and Surround	m	150	$60	$9,000	
Geotextile Filter	m^2	13,000	$4	$52,000	
Allowance for Sewer Connection	LS	1	$100,000	$100,000	
Engineering Allowance		20%		$209,900	$209,900
Contingency Allowance		25%		$353,000	$353,000
				Total =	**$1,762,900**

Phase 2 Lined Area = 13,000 m^2

Unit Cost (excluding engineering and contingency) = $92 per m^2

Fixed costs which include mobilization, bonding, temporary construction facilities, etc. are estimated to be approximately $150,000. The cost of constructing a composite liner that includes final grading, bedding layer, partial underdrain, geosynthetic clay liner (GCL) and 60 mil HDPE membrane is expected to cost approximately $642,000. The overlying leachate collection system which includes a geotextile cushion, continuous gravel drainage layer and perforated pipe, geotextile filter cloth and an allowance to connect to the Town of Golden's sanitary sewer system is expected to cost approximately $408,000. A 20% engineering allowance has been included to address detailed design, tendering and construction quality assurance. A 25% contingency has also

been included to account for unanticipated costs. The total capital cost associated with the Phase 2 leachate containment and collection system is expected to be approximately $1.76 million.

Quantifying the cost associated with lost airspace is a more involved task. A study conducted by Golder examined the cost implications associated with closing the Golden Landfill before its ultimate capacity was reached (Golder, June 2019 - Draft). One scenario examined the amortized capital cost of constructing an MSW transfer station along with the annual operating costs associated with operating that transfer station and hauling the waste to another regional landfill within the CSRD. It was estimated that adding these two new elements to the delivery of solid waste management services would increase the cost of waste disposal by approximately $145 per tonne.

The maximum remaining capacity of the Golden Landfill as a natural attenuation facility was previously estimated to be 575,000 tonnes at the end of 2019 (Golder, 2013). The remaining Landfill capacity as a lined disposal facility is 430,000 tonnes which equates to a reduced capacity of 145,000 tonnes. Based on the $145 per tonne increase in disposal cost described earlier, the reduced capacity is equivalent to an approximate $21 million cost (2019 dollars) incurred beyond the year 2080.

5.2 Surface Water Management

Surface water diversion works have been constructed at the Landfill to reduce surface water contact with the refuse, thereby reducing leachate generation potential. These works include the existing ditches described in Section 2.3 and shown in Figure 2. The proposed surface water controls presented on Figure 9 are recommended to enhance surface water management at the Landfill. These recommendations include the following:

- Infiltration ponds should be established at the northwest and southwest corners of the property. These ponds should be designed to accommodate the increase in runoff attributed to landfill development for a 1:100 year, 24-hour storm event. The ponds should also be constructed with spillway structures capable of allowing controlled discharge of potential overflows.
- Upgradient diversion ditches should be established outside the electric fence on the north and east edges of the property. These respective ditches will convey flow to the infiltration ponds at the northwest and southwest corners of the site.
- A ditch should be established along the inside edge of the existing bench road that is cut into the north slope of the property. This ditch will convey flow to the infiltration pond at the northwest corner of the site.
- A cut off berm should be established between the southeast edge of the existing Phase 1 fill area and the east slope of the property. This berm will reduce the amount of runoff that flows towards the south end of the site.
- The existing ditching northeast of the Phase 1 fill area and vehicle scale should be enhanced and extended to ensure the central portion of the site is well drained. These two ditches should converge at the culvert located east of the public drop off area and continue to flow west towards a new culvert that would pass under the access road that separates the west slope of the existing fill area and the electric fence. From here the ditching should be extended outside the electric fence to the southwest infiltration pond.

A preliminary assessment was performed to obtain an indication of the pond size required to accommodate the increased runoff associated with Landfill development. The HELP model results discussed in Section 5.1 suggest that, prior to Landfill development, approximately 43 percent of precipitation became surface runoff during peak storm events. This result was based on the assumption that the site had an overall 10 percent slope from east to west. This value was calculated by determining the elevation difference between undisturbed areas along the east and west fence lines and dividing that difference by the distance between the two fence lines.

The HELP model also suggests that developing a landfill with 3H:1V slopes (33 percent) and final cover results in an 11 percent increase in the amount of precipitation that becomes runoff during peak storm events relative to pre-development conditions.

The intensity of the 1:100 year, 24-hour storm event for the Golden Airport is 2.2 mm per hour or 52.8 mm over the 24-hour period. Applying the 11 percent increase in runoff discussed earlier and assessing the 7.3 ha Landfill footprint, it is estimated that the increased amount of runoff attributed to landfill development during this peak storm event is (0.0528 m x 0.11 x 73,000 m^2 =) 425 m^3. A visual assessment of the proposed final contours suggest that approximately two thirds of runoff will be conveyed to the northwest pond whereas the remainder will be conveyed to the southwest pond. It should be noted that these ponds are not intended to fully detain all surface water runoff collected on site. They will enhance sediment removal and on-site infiltration but they may reach capacity during intense runoff events and should be designed with an adequate spillway structure to allow for controlled outflow.

Surface water at the Site should be managed in accordance with the following general guidelines:

- Alterations to primary channels, if required, shall be carried out in accordance with designs prepared by a suitably experienced professional engineer. All such alterations shall be subject to the engineer's field review.
- None of the existing drainage facilities shall be obstructed without provision of alternate surface water routing.
- Sediment traps, channel enlargements, or energy dissipation basins should be provided where required to retain sediment near its source, and to reduce the potential for reduced channel capacity or clogging.
- The hydraulic characteristics of ditch inlets and outlets should be determined such that backwater effects do not develop.
- Channel slopes and other barren soil surfaces should be vegetated as soon as possible. Some channels may need enhanced erosion protection, such as cobbles or rip rap, depending on flow velocities.
- Accumulated sediment in infiltration ponds, sediment traps, and channels should be removed at frequent intervals, especially in the spring and fall, and after each major precipitation event.
- All access roads should be constructed with super-elevations to direct runoff towards ditches.
- Exposed waste along courses of the ditches should be removed (e.g., by pickup, or by excavating the waste and filling the excavated locations with relatively fine-grained mineral soil obtained from the on site borrow areas). This is particularly applicable to the ditches proposed adjacent to the existing fill area.

In addition, it is recommended that the configuration and condition of surface watercourses at the site be visually inspected each spring to confirm their adequacy to handle snow melt and precipitation events.

The concept of surface water routing and diversion shown on Figures 7 and 9 should be reviewed by a qualified professional engineer if future Landfill development materially deviates from the concept described in this Plan.

The closest water body to the Landfill is the Kicking Horse River located about 1.3 km south of the Landfill. No significant bodies of water are within 1 km of the Landfill, and all watercourses within 500 m of the Landfill are ephemeral. Hence, no surface water monitoring is recommended.

5.3 Landfill Gas Management

Landfill gas is generated at MSW landfills by the anaerobic decomposition of organic refuse. It is generally composed of about 60% methane and 40% carbon dioxide by volume, with trace concentrations of oxygen, nitrogen, hydrogen sulphide, non-methane organic compounds (NMOCs), and other gases. The odour from LFG is normally associated with its sulphur compounds and NMOCs. The actual proportion of gases can vary, depending on the age of refuse and the operation of an active LFG management system if used at the site.

The primary regulation pertaining to LFG management at MSW landfills is the Landfill Gas Management Regulation (Section 1.2.6). The 2017 GHD landfill gas generation assessment indicated that the current (2019) potential methane generation from the Landfill would be less than 1,000 tonne/year (see Appendix B), which is the trigger in the Landfill Gas Management Regulation for preparing an LFG management facility design plan for the Landfill, and the subsequent installation of such a system at the Landfill. Therefore, the installation and operation of an active LFG management facility is not mandatory at the Landfill at this time. In such cases, updated landfill gas generation assessments are required at five-year intervals to determine if the estimated methane generation rate has remained below the defined trigger level.

The Landfill has a weigh scale and a reuse centre. The weigh scale is occupied by the Site attendant during most of the operating hours, and the reuse centre is frequented occasionally by staff or Landfill users. Typically, Landfill buildings and offices are, and will be, all built above ground to reduce the potential for LFG migration into the structures. The scale house is equipped with a continuous gas monitoring detection unit so no additional gas monitoring is considered necessary at this time. The CSRD should carry out periodic LFG monitoring within the reuse centre and any other future enclosed structures (if any) to confirm that air in the structures and their crawlspaces complies with the *Occupational Health and Safety Regulation* BC Reg. 296/97 of the *Workers Compensation Act* (RSBC 1996). Alternatively, the CSRD can enhance the ventilation to the reuse centre by either removing the existing door or adding four 150 mm x 300 mm vents or openings on opposite walls and positioning them so that they are 0.6 to 1.5 m off the ground. These vents should remain unobstructed by materials inside the shed.

Landfill gas monitoring requirements are presented in the Environmental Monitoring Plan for the Golden Landfill that has been prepared as a separate document (Golden Landfill Environmental Monitoring Plan, 2019).

5.4 Final Cover Design

Golder recommends the following final cover concept design, based on the Landfill Criteria:

- Vegetation with a root system that will stabilize the topsoil layer without penetrating and damaging the barrier layer;
- A minimum 150 mm thickness of topsoil as a growing medium;
- A minimum 600 mm thick barrier layer consisting of compacted mineral soil having a hydraulic conductivity on the order of 1 x 10^{-5} cm/s;
- Final Landfill slopes generally between 4 and 33%; and
- Surface drainage works that are designed to allow runoff to quickly flow away from the cover in a controlled manner, and to accommodate post-construction settlements.

If treatment of collected leachate is a major problem in terms of cost or availability, consideration could be given to a geomembrane final cover system to reduce leachate generation to as low as practical. A geomembrane final cover system would be expected to be associated with an increase in final cover capital costs of approximately $30 to $40 per square metre of geomembrane final cover (2019 dollars), compared with the costs outlined in Table 2.

If establishing vegetation on the initial stage of final cover proves difficult, it may be necessary to increase the topsoil thickness from 150 mm to 300 mm to improve moisture retention.

5.5 Environmental Monitoring

The Environmental Monitoring Plan for the Golden Landfill has been prepared as a separate document (Golden Landfill Environmental Monitoring Plan, 2019). This plan should be reviewed and updated every five years to ensure that the monitoring program is still relevant in the context of operational practices, the monitoring data obtained and any trends or gaps that have become apparent through annual data interpretation.

6.0 SITE OPERATIONS

6.1 Designated Area for Recyclables

The CSRD provides facilities for separation and storage of recyclable or reusable materials. These areas include:

- Three 50-yd^3 (38-m^3) bins that accept wood waste and refuse.
- A marshalling area for the diversion of propane tanks, auto-batteries and household batteries.
- Facilities for Product Care Recycling and BC Used Oil Management Association as well as a small appliance drop-off area.
- A marshalling area for the diversion of household recyclables through Recycle BC.
- A reuse centre that accepts working items from Landfill users after they have paid the tipping fees at the weigh scale. These items are then available for others to take for free.

In addition, the Landfill has marshalling areas east of the scale house for a number of recyclable materials including concrete / brick / porcelain, asphalt roofing shingles, fridges and freezers, bulk metals and mattresses. Ozone depleting substances (ODS) are removed from the fridges and freezers before they are added to the bulk metal pile. There is also a household hazardous waste product storage compound that is serviced by a company retained by the CSRD as well as a lock block enclosure for compost that is for sale. Both yard/garden waste and clean dimensional wood waste are stockpiled near the active face where they are chipped. The chips remain on-site and are used to augment intermediate cover.

The CSRD may add or remove diversion programs at the Landfill from time to time depending on factors such as resource availability and market conditions.

6.2 Public Access

Public access is restricted to the public disposal and recycling area for waste disposal. The public disposal and recycling areas are accessible by the public in all weather conditions. Waste bins and recycling bins are provided at the drop-off facility for public use.

The Landfill attendant monitors people arriving at the Landfill to confirm that they are following the signs and rules posted at the Landfill.

6.3 Traffic Control

Waste disposed at the Landfill is delivered by the public, curbside collection vehicles, and commercial haulers. There appears to be adequate space for vehicles to queue on site without affecting traffic on Golden-Donald Upper Road which is the main access road leading to the Landfill. Further traffic controls are provided by signage and directions given by the site attendant at the scale house.

6.4 Site Access, Scales, Security, Safety, and Signage

Access to the Landfill is via Golden-Donald Upper Road branching from Highway 1. A lockable gate is located at the Landfill entrance. A sign is posted at the entrance gate showing the Site name, Landfill owner, contact telephone numbers, hours of operation, recyclable materials accepted, wastes accepted, prohibited materials and disposal fees.

Electric perimeter bear fencing is used to reduce the potential for unauthorized or unknown entry into the Landfill by persons or animals. “No Trespassing” signs are posted on the perimeter fencing at regular intervals.

Entry to the Site is restricted to the Contractor, site attendants, CSRD personnel, as well as authorized haulers, users, or visitors. The public is not permitted access to areas other than the public drop-off area and recycling area for waste disposal.

The Landfill is open to the local public from Monday to Saturday, and the entrance gate is unlocked during normal daylight hours of operation (currently from 10:00 a.m. to 4:00 p.m.). The Landfill is equipped with a vehicle scale.

The following measures are, and should continue to be, undertaken at the Landfill as a minimum to maintain a safe environment:

- Site access roads are designed for and maintained in good running condition, free of obstructions.
- Signs indicating areas for waste disposal or recycling (e.g., active face and the various marshalling areas) as well as traffic flow directions are posted at conspicuous locations across the Landfill.
- Waste is visually screened for unauthorized materials upon their arrival at the Landfill.
- Emergency telephone numbers are posted at the Site entrance.
- Heavy equipment is available and an adequate supply of nearby cover material is maintained at all times for firefighting purposes. In addition, the Landfill is equipped with a 200-Igal water tank. This tank is on skids and is equipped with a pump and hoses so that it can be hauled to any location within the Landfill to control fires.
- Smoking is strictly prohibited at the Site.

6.5 Compaction and Cover

At present, refuse is delivered to the Landfill by the public, curbside collection vehicles, and commercial haulers. Upon their arrival, vehicles are visually screened for unauthorized materials by the site attendant at the weigh scale. After the screening the vehicle is weighed and an assessment is made to determine if a tipping fee should be collected. They will then be directed to specific areas for waste disposal, depending on the type of waste that they carry. The waste unloaded at the active face is compacted and covered at the end of each working day.

Refuse placed at a landfill should be covered with suitable materials as soon as practical to reduce infiltration into exposed refuse, and to reduce odours, bird and vector problems, and litter. The following types of cover are used at the Landfill:

- Daily cover – Metal plates are used to cover exposed waste at the end of each working day. At times when the Landfill surface is saturated and non-trafficable, wood waste is chipped, mixed with mineral soil, and applied at the Site as a daily cover on the unloading pads of the active face (CSRD, 2012).

- Intermediate cover – Intermediate cover of minimum 300 mm thickness of mineral soil that is sometimes mixed with wood chips is applied to areas where disposal is not anticipated for 30 days or more (e.g., in the completed section of a strip; Section 4.4). The intermediate cover comprises mineral soil extracted from on-site locations or soils that are brought on-site for disposal. The clean wood and yard and garden waste that are stockpiled on site are chipped and the resulting chips are sometimes mixed with the mineral soil used for intermediate cover. It is recommended that the mineral soil to wood chip blend be at or larger than a 2:1 volume ratio (i.e. wood chips should not exceed one-third of the overall blend).
- Final cover – Final cover comprising mineral soil barrier layer overlain by topsoil and vegetative cover will be used to close the Landfill areas that have reached their design closure elevations. The mineral soil will likely have to be obtained from off-site locations. The topsoil will either be imported from off-site sources or fabricated using a mixture of mineral soil and organic amendments (e.g., biosolids).

When a new lift is started along the outer slope of the landfill, the CSRD should strip away the underlying intermediate cover to encourage the downward flow of leachate and thereby reduce the potential for leachate breakouts along the slope. This should only be done immediately prior to placing the overly MSW in the new lift.

6.6 Control of Windblown Materials

Windblown materials can create a litter problem at a landfill if not properly controlled. There are typically three general sources of windblown materials at a landfill. The first involves wastes that are lost from open-top vehicles travelling to and on the landfill property. While efforts are made by Landfill staff to seek the co-operation of local haulers to cover their loads, litter from this source is not within the Landfill operator’s control and must be cleaned up after the fact regularly.

The second source of windblown material occurs at the working face when the MSW leaves the hauling vehicle and is being spread. Several measures are employed at the Site to mitigate this problem. The most effective control is to maintain a small operating face, and to spread and compact the MSW as soon as possible after it is unloaded. If waste can not be compacted in the short-term, it should be covered.

The third source of windblown litter is when birds or other animals unearth refuse that has been covered. Metal plates are currently used as daily cover and these provide a solid barrier that animals can not dig through. It is around the edges of these plates, or within areas where intermediate soil cover is placed, that this problem occurs. The contractor should be diligent to ensure the edges around the plates are adequately covered and compacted. It may also be necessary to increase the compaction effort and thickness of soil cover at certain times of the year when the problem is more pronounced. Despite these measures however, it is likely that some amount of litter is inevitable and measures must be employed to manage it.

The CSRD has erected litter control netting along the southern perimeter of the site to intercept windblown litter. Litter that is intercepted is collected at the base of this netting on a periodic basis. In a similar manner, the use of natural or temporary artificial windbreaks can help reduce wind velocity at the working face and help to mitigate the problem. Portable litter control fencing should be used at or near the active working face when windy conditions arise.

Windblown materials are collected periodically by Landfill staff from temporary and perimeter fencing, and from roadways both on and around the Landfill. Should windblown materials be observed outside the Site, Landfill personnel should collect these materials as required with the permission of the land owner.

6.7 Vector and Bird Control

Bears may attempt entry to the Landfill. The Landfill has perimeter electric fencing to discourage bear entry. This fence should be inspected regularly and be maintained in good condition. Deer are known to jump over the electric fencing. The CSRD may need to upgrade the perimeter fencing to dissuade deer from attempting to jump over.

Vectors are discouraged through the operation of a small working face with an adequate layer cover material. Pest control professionals could be employed to monitor and control any rodents arriving at the Landfill, if needed.

Flies and mosquitoes are reduced through daily covering of the MSW, and by elimination of ponded water at the Landfill. Wasps are attracted to high-visibility vests and are a nuisance for site attendants. They are controlled with traps to catch the queens in the spring prior to nesting.

Bird control measures consist of maintaining a small working face with frequent equipment movements and adequate cover to discourage birds.

6.8 Dust Control

Dust control may be necessary from the late spring to the early fall. A water truck is available to water down access roads and other materials as required. The Contractor will arrange further water trucks for dust control with the CSRD, if needed. If necessary, dust suppressants (e.g., magnesium chloride) could be used at the Site (in the dry summer months) to control dust. However, the use of chloride-based dust suppressants may contribute to elevated chloride concentrations in the groundwater.

6.9 Leachate Management

The following measures have been, and should continue to be, undertaken at the Site to further reduce its leachate generation potential:

- Covering fresh refuse with daily cover (i.e., metal plates) that extends to the adjacent intermediate cover.
- Placing intermediate cover over exposed refuse that is not covered with the metal plates.
- Constructing and maintaining surface water diversion structures to divert surface water flow that can occur during localized, high-intensity rainfall events.

In addition, Landfill areas that have reached their design closure elevations should be covered with final cover once the filling phase is complete (i.e., the Landfill should be closed progressively).

6.10 Record Keeping

The following information should be maintained by the CSRD:

- Operational Certificate 17006 and subsequent amendments;
- Applicable plans and reports listed in Section 10 of the Landfill Criteria;
- Records of inspections conducted by regulatory agencies;
- Complaint ledger providing source and nature of the complaint as well as the date received and the action taken;
- Waste quantities disposed at the Landfill; and
- Quantity data pertaining to each category of waste and recyclable material received and exported from the Landfill.

7.0 FIRE SAFETY AND EMERGENCY RESPONSE PLANS

7.1 General

The following plans and procedures have been developed to provide CSRD staff and their contractors with general directions on how to handle various situations that could arise at the Landfill. Emergency situations can include fire, injury to workers or users, accidental spills, unauthorized dumping of prohibited waste at the Landfill, or detection of groundwater impacts.

The emergency co-ordinator for any of the above situations will be the CSRD's Team Leader - Environmental Health Services, or in their absence, their designate. Both will be familiar with the contingency plans for the event and are given the authority to commit the necessary resources to fully implement the contingency plans. Depending on the incident, other CSRD staff may also take the necessary prompt actions to deal with the situation.

From time to time, these contingency plans may be modified or expanded. The Team Leader - Environmental Health Services, or his designate, and the Contractor's office will ensure that the plans are kept current, and that Landfill staff understand and are trained in their responsibilities. The plans will be maintained at the Site in a readily available location.

7.2 Fire

7.2.1 Surface Fire – Prevention and Control

Open burning of any materials at the Site is strictly prohibited.

Most surface landfill fires are preventable by following the guidelines summarized below:

- A no-smoking rule must be rigorously enforced for all users, visitors, and operating staff at the Landfill.
- All incoming vehicles must be visually inspected for "hot loads." Should smoke, steam, or heat release be visible, the waste will be deposited away from the working face, spread, and, if necessary, drenched with water to remove any possibility of fire. After it is determined that there is no possibility of ignition, the waste will be incorporated into the working face.
- Landfill equipment should be removed from fuelling tanks as soon as possible after filling.
- Landfill equipment must be regularly cleaned of collected or adhering MSW to prevent combustion in or around hot engines or exhaust ports.
- Site buildings and operating equipment should be equipped with fire extinguishers.
- Roadways and working areas in the Landfill must be regularly cleared of any litter, weed, or other combustible material.
- Landfill equipment should not idle for extended periods, nor should it be left overnight on top of exposed MSW.
- The working face of the Landfill should be kept as small as possible to prevent and control fires.
- Firebreaks of intermediate soil cover should be developed within the landfill to reduce the potential for a fire to spread at the Site.

For fire prevention and control to work efficiently, the following guidelines should be implemented:

- Preparing a water source (e.g., a water truck or trailer) near the active area when weather permits.
- Maintaining in good working order several fire extinguishers at the Site in easily accessible and prominently displayed areas and providing regular inspection and service.

Should a fire occur at the Site, the steps outlined in the following sections should be taken after the type of fire has been identified.

7.2.1.1 Equipment Fire

1) If the equipment has a built-in fire suppression system, activate it. Assess the extent of the fire, and whether it can be safely put out using existing extinguishers.
2) If possible, move the equipment away from exposed MSW, fuel supplies, or both.
3) Shut off the engine, set the brake, and get out.
4) Alert other staff of the problem and request immediate notification of the local Fire Department.
5) Assist the Fire Department personnel when they arrive at the Site.

7.2.1.2 Building Fire

1) Immediately alert the local Fire Department and other nearby staff.
2) If the fire is small and manageable, use the available fire extinguishers to extinguish or control the fire. If there is any doubt as to the ability to safely extinguish the fire, immediately evacuate the burning area and await the local Fire Department.

7.2.1.3 Surface Burning Material

A surface landfill fire is defined herein as a fire that burn at surface, with or without a visible flame. A surface landfill fire could be caused by hot or burning incoming waste, ignition by chemical reactions, careless smoking, equipment sparks, arson, or spontaneous combustion. The following immediate actions should be taken for a surface burning material:

1) Alert the Site supervisor to assess the severity of the surface fire.
2) If the fire is large, notify the local Fire Department and the CSRD, shut down operations and evacuate the Site of all non-CSRD personnel, except those from the Fire Department, regulatory authorities and Landfill operating contractor. Assist the Fire Department in their fire fighting efforts as required.
3) If the fire is small, utilize suitable equipment to push off the burning material onto daily or intermediate cover, and to extinguish the burning material with water.
4) Water from the Landfill water tank may be used on a surface fire.
5) Should an isolated fire persist for more than one hour, notify the local Fire Department and the CSRD.
6) The CSRD will maintain a record of all fires.

7.2.1.4 Above-ground Flame-ignition Methane

An above-ground methane flame may be transparent during daylight or may appear blue in darkness. Such a flame cannot be easily extinguished with water. The flame should be extinguished by smothering its source, typically by placing mineral soil over the gas emission point. Other measures (e.g., carbon dioxide fire extinguishers) may be adopted, if necessary, to extinguish a surface flame.

7.2.1.5 Hot Loads

If the waste brought to the Landfill is on fire when it arrives at the Site (e.g., a “hot loads”), the following steps should be undertaken:

1) Immediately alert the Site supervisor and notify the local Fire Department and the CSRD.
2) Shut down operations and evacuate the Site of all non-Contractor and non-CSRD personnel, except those from the Fire Department and regulatory authorities.
3) Unload the waste on an area of bare soil and move the vehicle a safe distance away.
4) Assist the Fire Department in their fire fighting efforts as required.
5) After it is determined that there is no possibility of ignition, incorporate the waste into the working face.
6) The CSRD will maintain a record of all fires.

7.2.2 Subsurface Fire – Prevention and Control

7.2.2.1 Definition and Cause

A subsurface landfill fire is defined herein as a fire that burns below surface, and is detectable by one of more of the following:

- Sudden, localized landfill surface settlement.
- Cracking of the landfill cover.
- Emission of steam, smoke, or cinders from the landfill surface.

All or any of the above conditions may occur without a visible surface flame. A subsurface landfill fire may be the result of inadvertent burial of a surface fire with waste, or, to a less likely extent, spontaneous combustion of air entering the waste through cracks in the final cover due to convection currents established between the Landfill (higher temperature) and the atmosphere (lower temperature).

7.2.2.2 Prevention

The most likely cause of potential subsurface fires at the Landfill is through inadvertent burial of a surface fire with waste. To reduce this risk, all incoming vehicles must be visually inspected for “hot loads”. Should smoke, steam, or heat release be visible, the steps outlined in Section 7.2.1.5 should be undertaken. Landfill staff shall confirm that only waste that has been determined to have no possibility of ignition shall be buried in the Landfill.

Subsurface fire could also be caused by spontaneous combustion of air entering the waste through cracks in the final cover due to convection currents established between the Landfill and the atmosphere. This risk can be mitigated by maintaining a minimum thickness of 0.75 m of final cover over completed slopes.

7.2.2.3 Immediate Actions

The following immediate actions should be taken for a subsurface fire:

1) Immediately alert the Contractor's office and the CSRD.

2) Upon receipt of the CSRD's approval, cover the affected area and at least 5 m beyond with at least 500 mm thickness of mineral soil. The Landfill operator should be aware that a subsurface fire could develop a subsurface void, and that the ground surface of the affected area may collapse suddenly and without warning. This could result in an explosive burst of flame.

3) Should an isolated fire persist for more than one hour, notify the MoE&CCS.

4) Maintain a record of all fires.

7.2.2.4 Health and Safety Considerations

To fight a subsurface landfill fire, the following health and safety considerations should be noted:

- Standing or operating equipment upwind, if possible, from the fire. Wearing appropriate respiratory equipment if there is any potential for smoke inhalation.
- Being aware that a subsurface fire could develop a subsurface void and the ground surface of the affected area may not support personnel or equipment.

7.2.2.5 Other Relevant Information

The following should be noted when fighting a subsurface landfill fire:

- All three of the following are required for a fire to exist: a fuel source, an ignition source (flame, heat, or spark), and oxygen (air). Removing one of these items, and the fire can be controlled.
- If at all possible, do not use water to fight a subsurface landfill fire. A surface water application is likely to channelize through the waste and therefore, isolated embers are unlikely to be extinguished. In addition, water generates leachate, increases the methane generating capability of the waste, and may enhance the conditions favouring spontaneous combustion.
- To limit oxygen supplied to the fire or embers, do not excavate into or expose the refuse.

7.3 Accidental Spills, or Unauthorized Dumping of Prohibited Waste

Notwithstanding what efforts are made to prevent prohibited wastes from being disposed at the Site, should such an incident occur, the following steps should be undertaken:

1) If the dumping generates a release of some unusual vapours or other suspicious indicators, personnel and other Site users shall be removed from the area.

2) Operations shall be discontinued, and the Contractor's office and CSRD shall be called to investigate the cause and corrective measures, if possible.

3) If the prohibited material is safe to handle, the waste will be placed back on the delivery vehicle. If the user refuses, they shall be requested to remain at the Site and the police shall be called.

4) If the user leaves the Site without the waste, the vehicle's license plate number and a description of the user shall be taken.

5) Waste shall not be moved without instructions from Contractor's office and the CSRD. The area is to be isolated from further filling with MSW or soil cover, pending a proper cleanup of the prohibited material.

6) Should a reportable spill occur, the event shall be documented and reported to the MoE&CCS in accordance with the Spill Reporting Regulation (BC Reg. 376/2008, December 9, 2008).

7.4 Groundwater Impacts Detected

If there is a discharge of leachate to the groundwater, as indicated by test results from the monitoring wells, the following contingency actions should be undertaken:

- Notify the MoE&CCS.
- Retain a qualified professional to assess the situation. It is anticipated that this assessment would include possible confirmation monitoring and/or a risk assessment as well as recommendations for mitigation actions, if necessary.

7.5 Landfill Gas Detected in On-site Structures

Should elevated LFG concentrations be observed in enclosed spaces at the Landfill, the Site personnel occupying the structures shall be evacuated immediately and the door left open. The Contractor's office and CSRD shall also be notified to investigate the cause and implement corrective measures. The structures shall be banned from use until the corrective measures have been completed and subsequent monitoring indicates that the air is of acceptable quality.

8.0 CLOSURE PLAN

8.1 Final Landfill Configuration

The final Landfill contours are presented on Figure 7. It is estimated that the Landfill will have received approximately 460,000 tonnes of waste at the time of closure in about 2080, although this estimate is very approximate. The closed Landfill will have an MSW footprint of approximately 7.3 ha.

8.2 Final Cover Design

The final cover design concept for the Landfill is outlined in Section 5.4.

8.3 Progressive Closure

Progressive closure will be carried out during Landfill development to reduce potential leachate generation from the Landfill. Areas in the Landfill that have reached their final design elevations will be capped with the final cover described in Section 5.4. Progressive closure is planned to occur sequentially from Phases 1 to 5 as shown on Figure 7.

8.4 Public Notification

The public will be notified of the Landfill closure and alternative waste disposal facilities by the following:

- Providing the Contractor with a written notice at least 90 days before Landfill closure.
- Issuing a notice on the CSRD website both six months and one month prior to the anticipated closure date.
- Posting a sign at the Landfill entrance six months prior to the anticipated closure date. The sign will remain posted and will be updated and maintained for at least one year after the closure date.

The above notice and sign will indicate the anticipated Landfill closure date and the location(s) of alternative waste disposal facilities.

8.5 Declaration

Upon Landfill closure, the CSRD will need to register a charge against the property on the land title to indicate that it has been used as a landfill.

8.6 Early Closure

If the Landfill is closed prior to reaching design capacity, then a Closure Plan and closure design should be prepared as soon as practical that describe the following:

- Grading required to achieve suitable surface water runoff from the Landfill.
- The final cover system design.
- Post-closure monitoring and maintenance plan.
- The financial security described in Section 8.10 that may be applied to fund this closure.

8.7 Post-closure Use

Due to the planned closure topography, no post-closure land use has been specified. Grazing of livestock on closed Landfill slopes is not recommended. The closed Site will be fenced off from livestock grazing to protect its integrity.

Ultimately, the Site will be returned to the provincial government, who owns the land.

8.8 Contaminating Lifespan

The Landfill Criteria states that the duration of the post-closure period will be determined based on the contaminating lifespan of the Landfill. The contaminating lifespan is to be determined based on an assessment of environmental monitoring information. The latest groundwater quality interpretation indicates that there are some groundwater parameters that exceed applicable water quality guidelines. However, further monitoring has been recommended before drawing any conclusions as to whether these results are consistent or attributable to the Landfill.

To date, the Golden Landfill has been operated as a natural attenuation facility where leachate is not actively collected. The strategy proposed in this DOCP is to transition to an engineered landfill where future landfill development phases have an engineered liner and leachate collection system. This approach will help reduce the risk of future groundwater impacts.

Given the uncertainty associated with existing groundwater monitoring interpretation and the impacts that will result from transitioning the Landfill to an engineered facility, it is recommended that the default contaminating lifespan listed in the Landfill Criteria be adopted. It is estimated that the Landfill will contain approximately 575,000 tonnes of waste when it reaches its design capacity. The Landfill Criteria provide a default contaminating lifespan of 100 years for sites that range in capacity from 100,000 to 1,000,000 tonnes of waste. Therefore, it is proposed that a 100-year timeframe be assumed when planning for post-closure monitoring and maintenance.

8.9 Post-closure Monitoring and Maintenance

The following outlines a post-closure Landfill monitoring plan for a minimum period of 25 years after Landfill closure:

- Groundwater – continue groundwater monitoring per the environmental monitoring plan in all monitoring wells that form part of the pre-closure monitoring network. Continue to review and update the environmental monitoring plan based on the interpretation of water quality results.

- Surface water – carry out annual site visits to check that surface watercourses are functioning properly.
- Erosion – carry out semi-annual site visits, record erosion of final cover and access roads, if any, and the impacts of this erosion on the drainage ditches and channels; make repairs as required and report findings to the MOE; conduct site reconnaissance after each heavy rainfall event and record erosion damage, if any; make immediate repairs, and implement recommendations regarding channel configuration or cleaning.
- Vegetation – conduct semi-annual site visits to monitor vegetation coverage on the Landfill. Areas with sparse vegetation or excessive weed growth should be mitigated to re-establish self-sustaining vegetation.
- Rodents – conduct visual inspection of Landfill cover for rodent activities (e.g., burrowing) during times of other inspections, and implement a control program, if required.
- Settlement – regrade ditches as necessary to maintain flow. Any areas requiring additional fill to maintain positive drainage should be first stripped of the organic layer and then mineral soil placed to the required elevation to restore grades. Topsoil shall then be replaced and seeded to maintain the final cover system.

After this initial five-year period of data collection, the Landfill performance will be assessed and any recommended changes to the post-closure monitoring plan will be made to accommodate these findings. An annual performance monitoring report presenting the above monitoring data should be prepared. Post-closure monitoring and maintenance may be required beyond the minimum 25-year period depending upon the risk of future impacts.

8.10 Financial Security

The CSRD has established a Landfill Closure Special Reserve Fund to support closure and post-closure activities in the landfills at Golden, Salmon Arm, Revelstoke, and Sicamous.

8.11 Cost Estimates

8.11.1 Closure Cost Estimate

A preliminary cost estimate to close the Landfill is shown in Table 7. These closure costs are in 2019 dollars (excluding applicable taxes), and assumes that Landfill closure will be 7.3 ha in plan area, the final cover soil would be locally available, and that the CSRD would retain qualified staff based in the local area to perform the work. Costs may differ significantly from our estimated cost, depending on market prices at the time of closure works.

8.11.2 Annual Post-closure Cost Estimate

A preliminary (Class D) cost estimate for post-closure monitoring and maintenance activities at the Landfill has been developed using the information provided by the CSRD and the observations in Golder's 2019 site visit. Golder recommends that the allowances summarized in Table 7 be made for the annual costs of post-closure monitoring and maintenance activities at the Landfill. All costs in Table 7 are in 2019 dollars and exclude applicable taxes and assume that the CSRD would retain qualified staff based in the local area to perform the work. Actual costs may vary due to market conditions.

Table 7: Estimated Closure and Annual Post-Closure Costs

Landfill Closure Cost

Closure Area (m^2) = 73,000

Item	Units	Qty	Unit Price	Price	Total
Fixed Cost	LS	1	$600,000	$600,000	$600,000
Final Cover					$2,190,000
Grading Allowance	m^2	73,000	$2.50	$182,500	
Barrier Layer	m^3	43,800	$35	$1,533,000	
Top Soil	m^3	10,950	$30	$328,500	
Seeding	m^2	73,000	$2.00	$146,000	
Surface Water					$787,500
Toe Berm Ditch	m	850	$450	$382,500	
Mid-slope and Bench Roads	m	900	$450	$405,000	
Decommissioning Infrastructure	LS	1	$100,000	$100,000	$100,000
Engineering Allowance		20%		$715,500	$715,500
Contingency		25%		$919,400	$919,400
				Total =	**$5,312,400**

Annual Post-Closure Monitoring and Maintenance

Item	Units	Qty	Unit Price	Price	Total
Site Maintenance Allowance					$30,000
Semi-annual Inspections	LS	1	$5,000	$5,000	
Fencing	LS	1	$1,500	$1,500	
Drainage works	LS	1	$3,500	$3,500	
Settlement / Erosion repairs	LS	1	$10,000	$10,000	
Vegetation irrigation[1]	LS	1	$10,000	$10,000	
Monitoring and Reporting					$50,000
Environmental Monitoring	Ea.	3	$10,000	$30,000	
Annual Reporting Allowance	LS	1	$20,000	$20,000	
Administration Allowance					$100,000
Crown Lease Fees	LS	1	$85,000	$85,000	
Taxes	LS	1	$15,000	$15,000	
Contingency Allowance		25%		$45,000	$45,000
				Total =	**$225,000**

Notes:

1) Irrigation is anticipated for the first four years and discontinued thereafter

9.0 CLOSING COMMENTS

This report was prepared by Golder Associates Ltd. in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering profession currently practicing under similar conditions in British Columbia, subject to the time limits and physical constraints applicable to this report. The report relies on information provided to us; Golder did not independently check the accuracy or completeness of any of this information.

Thank you for the opportunity to prepare this DOCP Update on behalf of the CSRD. Should there be any questions or points requiring further clarification, please Michael Budzik, P.Eng., at 604-296-4200.

Golder Associates Ltd.

Jan 17, 2020

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https://golderassociates.sharepoint.com/sites/107360/project files/6 deliverables/issued to client_for wp/issued to client_for wp/19120797-003-r-rev0/19120797-003-r-rev0-2019 goldenlf docpupdate-20jan_20.docx

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Tetra Tech Canada Inc.'s (Tetra Tech's) report titled 2018 Waste Characterization Study, Golden Refuse Disposal Site (file no. 704-SWM.PLAN03050-01, dated September, 2018).

WWAL (Western Water Associates Ltd.). 2017 Environmental Monitoring Report Salmon Arm Refuse Disposal Facility (MR - 05479), Salmon Arm, BC. Prepared for Columbia Shuswap Regional District. WWAL Project No. 14-024-13.

WWAL (Western Water Associates Ltd.). 2019a. 2018 Hydrogeological Characterization Report, Golden Refuse and Disposal Facility (MR - 17006), Golden, BC. Prepared for Columbia Shuswap Regional District. WWAL Project No. 14-024-21.

WWAL (Western Water Associates Ltd.). 2019b. 2018 Environmental Monitoring Report Golden Refuse and Disposal Facility (MR - 17006), Golden, BC. Prepared for Columbia Shuswap Regional District. WWAL Project No. 14-024-16.

REFERENCE

BASE MAP FROM GOOGLE MAPS, https://maps.google.com, © Google 2013

0 250 500 750

APPROXIMATE SCALE METRES

CLIENT

COLUMBIA SHUSWAP REGIONAL DISTRICT

CONSULTANT

GOLDER

YYYY-MM-DD	2020-01-16
DESIGNED	MB
PREPARED	GB
REVIEWED	CW
APPROVED	MB

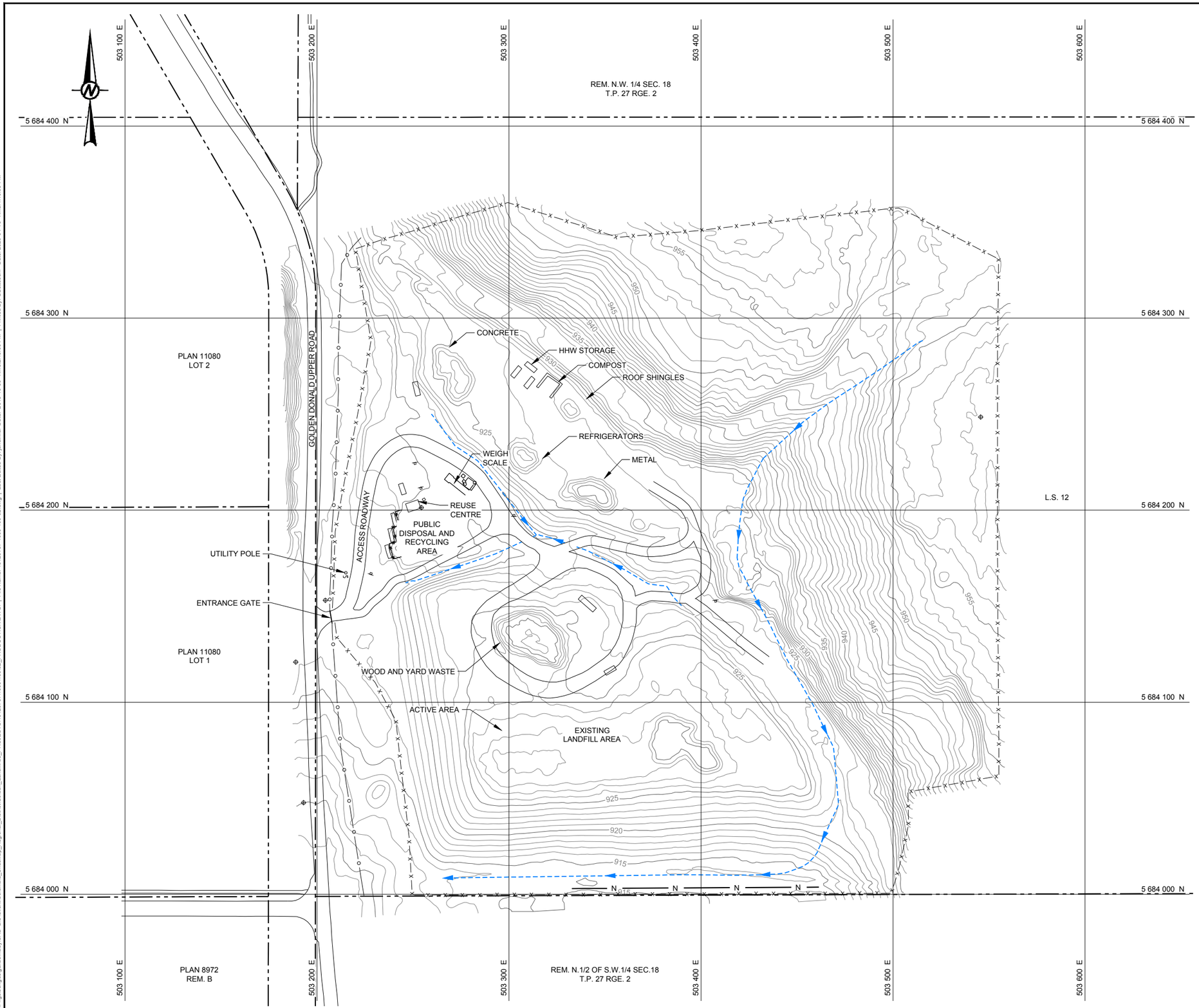
PROJECT

GOLDEN LANDFILL
DESIGN, OPERATIONS AND CLOSURE PLAN
GOLDEN, B.C.

TITLE

KEY PLAN

PROJECT NO.	PHASE/TASK	REV.	FIGURE
19120797	1000/100	B	1



0 50 100
1:2,000 METRES

LEGEND

- 590 — EXISTING TOPOGRAPGHY CONTOURS (JUNE 13, 2019)
- PROPERTY LINE
- EXISTING ELECTRIC FENCE
- EXISTING CHAIN LINK FENCE
- N — EXISTING LITTER NETTING
- EXISTING POWER POLE
- EXISTING DITCH

NOTES

1. ALL UNITS IN METRES UNLESS OTHERWISE NOTED.
2. COORDINATES ARE SHOWN IN DATUM: NAD 83, PROJECTION: UTM ZONE 11N.
3. CONTOUR INTERVALS ARE SHOWN AT 5 m MAJOR AND 1m MINOR.
4. LOCATION OF PROPERTY LINE IS BASED ON AVAILABLE INFORMATION, AND NOT ON A SURVEY. THUS, IT MAY NOT BE COMPLETELY ACCURATE.

REFERENCE

1. TOPOGRAPHIC SURVEY CONDUCTED ON JUNE 13, 2019 BY HARRIER AERIAL SURVEYS.

DISCLAIMER

CLIENT
COLUMBIA SHUSWAP REGIONAL DISTRICT

PROJECT
GOLDEN LANDFILL
DESIGN, OPERATIONS AND CLOSURE PLAN
GOLDEN, B.C.

TITLE
SITE PLAN
(JUNE 13, 2019)

CONSULTANT
GOLDER

YYYY-MM-DD	2020-01-16
DESIGNED	MB
PREPARED	GB
REVIEWED	CW
APPROVED	MB

PROJECT NO.	PHASE/TASK	REV.	FIGURE
19120797	1000/100	B	2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

0 25 mm

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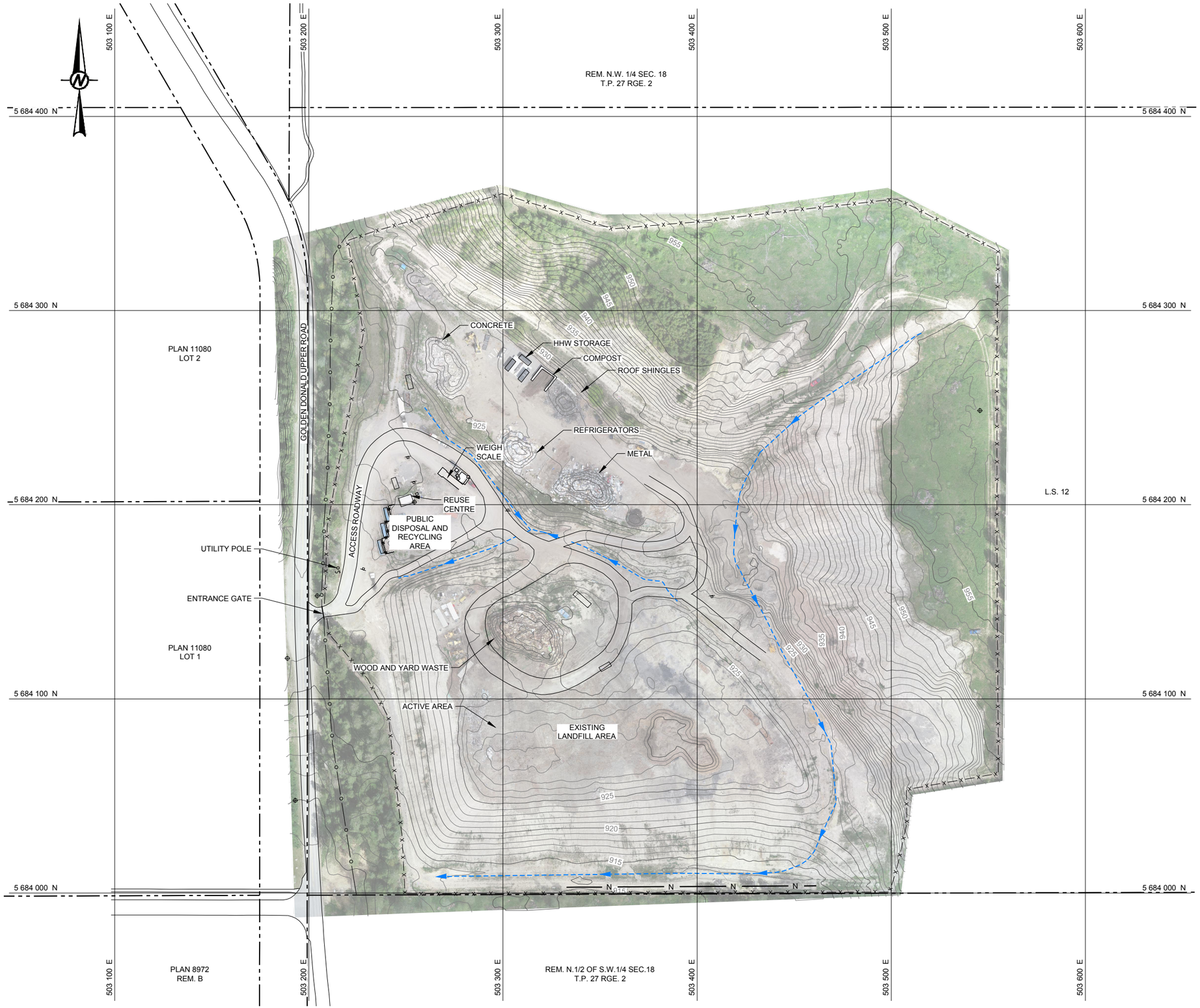

0 50 100
1:2,000 METRES

LEGEND

- EXISTING TOPOGRAPGHY CONTOURS (JUNE 13, 2019)
- PROPERTY LINE
- EXISTING ELECTRIC FENCE
- EXISTING CHAIN LINK FENCE
- EXISTING LITTER NETTING
- EXISTING POWER POLE
- EXISTING DITCH

NOTES

1. ALL UNITS IN METRES UNLESS OTHERWISE NOTED.
2. COORDINATES ARE SHOWN IN DATUM: NAD 83, PROJECTION: UTM ZONE 11N.
3. CONTOUR INTERVALS ARE SHOWN AT 5 m MAJOR AND 1m MINOR.
4. LOCATION OF PROPERTY LINE IS BASED ON AVAILABLE INFORMATION, AND NOT ON A SURVEY. THUS, IT MAY NOT BE COMPLETELY ACCURATE.

REFERENCES

1. TOPOGRAPHIC SURVEY CONDUCTED ON JUNE 13, 2019 BY HARRIER AERIAL SURVEYS.
2. AERIAL PHOTOTO PROVIDED BY HARRIER, ON 13-06-2019.
   FILE: GoldenLandfill_13-06-2019_transparent_mosaic_group1.tif.

DISCLAIMER

CLIENT
COLUMBIA SHUSWAP REGIONAL DISTRICT

PROJECT
GOLDEN LANDFILL
DESIGN, OPERATIONS AND CLOSURE PLAN
GOLDEN, B.C.

TITLE
AERIAL PHOTOGRAPH
(JUNE 13, 2019)

CONSULTANT
GOLDER

YYYY-MM-DD	2020-01-16
DESIGNED	MB
PREPARED	GB
REVIEWED	CW
APPROVED	MB

PROJECT NO.	PHASE/TASK	REV.	FIGURE
19120797	1000/100	B	3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

0 25 mm

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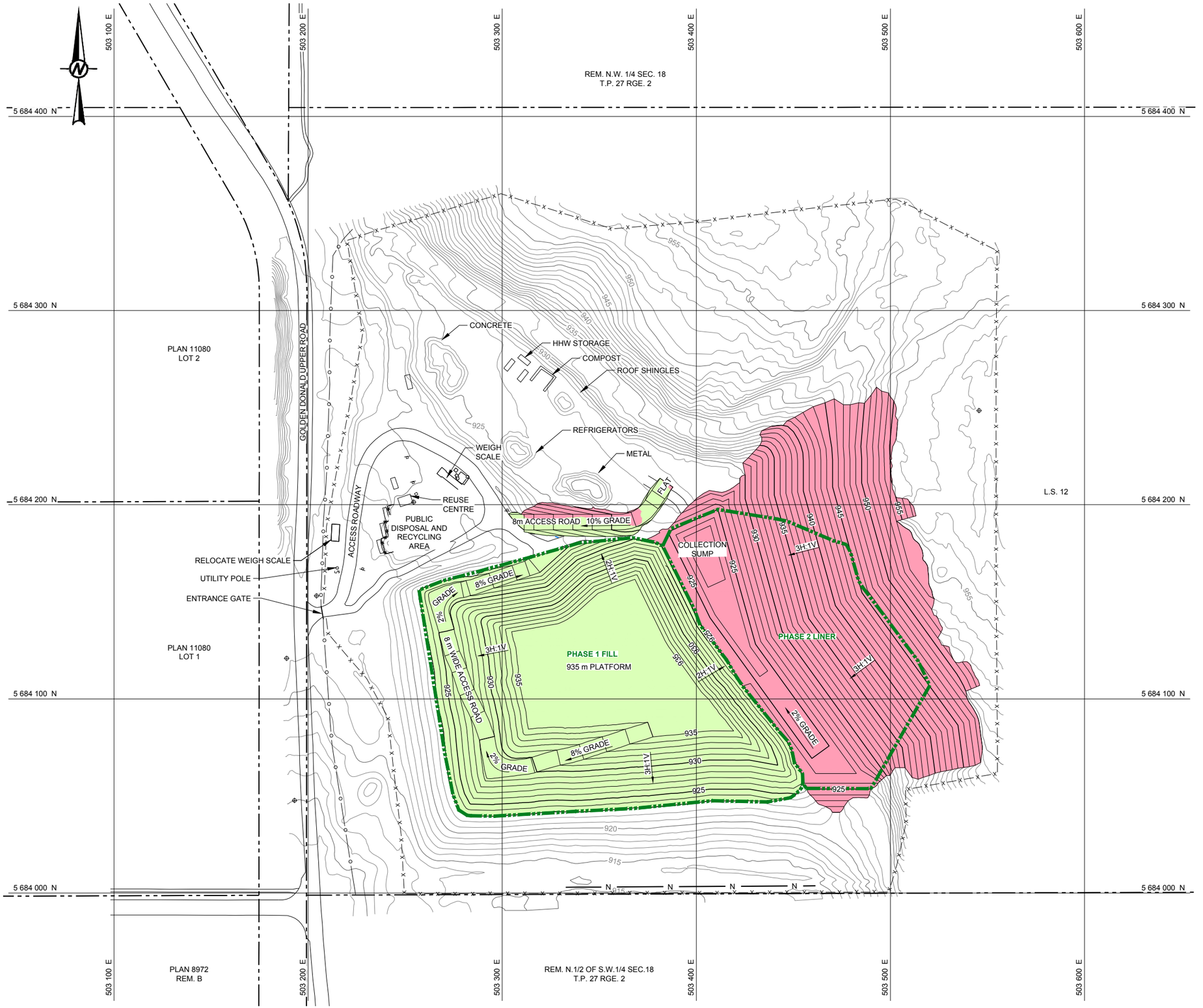

0 50 100
1:2,000 METRES

LEGEND

- 590 — EXISTING TOPOGRAPGHY CONTOURS (JUNE 13, 2019)
- PROPERTY LINE
- EXISTING ELECTRIC FENCE
- EXISTING CHAIN LINK FENCE
- N — EXISTING LITTER NETTING
- PHASE
- EXISTING POWER POLE
- CURRENT FILLING SEQUENCE
- CURRENT SITE PREPARATION SEQUENCE

NOTES

1. ALL UNITS IN METRES UNLESS OTHERWISE NOTED.
2. COORDINATES ARE SHOWN IN DATUM: NAD 83, PROJECTION: UTM ZONE 11N.
3. CONTOUR INTERVALS ARE SHOWN AT 5 m MAJOR AND 1m MINOR.
4. LOCATION OF PROPERTY LINE IS BASED ON AVAILABLE INFORMATION, AND NOT ON A SURVEY. THUS, IT MAY NOT BE COMPLETELY ACCURATE.

REFERENCE

1. TOPOGRAPHIC SURVEY CONDUCTED ON JUNE 13, 2019 BY HARRIER AERIAL SURVEYS.

DISCLAIMER

CLIENT
COLUMBIA SHUSWAP REGIONAL DISTRICT

PROJECT
GOLDEN LANDFILL
DESIGN, OPERATIONS AND CLOSURE PLAN
GOLDEN, B.C.

TITLE
CONCEPTUAL PHASE 2 SITE PREPARATION CONTOURS & PHASE 1 FILL CONTOURS

CONSULTANT
GOLDER

YYYY-MM-DD	2020-01-16
DESIGNED	MB
PREPARED	GB
REVIEWED	CW
APPROVED	MB

PROJECT NO.	PHASE/TASK	REV.	FIGURE
19120797	1000/100	C	4

LEGEND

- 590 — EXISTING TOPOGRAPGHY CONTOURS (JUNE 13, 2019)
- 590 — DESIGN GRADE CONTOURS
- PROPERTY LINE
- EXISTING ELECTRIC FENCE
- EXISTING CHAIN LINK FENCE
- N — EXISTING LITTER NETTING
- PHASE
- EXISTING POWER POLE
- CURRENT FILLING SEQUENCE

NOTES

1. ALL UNITS IN METRES UNLESS OTHERWISE NOTED.
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3. CONTOUR INTERVALS ARE SHOWN AT 5 m MAJOR AND 1m MINOR.
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REFERENCE

1. TOPOGRAPHIC SURVEY CONDUCTED ON JUNE 13, 2019 BY HARRIER AERIAL SURVEYS.

DISCLAIMER

CLIENT
COLUMBIA SHUSWAP REGIONAL DISTRICT

PROJECT
GOLDEN LANDFILL
DESIGN, OPERATIONS AND CLOSURE PLAN
GOLDEN, B.C.

TITLE
CONCEPTUAL PHASE 2 FILL CONTOURS

CONSULTANT
GOLDER

YYYY-MM-DD	2020-01-16
DESIGNED	MB
PREPARED	GB
REVIEWED	CW
APPROVED	MB

PROJECT NO.	PHASE/TASK	REV.	FIGURE
19120797	1000/100	C	5

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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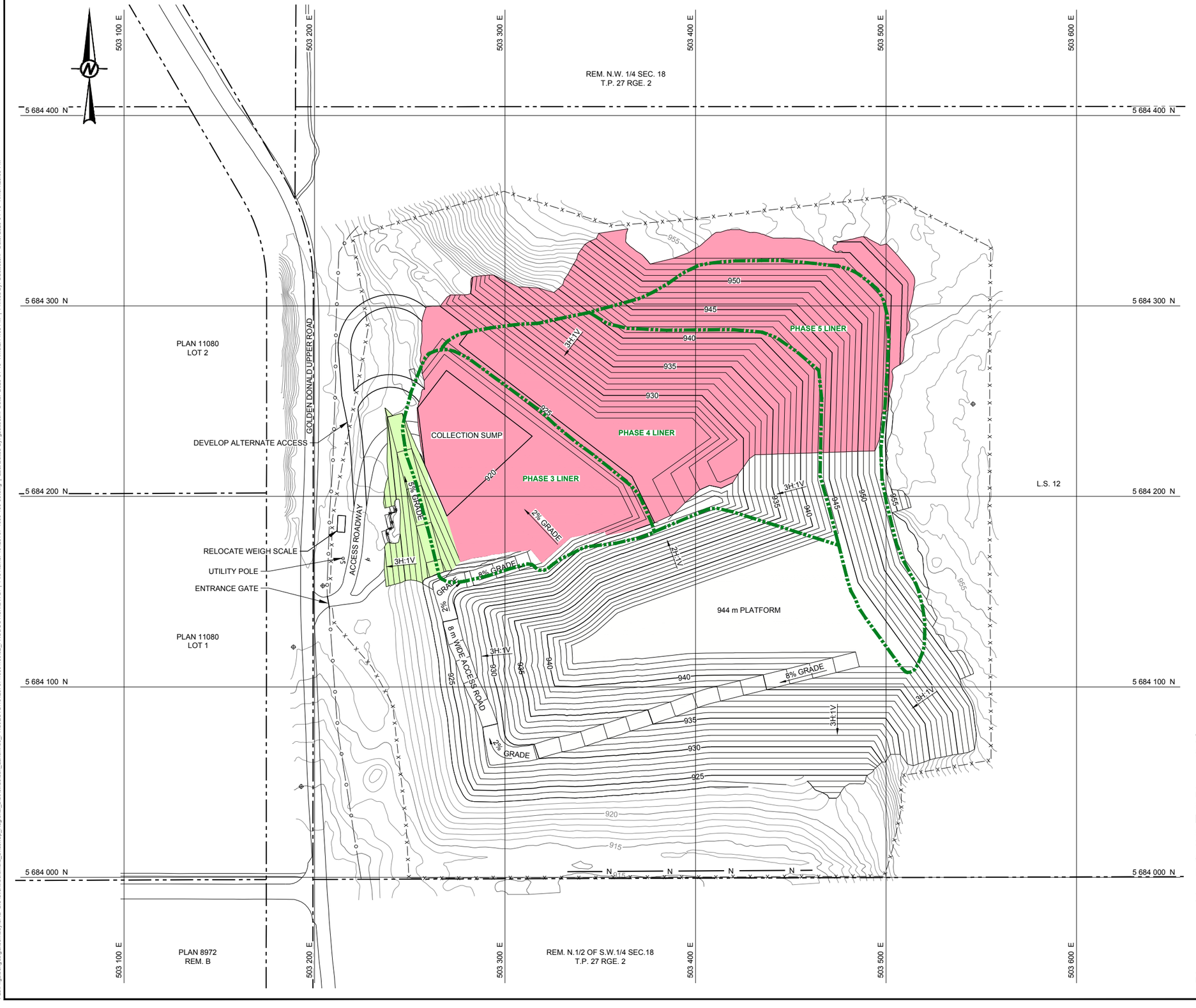

0 50 100
1:2,000 METRES

LEGEND

- EXISTING TOPOGRAPGHY CONTOURS (JUNE 13, 2019)
- DESIGN GRADE CONTOURS
- PROPERTY LINE
- EXISTING ELECTRIC FENCE
- EXISTING CHAIN LINK FENCE
- EXISTING LITTER NETTING
- PHASE
- EXISTING POWER POLE
- CURRENT FILLING SEQUENCE
- CURRENT SITE PREPARATION SEQUENCE

NOTES

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REFERENCE

1. TOPOGRAPHIC SURVEY CONDUCTED ON JUNE 13, 2019 BY HARRIER AERIAL SURVEYS.

DISCLAIMER

CLIENT
COLUMBIA SHUSWAP REGIONAL DISTRICT

PROJECT
GOLDEN LANDFILL
DESIGN, OPERATIONS AND CLOSURE PLAN
GOLDEN, B.C.

TITLE
CONCEPTUAL SITE PREPARATION CONTOURS REMAINING PHASES

CONSULTANT
GOLDER

YYYY-MM-DD	2020-01-16
DESIGNED	MB
PREPARED	GB
REVIEWED	CW
APPROVED	MB

PROJECT NO.	PHASE/TASK	REV.	FIGURE
19120797	1000/100	C	6

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

0 25 mm

LEGEND

- EXISTING TOPOGRAPGHY CONTOURS (JUNE 13, 2019)
- DESIGN GRADE CONTOURS
- PROPERTY LINE
- EXISTING ELECTRIC FENCE
- EXISTING CHAIN LINK FENCE
- EXISTING LITTER NETTING
- PROPOSED DITCH
- PHASE
- EXISTING POWER POLE
- CURRENT FILLING SEQUENCE

NOTES

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REFERENCE

1. TOPOGRAPHIC SURVEY CONDUCTED ON JUNE 13, 2019 BY HARRIER AERIAL SURVEYS.

DISCLAIMER

CLIENT
COLUMBIA SHUSWAP REGIONAL DISTRICT

PROJECT
GOLDEN LANDFILL
DESIGN, OPERATIONS AND CLOSURE PLAN
GOLDEN, B.C.

TITLE
CONCEPTUAL CLOSURE TOPOGRAPHY AND PROGRESSIVE CLOSURE SEQUENCE

CONSULTANT
GOLDER

YYYY-MM-DD	2020-01-16
DESIGNED	MB
PREPARED	GB
REVIEWED	CW
APPROVED	MB

PROJECT NO.	PHASE/TASK	REV.	FIGURE
19120797	1000/100	C	7

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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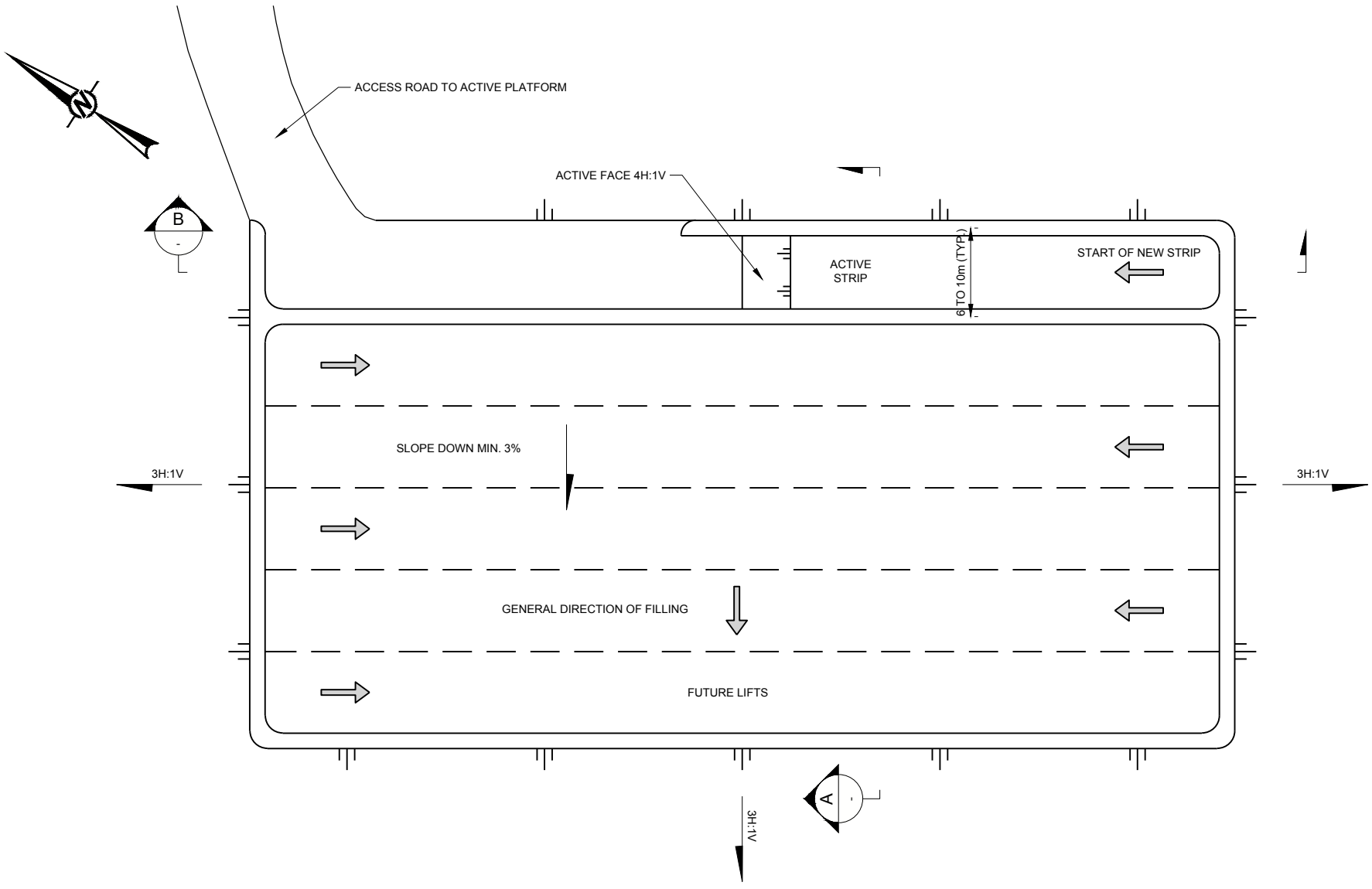
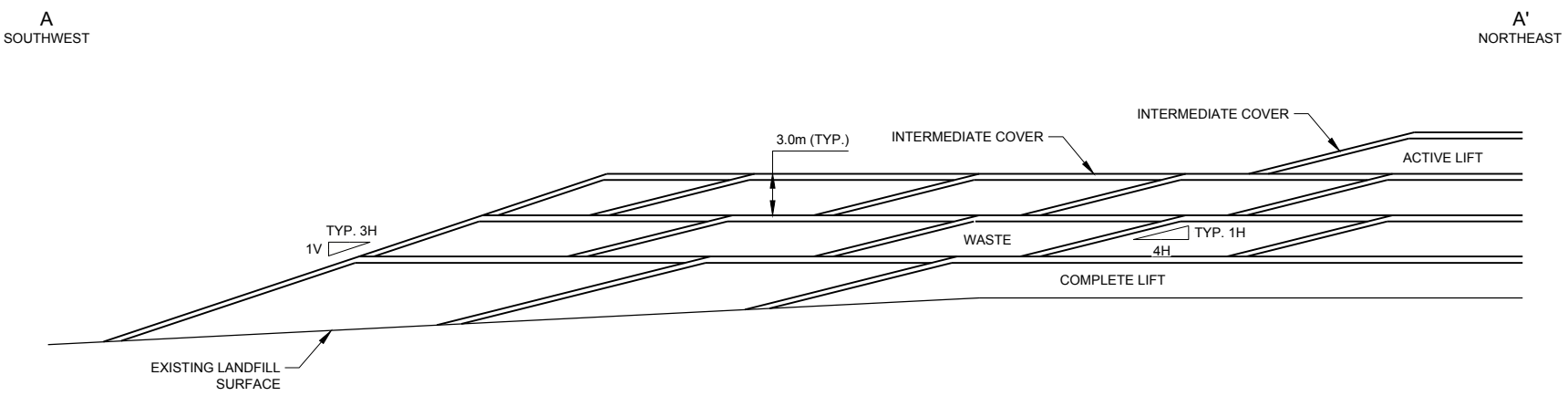
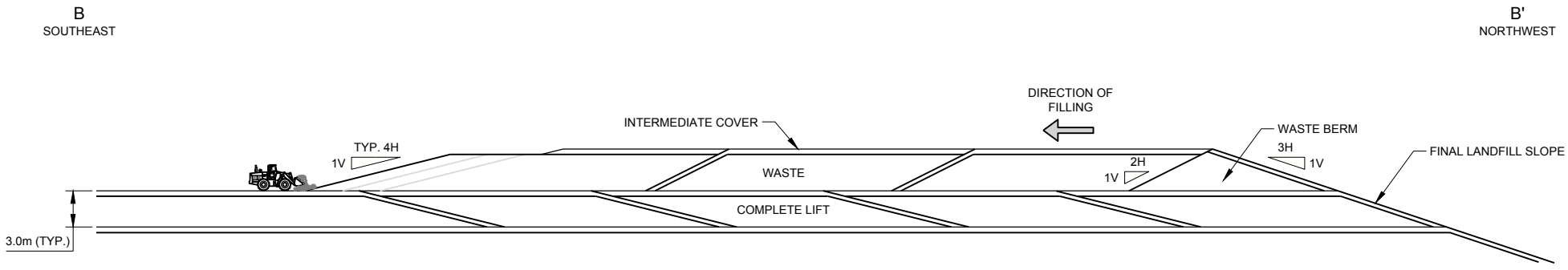


NOT TO SCALE 1 PLAN VIEW



NOT TO SCALE A TYPICAL CROSS-SECTION OF WASTE LIFTS



NOT TO SCALE B TYPICAL CROSS-SECTION OF ACTIVE STRIP

CLIENT
COLUMBIA SHUSWAP REGIONAL DISTRICT

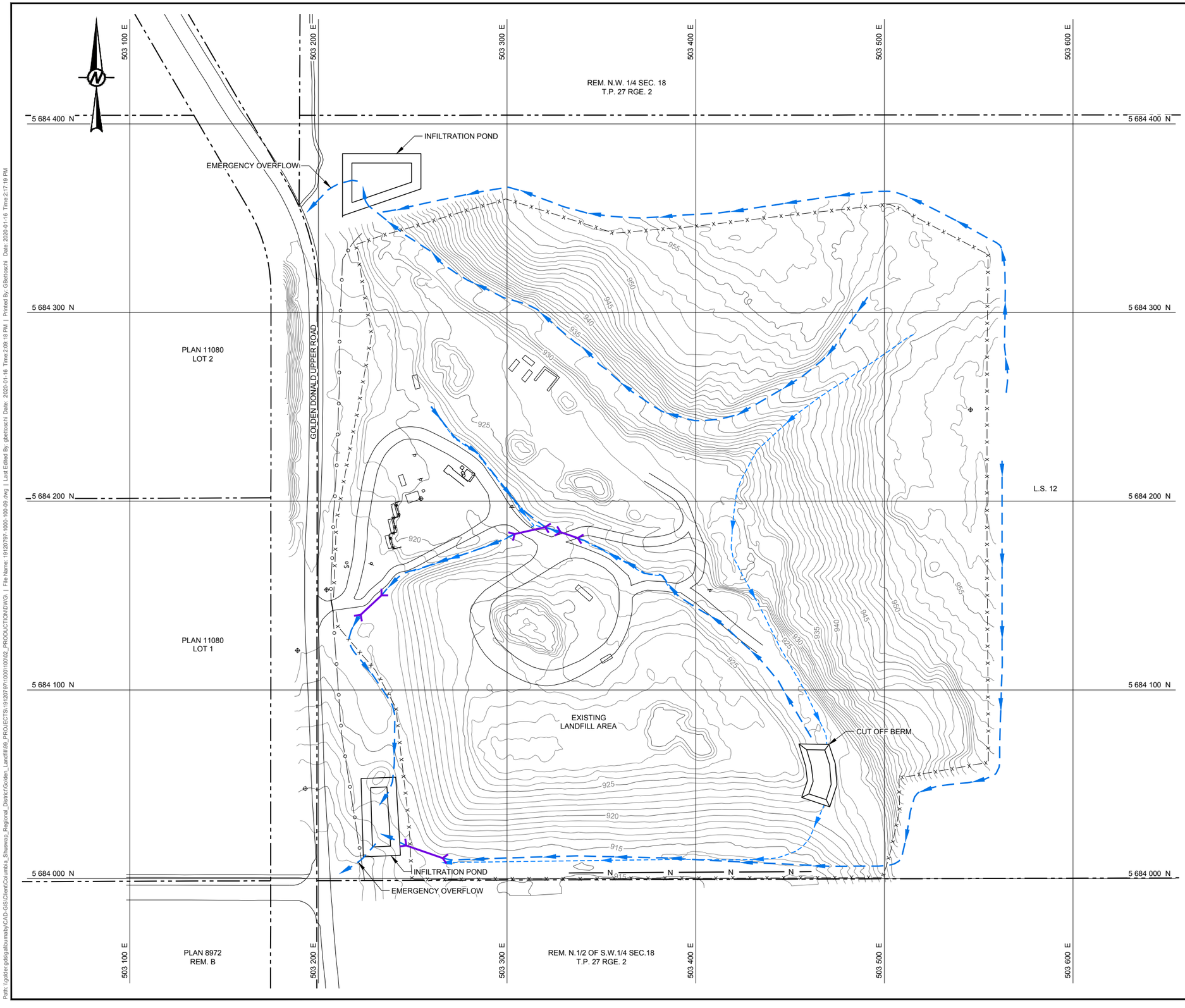
CONSULTANT
GOLDER

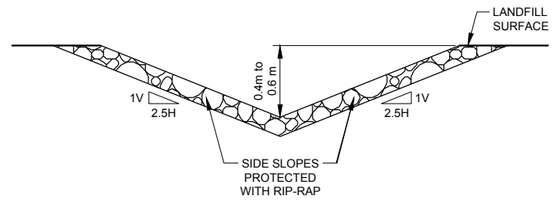
YYYY-MM-DD	2020-01-16
DESIGNED	MB
PREPARED	GB
REVIEWED	CW
APPROVED	MB

PROJECT
GOLDEN LANDFILL
DESIGN, OPERATIONS AND CLOSURE PLAN
GOLDEN, B.C.

TITLE
SCHEMATIC FILLING IN ACTIVE PLATFORM

PROJECT NO.	PHASE/TASK	REV.	FIGURE
19120797	1000/100	B	8





CONCEPTUAL DRAINAGE DITCH CROSS-SECTION

NOT TO SCALE

0 50 100

1:2,000 METRES

LEGEND

- 590 — EXISTING TOPOGRAPGHY CONTOURS (JUNE 13, 2019)
- PROPERTY LINE
- EXISTING ELECTRIC FENCE
- EXISTING CHAIN LINK FENCE
- EXISTING POWER POLE
- PROPOSED DITCH
- CULVERT

NOTES

1. ALL UNITS IN METRES UNLESS OTHERWISE NOTED.
2. COORDINATES ARE SHOWN IN DATUM: NAD 83, PROJECTION: UTM ZONE 11N.
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4. LOCATION OF PROPERTY LINE IS BASED ON AVAILABLE INFORMATION, AND NOT ON A SURVEY. THUS, IT MAY NOT BE COMPLETELY ACCURATE.

REFERENCE

1. TOPOGRAPHIC SURVEY CONDUCTED ON JUNE 13, 2019 BY HARRIER AERIAL SURVEYS.

DISCLAIMER

CLIENT
COLUMBIA SHUSWAP REGIONAL DISTRICT

PROJECT
GOLDEN LANDFILL
DESIGN, OPERATIONS AND CLOSURE PLAN
GOLDEN, B.C.

TITLE
SURFACE WATER MANAGEMENT STRATEGY

CONSULTANT
GOLDER

YYYY-MM-DD	2020-01-16
DESIGNED	MB
PREPARED	GB
REVIEWED	CW
APPROVED	MB

PROJECT NO.	PHASE/TASK	REV.	FIGURE
19120797	1000/100	B	9

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

0 25 mm

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APPENDIX A

Operational Certificate 17006 and 31 October 2019 Amendment Letter

October 31, 2019

Tracking Number: n/a
Authorization Number: 17006

Columbia Shuswap Regional District
Box 978
555 Harbourfront Drive NE
Salmon Arm, BC V1E 4P1

Dear Operational Certificate Holder,

Operational Certificate 17006 Amendment, Section 3.4 Contaminated Soils, under the *Environmental Management Act*

Further to the discussion with the Columbia Shuswap Regional District (CSRD) Team Leader, Environmental Health Services, Ben Van Nostrand, and considering technical information available to me including recent compliance inspections conducted at the site, and pursuant to Section 16 of the *Environmental Management Act*, effective November 18, 2019, operational certificate 17006, dated August 29, 2012, is hereby amended as follows:

Subsection 3.4 – Contaminated Soil is amended from:

> Soil that contains contaminants in concentrations less than "hazardous waste" as defined by the Hazardous Waste Regulation may be disposed of at the landfill site. Disposal includes monofilling, co-disposal with other wastes, use as a refuse cell berm material and use as a refuse cell cover material. Disposal does not include use as final cover material.

to:

> Soil in which the concentrations of all substances are less than the lowest applicable industrial land use standard specified for those substances in
>
> > (i) the generic numerical soil standards,
> > (ii) the matrix numerical soil standards, or
> > (iii) a director's interim standard for soil, referred to in section 41(1)(a) of the Contaminated Sites Regulation, B.C. Reg. 375/96
>
> may be disposed of at the landfill site. Disposal includes monofilling, co-disposal with other wastes, use as a refuse cell berm material and use as a refuse cell cover material. Disposal does not include use as final cover material.

This amendment acknowledges that the CSRD is currently preparing a Design, Operational and Closure Plan update for review and approval by the ministry. It also acknowledges that the ministry is currently reviewing the 2018 Hydrogeology Characterization Report, dated April 2019, prepared by Western Water Associates Ltd. for the CSRD and that preliminary review information suggests that the receipt of

contaminated soils at the landfill, as previously authorized under Section 3.4 of the operational certificate, needs to be carefully re-evaluated to ensure the ongoing protection of human health and the environment.

All other terms and conditions of the operational certificate remain in full force and effect.

Please note that although a revised operational certificate document has not been produced at this time a copy of this letter is being placed on the operational certificate file, as an addendum to the operational certificate, to formally reflect the amendments.

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

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

Administration of this operational certificate will be carried out by staff from the Environmental Protection Division's Regional Operations Branch. Documents pertinent to the operational certificate are to be submitted by email or electronic transfer to the Director, in accordance with the ministry Data & Report Submissions website at: http://www2.gov.bc.ca/gov/content/environment/waste-management/waste-discharge-authorization/data-and-report-submissions, or as further instructed. If you have any questions or concerns, please contact Authorizations - South at Authorizations.South@gov.bc.ca.

Yours truly,

Luc Lachance, P.Eng
for Director, *Environmental Management Act*

ENCL: Operational Certificate 17006, dated August 29, 2012

August 29, 2012

Tracking Number: 243578
Authorization Number: 17006

REGISTERED MAIL

Columbia Shuswap Regional District
Box 978
781 Marine Park Drive NE
Salmon Arm, BC V1E 4P1

Dear Operational Certificate Holder:

Enclosed is Amended Operational Certificate 17006 issued under the provisions of the *Environmental Management Act*. Your attention is respectfully directed to the terms and conditions outlined in the operational certificate. An annual fee will be determined according to the Permit Fees Regulation.

This operational certificate does not authorize entry upon, crossing over, or use for any purpose of private or Crown lands or works, unless and except as authorized by the owner of such lands or works. The responsibility for obtaining such authority rests with the operational certificate holder. It is also the responsibility of the operational certificate holder to ensure that all activities conducted under this authorization are carried out with regard to the rights of third parties, and comply with other applicable legislation that may be in force.

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

...2

Ministry of Environment
Environmental Protection Division
401 - 333 Victoria St.
Nelson, BC V1L 4K3
Southern Interior Region - Kootenay
Telephone: (250) 354-6333
Facsimile: (250) 354-6332

Administration of this operational certificate will be carried out by staff from the Southern Interior Region - Kootenay. Plans, data and reports pertinent to the operational certificate are to be submitted to the Regional Manager, Environmental Protection, at Ministry of Environment, Regional Operations, Southern Interior Region - Kootenay, 401 - 333 Victoria St., Nelson, BC V1L 4K3.

Yours truly,

Chris Stroich, M.Sc., P.Ag.
for Director, *Environmental Management Act*
Southern Interior Region - Kootenay

Enclosure

cc: Environment Canada

MINISTRY OF ENVIRONMENT

OPERATIONAL CERTIFICATE

17006

Under the Provisions of the Environmental Management Act

Columbia Shuswap Regional District

Box 978
781 Marine Park Drive NE
Salmon Arm, BC V1E 4P1

is authorized to manage waste and recyclable material from the Columbia Shuswap Regional District and environs at the Columbia Shuswap Regional District in Golden landfill located near Golden, British Columbia, subject to the conditions listed below. Contravention of any of these conditions is a violation of the *Environmental Management Act* and may result in prosecution.

This Operational Certificate supersedes all previous versions of the Operational Certificate MR-17006 issued under the authority of the *Environmental Management Act.*

1. AUTHORIZED DISCHARGE

This section applies to the discharge of refuse from municipal, commercial and light industrial sources to a sanitary landfill known as the GOLDEN LANDFILL. The site reference number for this discharge is E246600.

1.1 The authorized works are a sanitary landfill and related appurtenances approximately located as shown on the attached location map.

Date issued: May 5, 2003
Date amended: August 29, 2012
(most recent)

Chris Stroich, M.Sc., P.Ag.
for Director, *Environmental Management Act*
Southern Interior Region - Kootenay

1.2 The maximum quantity of waste discharges must not exceed the design capacity of the landfill as specified in the approved Design and Operations Plan. The final footprint and profile of the discharged waste must be within that specified in the Design and Operations Plan, and approximately as shown on the attached location map.

1.3 The authorized discharge is municipal solid waste as defined in the *Environmental Management Act* and other waste as may be authorized by the Director.

1.4 The legal description of the location of the authorized landfill facility is Subdivision 12 of Section 18, Township 27, Range 21, West of the 5th Meridian, Kootenay District.

1.5 The site is located approximately 2 kilometres travelling northeast on Highway 1 as shown on the location map.

2. DESIGN AND PERFORMANCE REQUIREMENTS

2.1 Design and Operating Plan

The Operational Certificate holder must prepare and maintain a current Design and Operations Plan prepared by a qualified professional. The Plan must be reviewed and updated as needed at least once every five years. The next update must be undertaken and completed in 2013. The Plan must address, but not be limited to, each of the subsections in the Landfill Criteria for Municipal Solid Waste including performance, siting, design, operational, closure and post-closure criteria. The facilities must be developed, operated and closed in accordance with the Plan. Should there be any inconsistency between this Operational Certificate and the Plan, this Operational Certificate must take precedence.

Written authorization from the Director must be obtained prior to implementing any changes to the approved plans. Based on any information obtained in connection with this facility, the Director may require revision of, or addition to, the design, operating and closure plans.

Date issued: May 5, 2003
Date amended: August 29, 2012
(most recent)

Chris Stroich, M.Sc., P.Ag.
for Director, *Environmental Management Act*
Southern Interior Region - Kootenay

2.2 Qualified Professionals

All facilities and information, including works, plans, assessments, monitoring, investigations, surveys, programs and reports, must be certified by Qualified Professionals.

2.3 Maintenance of Works and Emergency Procedures

The authorized works must be inspected regularly and maintained in good working order. In the event of an emergency or condition beyond the control of the Columbia Shuswap Regional District including, but not limited to, unauthorized fires arising from spontaneous combustion or other causes, or detection of surfacing leachate on the property, the Columbia Shuswap Regional District must take appropriate remedial action and notify the Regional Office. The Director may reduce or suspend operations to protect the environment until the authorized works has been restored, and/or corrective steps taken to prevent unauthorized discharges.

2.4 Additional Facilities or Works

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

2.5 Public Health, Safety and Nuisance

The landfill must be operated in a manner such that it will not create a public nuisance or become a significant threat to public health or safety with respect to landfill gas, unauthorized access, roads, traffic, airport activity, noise, dust, litter, vectors, or wildlife attraction.

2.6 Ground and Surface Water Quality Impairment

The landfill must be operated in a manner such that ground or surface water quality does not decrease beyond that specified by the British Columbia Water Quality Guidelines, or other appropriate criteria as may be specified by the Director, at or beyond the landfill property boundary.

The certificate holder must take all reasonable measures to ensure that BCWQG are met at or beyond the property boundary. These measures include but are not limited to:

a) Prohibiting the discharge of municipal solid waste into water.

b) Ensuring that no new waste is landfilled within 1.2 m of the highest groundwater level.

c) Ensuring that adequate surface water and groundwater diversion works are constructed and maintained to minimize surface water run-off and groundwater seepage from entering the landfill.

d) Ensuring that the management systems for surface water that has not come in contact with waste are hydraulically separate from those for managing impacted surface water.

e) Ensuring that the landfill is operated in a manner that prevents the exceedance in surface water and groundwater of anticipated leachate indicators or parameters distinctive of leachate or those specified by the Director at the landfill boundary.

f) Ensuring that the indicators in e) above, at specified groundwater monitoring wells within the property boundary are in accordance with those predicted by design and that suitable measures are taken to address the cause of any exceedances above the trigger levels identified in the most current Design and Operations Plan.

g) Ensuring that the landfill is operated in accordance with a Design & Operations Plan which specifies measures to prevent decreases in groundwater and surface water quality at and beyond the property boundary.

If exceedances to the specified water quality criteria occur as a result of landfill operations, the Director may require that leachate management control measures or works be undertaken. Terms of reference for any leachate management study and/or design work must be submitted to the Director for review prior to conducting the work.

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2.7 Landfill Gas Management

The Landfill must not cause combustible gas concentrations to exceed the lower explosive limit in soils at the property boundary or 25% of the lower explosive limit at or in on-site or off-site structures.

The Operational Certificate holder must ensure that the facility is in compliance with the requirements of the Landfill Gas Management Regulation under the *Greenhouse Gas Reduction (Emissions Standards) Statutes Amendment Act*, 2008 on or before applicable dates specified in the regulation. The requirements of the regulation and its guideline documents must be incorporated by the Operational Certificate holder into the Design and Operation Plan revisions as they come into effect and as applicable.

2.8 Buffer Zone

No material must be landfilled within 50 metres of the property boundary.

3. OPERATIONAL REQUIREMENTS

3.1 Waste Compaction and Coverage

The Operational Certificate holder must ensure that waste deposition and compaction meets or exceeds the requirements of the BC Landfill Criteria or its most current version for daily, intermediate and final cover. Control must be exercised to ensure keeping freshly deposited refuse in a well defined and small / manageable working face.

3.2 Prohibited Wastes

The disposal of the following types of wastes is strictly prohibited:

(a) Hazardous Wastes other than those specifically approved for disposal to authorized landfills in the Hazardous Waste Regulation under the *Environmental Management Act*.

(b) Biomedical wastes as defined in the Guidelines for the Management of Biomedical Wastes in Canada (Canadian Council of Ministers of the Environment, February 1992),

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(c) Bulk liquids and semi-solid wastes, which contain free liquids, as determined by US EPA Method 90954 Paint Filter Liquids Test, Test Methods for Evaluating Solid Wastes-Physical/Chemical Methods (EPA Publication No. Sw-846),

(d) Release of ozone depleting substances from the storage, handling and disposal of used appliances, equipment, or any material containing ozone depleting substances is prohibited in accordance with the requirements of the Ozone Depleting Substances Regulation. Onsite removal or evacuation of Ozone Depleting Substances (ODS) from appliances and the subsequent storage of appliances on site is permitted subject to both activities being in compliance with the Ozone Depleting Substances Regulation.

3.3 **Waste Asbestos**

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

(a) The asbestos waste may not be mixed with any other hazardous waste.

(b) The Regional District must approve the disposal before disposal takes place.

(c) All other applicable requirements of the Hazardous Waste Regulation, including but not limited to manifesting and waste record keeping, must also be complied with.

3.4 **Contaminated Soil**

Soil that contains contaminants in concentrations less than "hazardous waste" as defined by the Hazardous Waste Regulation may be disposed of at the landfill site. Disposal includes monofilling, co-disposal with other wastes, use as a refuse cell berm material and use as a refuse cell cover material. Disposal does not include use as final cover material.

3.5 **Wildlife and Vector Control**

Vectors (carriers capable of transmitting a pathogen from one organism to another including, but not limited to flies and other insects, rodents, and birds) must be controlled by the application of cover material at the required frequency or by such additional methods as specified by the Director. Wildlife control fencing must be maintained around the perimeter of the landfill site and must be

electrified for at least the active bear season of each year.

This landfill must be operated so as to minimize the attraction of wildlife such as bears and birds by applying cover at required frequencies and instituting a good housekeeping program.

3.6 Site Access and Supervision

A landfill operator that has received BC Qualified Landfill Operator training, is familiar with the requirements of the Operational Certificate and the specifications of the Design and Operations Plan, must be present at all times during operating hours.

Locking gates must be maintained at all access routes to the landfill site. Gates, perimeter fencing and/or barriers must be installed where necessary to prevent unauthorized access to the site by vehicles. Gates must be locked during non-operating hours.

3.7 Dust Control

Dust created within the landfill property must be controlled, using methods and materials acceptable to the Director, such that it does not cause a public nuisance.

3.8 Litter Control

The best practical means must be used to prevent the scatter of litter. Any litter scattered into the neighbouring property, along access roads, in drainage ditches, along litter-control fences, into surrounding trees or elsewhere on the landfill site must be cleaned up. The frequency of clean up and other additional requirements for refuse scatter control must be determined by the Director.

3.9 Waste Reduction and Alternate Disposal

The Provincial Government has developed policies to promote the reduction, reuse and recycling of wastes. The Operational Certificate holder is encouraged to segregate for recycling and reuse, where possible, materials destined for disposal at this site.

Public scavenging must not be permitted at the landfill. The controlled salvaging of waste by the landfill operator or persons authorized by the

Operational Certificate holder is encouraged if areas or facilities for separation and storage of recyclable or reusable materials are provided.

In certain landfill environments, some construction and demolition debris or other wastes may create specific air and water quality concerns. If problems arise at this site that are attributable to specific wastes, the Director may require that alternate disposal/storage procedures be implemented.

3.10 Operations and Maintenance Manual

The Operational Certificate holder must prepare an Operations and Maintenance Manual to be reviewed and updated as necessary on at least an annual basis.

4. MONITORING AND REPORTING REQUIREMENTS

4.1 Landfill Monitoring

A monitoring program must be developed by a Qualified Professional and identify potential environmental impacts of the authorized facility and must address but not be limited to the Landfill Criteria for Municipal Solid Waste and Guidelines for Environmental Monitoring. The monitoring program must be updated every five years and submitted to the satisfaction of the Director. The next monitoring plan update is required to be undertaken and completed in 2013. Monitoring must be conducted in accordance with the monitoring program.

The program must be designed to assess and identify:

- The design performance of the landfill as per the Design & Operations Plan including but not limited to compliance with water quality performance standards at the landfill boundary.
- Landfill leachate as a contaminant source.
- Residential well water quality.
- Surface water quality.

The monitoring program must address, but not be limited to relevant sections of the Landfill Criteria for Municipal Solid Waste and the Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills. The Environmental Monitoring Program must take into consideration results from previous monitoring programs and any other investigations conducted at the site to ensure that early detection of potential impacts is possible.

4.2 Sampling Techniques

Sampling must be carried out in accordance with the procedures described in the most recent edition of the "British Columbia Field Sampling Manual for Continuous Monitoring Plus the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples", or by suitable alternative procedures as authorized by the Director. A copy of the above manual may be purchased from the Queen's Printer Publications Centre, P.O. Box 9452, Stn. Prov. Gov't., Victoria, British Columbia, V8W 9V7 (1-800-663-6105 or (250) 387-6409).

4.3 Analysis

Analyses must be carried out in accordance with procedures described in the most recent edition of the "British Columbia Environmental Laboratory Manual for the Analysis of Water, Wastewater, Sediment and Biological Materials", or by suitable alternative procedures as authorized by the Director. A copy of the above manual may be purchased from the Queen's Printer Publication Centre.

4.4 Quality Assurance

The Operational Certificate holder must produce, within 60 days on the request of the Regional Manager Environmental Protection, 'Field and Laboratory Quality Protocols and Quality Assurance Criteria' acceptable to the Director. The 'Laboratory Quality Protocols' must include the procedures used to assess precision, accuracy and blank quality, including frequency of application of those procedures, the procedures for sampling, handling (e.g. preservation, hold times) and corrective measures to be initiated when deficiencies are indicated. The 'Quality Assurance Criteria' must include the acceptance criteria for accuracy (based on recoveries for reference samples/spikes), for precision (based on deviation in field and lab duplicates) and method blanks (designed to indicate false positives).

5. LANDFILL REPORTING

5.1 Annual Report

The Operation Certificate Holder must submit an Annual Report to the Director on or before April 30th each year for the previous calendar year. The report must contain at least the following information:

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(a) an executive summary;

(b) the type and tonnage of waste received, recycled, stored on-site and discharged / landfilled for the year;

(c) Any proposed changes to the Design and Operations Plan and the environmental monitoring program (EMP), with rationale for the changes; a description of unanticipated occurrences and any changes to the closure or post-closure plans and funds;

(d) A review of the preceding year of operation or an operations update which summarizes landfill development work completed in the subject reporting year and work planned for the subsequent year. A summary of any new information or changes to the facilities and plans, assessments, surveys, programs and reports;

(e) Occurrences or observations of wildlife (medium and large carnivores) at the facility;

(f) A statement regarding the facility's progress in reducing the regional solid waste stream being landfilled and the objectives of the Regional Solid Waste Management Plan;

(g) An outline of the current Environmental Monitoring Program and a compendium of all environmental monitoring data in accordance with requirements specified in the most recent version of Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills and Landfill Criteria for Municipal Solid Waste. The annual report must document any effect of the discharge on the quality of the receiving environment using appropriate statistical and graphical analysis. Trend analyses, as well as an evaluation of the impacts of the discharges on the receiving environment must be included;

(h) A list of training programs completed for landfill operators during the previous year; and

(i) Any additional information requested by the Director.

All reports must be submitted, suitably formatted and tabulated in both print and electronic format (portable document format).

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5.2 **Five Year Report**

The Operation Certificate Holder must submit a Five Year Report to the Director on or before April 30th on the five year anniversary of the last submission. The next report is due by the end of 2013. The report must contain at least the following information:

(a) An executive summary;

(b) An updated Design and Operations Plan;

(c) A detailed hydrogeological assessment;

(d) The type and tonnage of waste received, recycled, stored on-site and discharged / landfilled for the year;

(e) A current topographic map detailing airspace consumption, on-site borrow pit changes and future developments;

(f) Volume and density analysis or an in-place material summary, updated estimates for the remaining capacity, site life, revised closure date for the current phase or sequence and revised closure date for the current landfill footprint;

(g) An outline of the current Environmental Monitoring Program and a compendium of all environmental monitoring data in accordance with requirements specified in the most recent version of Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills and Landfill Criteria for Municipal Solid Waste. The annual report must document any effect of the discharge on the quality of the receiving environment using appropriate statistical and graphical analysis. Trend analyses, as well as an evaluation of the impacts of the discharges on the receiving environment must be included;

(h) An update on the financial assurance mechanism including a statement of the current dollar value of the Closure Fund and the amount earmarked for the Landfill site; and

(i) Any additional information requested by the Director.

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6. LANDFILL CLOSURE PLAN

6.1 Closure Plan and Post Closure

The Operational Certificate holder must perform closure and post-closure care in accordance with all applicable requirements of the BC Landfill Criteria for Municipal Solid Waste. This Operational Certificate is issued on the condition that a Closure Plan and Final Cover Design that meets or exceeds the requirements of the criteria will be submitted to the Director during the operating life of the landfill. The Closure Plan must be reviewed every five years throughout the operating life of the landfill.

A certification by a Qualified Professional attesting that all closure works have been completed in accordance with the Closure Plan and Final Cover Design is to be submitted to the Director no later than 60 days after the implementation of the Final Cover Design.

The Operational Certificate Holder must submit a Post Closure or Aftercare Plan to the Ministry at least two years prior to the anticipated closure date of the landfill.

6.2 Closure Fund

The Operational Certificate holder must provide for the funding of progressive closure operations, final closure and operations beyond closure by maintaining a closure fund. The value of the closure fund must meet or exceed the estimated closure and post-closure costs as established in the approved Design and Operations Plan and updated in the annual report, plus a reasonable contingency for any remediation which may be required. Reported costs must be adjusted for inflation annually. Alternately, a closure and post-closure financial security acceptable to the Director may be built over time.

The Operational Certificate holder must determine and ensure that the closure fund is adequate by preparing annually a financial statement of the fund which must be made available to the Director upon request. The financial statement must report the accrued capital, interest and additions to the fund for the previous year and review the sufficiency of the fund and the rate of accrual in consideration of the projected costs of closure and post-closure obligations.

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6.3 Site Decommissioning

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

6.4 Declaration of Landfill

Landfills sited on titled land must register a covenant that the property was used for the purpose of waste disposal as a charge against the title to the property as provided for under Section 215.1 of the *Land Title Act.* Landfills located on crown land are to have a "notation on file" registered that the property was used for the purpose of waste disposal.

The Operational Certificate holder must, upon closure of the landfill, register a charge against the property title, or provide other legal notification acceptable to the Director that the property described in Section 1 was used for the purpose of waste disposal. The Director must be notified of the charge or legal notification.

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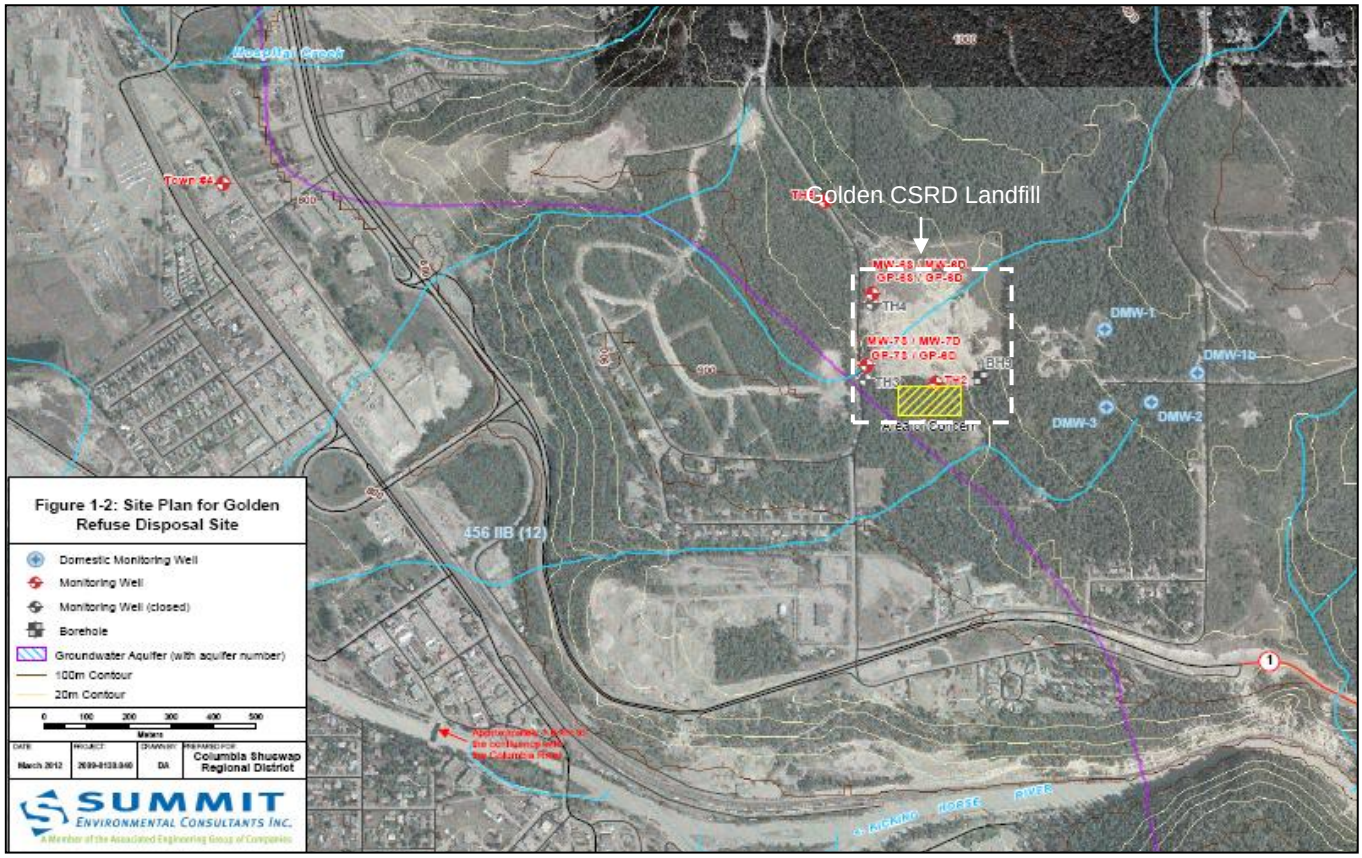
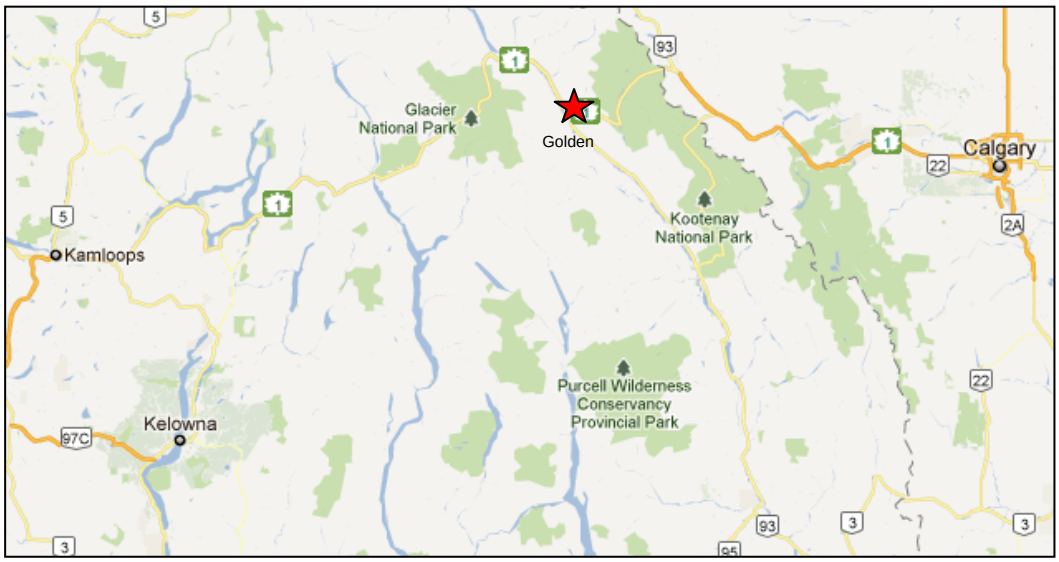
Location Map





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(most recent)

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Southern Interior Region - Kootenay

APPENDIX B

Landfill Gas Generation Assessment Report for the Golden Landfill (GHD – June 2017)

Supplemental Landfill Gas Generation Assessment

Golden Landfill

Columbia-Shuswap Regional District

GHD | 10271 Shellbridge Way Suite 165 Richmond British Columbia V6X 2W8 Canada

052164 | 07 | ** | Report No 11 | June 21 2017

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1. Introduction

GHD Limited (GHD) has prepared the following report entitled, "Supplemental Landfill Gas Generation Assessment Report" for the Golden Landfill on behalf of the Columbia-Shuswap Regional District (CSRD). The Golden Landfill (Site) is a municipal solid waste (MSW) management facility managed by the CSRD.

This report has been prepared in accordance with the Landfill Gas Generation Assessment Procedure Guidance Report, prepared for the British Columbia Ministry of Environment (MOE) by Conestoga-Rovers & Associates (CRA, now GHD), dated March 2009 (Guidelines), and in accordance with the requirements of the MOE's Landfill Gas Management Regulation (the Regulation), approved and ordered on December 8, 2008. This report has been prepared by a qualified professional and meets the requirements of Section 4(3)(e) of the Regulation.

1.1 Landfill Gas Generation Assessment Requirements

As required by Section 4(5) of the Regulation, this section relates to the tonnage thresholds that determine the regulatory requirement to prepare a landfill gas (LFG) generation assessment. The Regulation applies to landfills that accept MSW on or after January 1, 2009. A landfill is termed a *regulated landfill site* under the Regulation if it has 100,000 tonnes or more of MSW in place or receives 10,000 or more tonnes of MSW in any calendar year after 2008.

As a result, the Site is considered a *'regulated landfill site'* as per Section 4(5) of the Regulation and a LFG generation assessment report was submitted to the MOE prior to January 1, 2011 as required in Section 4(5) of the Regulation.

1.2 Previous Landfill Gas Generation Assessments

As noted in Section 3.0 of the Guidelines, previous LFG generation assessments can act as a useful record of historical site-specific information and should be reviewed as a starting point to completing the LFG generation assessment.

A LFG Assessment was conducted by GHD in June 2012 and identified that the Site would generate 202 tonnes of methane in the 2011 calendar year and, as such, the completion of a LFG Management Facility Design Plan was not required under the Regulation Landfill Gas Generation Assessment

2. Landfill Gas Generation Assessment

2.1 Landfill Information

This section summarizes characteristics at the Site, including background information, historical waste tonnage and waste characterization, as required by Sections 4(2)(a), 4(2)(b), 4(2)(c), 4(3)(a), and 4(3)(d) of the Regulation and described in Section 5.1 of the Guidelines.

The Site has been in operation since the early 1970s and currently accepts solid waste from residents, businesses, and institutions within the municipality of Golden surrounding area, and Electoral Area 'A'. The site came under management of the Columbia Shuswap Regional District in the late 70s.

Approximately 158,773 tonnes of waste has been landfilled at the Site since 1987 (30 years prior to this assessment). Only 30 years of historical data is used as per the Guidelines. Table 2.1 includes a summary of projected annual waste tonnages for 4 years following the assessment and the estimated total waste in place.

For this assessment, landfilled waste was segregated into the following three categories by mass:

- Relatively inert (waste includes waste materials with low or no degradable organic carbon, such as metal, glass, plastic, soil, contaminated soils, and water treatment plant screened fines).
- Moderately decomposable (includes materials with a degradable organic carbon fraction that will decompose at a moderate or slower rate such as paper, wood, wooden furniture, rubber, textiles, and construction and demolition material).
- Decomposable (includes materials with a high degradable organic carbon fraction that will decompose relatively quickly such as food waste, yard waste, and slaughterhouse waste).

2.2 Waste Characterization

As per Section 4(3)(d) of the Regulation and described in Section 5.1 of the Guidelines, waste characterization information is required as part of the generation assessment. This information should include the historical and projected annual waste mass categorized into mass of relatively inert, moderately decomposable, and decomposable wastes, and historical and projected waste mass for any years from 1987 to 2021.

Waste characterization information was obtained from the 2006 CSRD Solid Waste Composition Study (2006 SWCS) (Technology Resources Inc., 2006) and the 2013 CSRD Solid Waste Characterization Study (2013 SWCS)(TRI Environmental Consulting Inc., 2013). Table 2.2 outlines the waste characterization data from the 2006 SWCS and 2013 SWCS.

2.3 Climate

The moisture content within a landfill is one of the most important parameters affecting the gas generation rate. Moisture provides an aqueous environment necessary for anaerobic processes responsible for LFG production, and serves as a medium for transporting nutrients and bacteria that play a major role in the decomposition process. The following section presents the information required by Section 4(3)(d) of the Regulation and described in Section 5.1 of the Guidelines, relating to moisture content.

The average annual precipitation recorded in Golden, BC (Climate ID: 1173210) is approximately 466.8 millimetres per year (mm/year) (Environment Canada 1980 to 2010 Climate Normals, 2017). The precipitation data was used to determine appropriate values for model input parameters.

2.4 Model Input Parameters Used and Justification

The following section presents the information required by Section 4(3)(d) of the Regulation and described in Sections 5.2 (Methane Generation Rate Selection Matrix) and 5.3 (Water Addition Factor) of the Guidelines.

The methane generation potential, L_o, represents the total potential yield of methane from a mass of waste (m^3 of methane per tonne of waste). The L_o value is dependent on the composition of waste, and in particular the fraction of organic matter present. The methane generation rate, k, represents the first-order biodegradation rate at which methane is generated following waste placement. This constant is influenced by moisture content, the availability of nutrients, pH, and temperature.

The moisture content within a landfill is one of the most important parameters affecting the LFG generation rate and is influenced primarily by the infiltration of precipitation through the landfill cover and the nature and composition of the waste. As per the Guidance, a water addition factor of 1.0 was selected for the Site as there is partial infiltration of water to the waste mass at the Site. This factor value was selected as landfill storm water management best practices are partially implemented across the Site, there is sloped, cover on a portion of the Site, and there is no leachate recirculation or storm water injection. This results in partial water addition to the waste mass.

3. Landfill Gas Generation Model Results

The Regulation [Sections 4(2)(d), 4(2)(e), and 4(3)(a)] requires that the LFG generation assessment include the following:

- The annual tonnage of MSW received for disposal at the Site in the calendar year immediately preceding the year in which the assessment is conducted.
- An estimate of the quantity of methane generated at the landfill site in the calendar year immediately preceding the calendar year in which the assessment is conducted.
- Projections for methane anticipated to be generated annually at the Site in the calendar year of the assessment and in each of the four calendar years following the calendar year of the assessment.

Table 2.1 presents a summary of the above information, as required by the Regulation. As noted on the table, the methane generation for 2016 is estimated to be approximately 202 tonnes.

Table 2.2 presents the input values for the Scholl Canyon Model and LFG generation results. Figure 1 shows a graphical representation of the LFG generation estimate.

4. Food Waste Ban Model

GHD performed an analysis of the LFG generation should a food waste ban be implemented at the Site. The food waste ban would decrease the decomposable waste being landfilled. The assumptions made in the analysis are:

- Waste tonnages would continue to increase at the rate recorded from 2011 to 2016
- Waste composition will continue to be the same as the 2013 waste composition study
- The food waste ban would decrease food waste in the waste stream by 50 percent
- The food waste ban would be implemented at the beginning of 2019

Without the food waste ban, the projected year that the methane generated at the site exceeds the 1,000 tonne regulatory threshold is 2155 (if landfilling would continue until then). With the food waste ban, the Site is projected to exceed the regulatory threshold in 2174. The summary of this information is shown in Table 2.1.

5. Discussion of Next Steps

The following section presents the information required by Section 4(3)(c) of the Regulation.

As the regulatory threshold is 1,000 tonnes of methane per year, the Site is below the threshold and is not required to submit a LFG Management Facility Design Plan to the MOE. The CSRD is required to submit an annual report to the MOE, and will be required to conduct a supplementary LFG generation assessment in 2022 (five years following the previous assessment).

The following information should be included in the LFG annual report in accordance with the Guidelines and in addition to any existing annual reporting requirements:

- Quantity of municipal solid waste received for disposal into the landfill site
- Composition of municipal solid waste received for disposal into the landfill site, if the owner or operator has monitored or analyzed the composition of the municipal solid waste
- A description of any organics diversion program used at the landfill site
- Any additional information requested in writing by the director

The annual report is due to the MOE on March 31 each year, as per the Regulation.

6. References

Conestoga-Rovers & Associates. Landfill Gas Generation Assessment Report for the Golden Landfill, Golden Landfill, Columbia-Shuswap Regional District, June 2012.

Conestoga-Rovers & Associates. Prepared for British Columbia Ministry of Environment, Landfill Gas Generation Assessment Procedure Guidance Report, March 2009.

Environment Canada. Canadian Climate Normals 1981-2010 Station Data. Source: http://climate.weather.gc.ca/climate_normals/index_e.html, last accessed February 21, 2017.

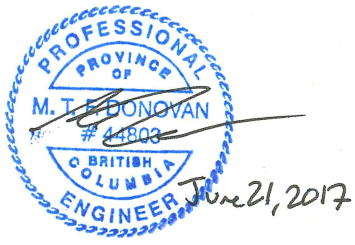
Prepared for British Columbia Ministry of Environment, Landfill Gas Generation Assessment Procedure Guidance Report, March 2009.

Province of British Columbia, Landfill Gas Management Regulation, Approved and Ordered December 8, 2008. Source: http://www.env.gov.bc.ca/epd/codes/landfill_gas/index.htm, last accessed September 30, 2009.

TRI Environmental Consulting Inc. Prepared for Columbia-Shuswap Regional District, 2013 Solid Waste Characterization Study Golden Refuse Disposal Site, November 1, 2013.

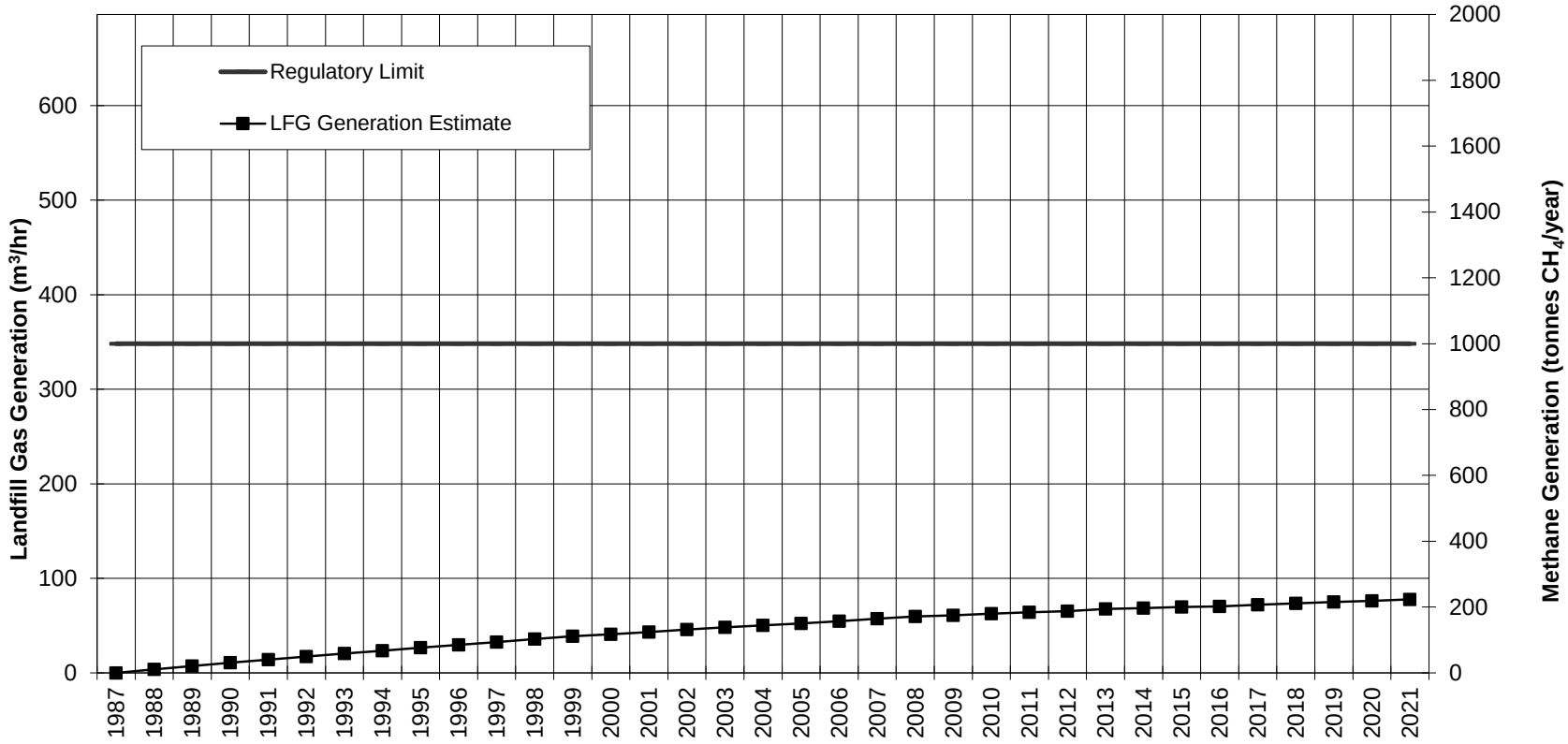
All of Which is Respectfully Submitted,

GHD



Michael Donovan, P.Eng.

Deacon Liddy, P.Eng., MBA



k values (year^{-1})	0.01, 0.02, 0.05	Waste Composition	2006	2013
L_o (weighted) (m^3 CH4/tonne)	20, 120, 160	Relatively Inert (%)	31.8%	41.4%
Precipitation (mm/year)	467	Moderately Decomposable (%)	38.7%	24.5%
Volumetric LFG Composition (percent methane)	50%	Decomposable (%)	29.6%	34.1%

figure 1

LANDFILL GAS GENERATION ESTIMATE

SUPPLEMENTAL LANDFILL GAS GENERATION ASSESSMENT REPORT

GOLDEN LANDFILL

Columbia-Shuswap Regional District

Table 2.1

Landfill Gas Generation Summary
Supplemental Landfill Gas Generation Assessment Report
Golden Landfill
Columbia-Shuswap Regional District

Year	Annual Waste Tonnage (tonnes)	Methane Generation (tonnes CH4/year)	Total Waste in Place (tonnes)
2016	5,494	202	158,773
2017	5,548	206	164,321
2018	5,603	211	169,924
2019	5,663	215	175,587
2020	5,722	219	181,308
2021	5,781	223	187,089
Estimated year that the regulatory threshold is met:			
2154	22,004	992	1,809,417
2155	**22,226**	**1,002**	**1,831,644**
2156	22,451	1,012	1,854,094
Estimated year that the regulatory threshold is met if the food waste ban is implemented:			
2173	24,223	991	2,082,123
2174	**24,468**	**1,002**	**2,106,591**
2175	24,715	1,012	2,131,306

Note
This table presents the results of the landfill gas (LFG) assessment for the year preceding the assessment (2016) and four years following the assessment (2017-2021) in accordance with the LFG Management Regulation

Table 2.2

Landfill Gas Generation Results
Supplemental Landfill Gas Generation Assessment Report
Golden Landfill
Columbia-Shuswap Regional District

	Relatively Inert	Moderately Decomposable	Decomposable	
Gas Production potential, Lo =	20	120	160	m^3 CH_4/tonne
Waste Composition (2006)	31.8%	38.7%	29.6%	
Waste Composition (2013)	41.4%	24.5%	34.1%	
lag time before start of gas production, lag =	1	years		
Historical Data Used (years)	30			
1st Year of Historical Data Used	1987			
4 Years after reporting year	2021			
methane (by volume)	50%			
carbon dioxide (by volume)	50%			
methane (density)	0.6557	kg/m^3	(25°C,1ATM)	
carbon dioxide (density)	1.7988	kg/m^3	(25°C,1ATM)	

Year	Annual Tonnage (tonnes)	Cumulative Waste-in-place (tonnes)	Waste Tonnage			Methane Generation Rate, k			Annual Methane Production (tonnes/yr)	Landfill Gas Production (m^3/hr)	Greenhouse Gas Emissions (as CO_2e/year)
			Relatively Inert (tonnes)	Moderately Decomposable (tonnes)	Decomposable (tonnes)	Relatively Inert ($year^{-1}$)	Moderately Decomposable ($year^{-1}$)	Decomposable ($year^{-1}$)			
1987	4,913	4,913	1,560	1,899	1,453	0.01	0.02	0.05	0.0	0.0	0
1988	4,950	9,863	1,572	1,913	1,464	0.01	0.02	0.05	10.6	3.7	223
1989	4,988	14,851	1,584	1,928	1,476	0.01	0.02	0.05	20.9	7.3	439
1990	5,027	19,878	1,596	1,943	1,487	0.01	0.02	0.05	30.8	10.7	648
1991	5,065	24,943	1,609	1,958	1,498	0.01	0.02	0.05	40.5	14.1	850
1992	5,103	30,047	1,621	1,972	1,510	0.01	0.02	0.05	49.8	17.3	1,046
1993	5,172	35,219	1,643	1,999	1,530	0.01	0.02	0.05	58.9	20.5	1,237
1994	5,241	40,459	1,665	2,026	1,550	0.01	0.02	0.05	67.7	23.6	1,423
1995	5,311	45,770	1,687	2,053	1,571	0.01	0.02	0.05	76.4	26.6	1,604
1996	5,382	51,152	1,709	2,080	1,592	0.01	0.02	0.05	84.9	29.6	1,782
1997	6,334	57,486	2,012	2,448	1,874	0.01	0.02	0.05	93.2	32.4	1,957
1998	5,595	63,082	1,777	2,163	1,655	0.01	0.02	0.05	103.2	35.9	2,168
1999	4,820	67,902	1,531	1,863	1,426	0.01	0.02	0.05	111.3	38.7	2,337
2000	5,227	73,129	1,660	2,020	1,546	0.01	0.02	0.05	117.4	40.9	2,465
2001	5,829	78,958	1,851	2,253	1,724	0.01	0.02	0.05	124.1	43.2	2,606
2002	5,476	84,434	1,739	2,117	1,620	0.01	0.02	0.05	131.9	45.9	2,770
2003	5,115	89,550	1,625	1,977	1,513	0.01	0.02	0.05	138.6	48.3	2,911
2004	5,281	94,830	1,677	2,041	1,562	0.01	0.02	0.05	144.3	50.3	3,031
2005	5,869	100,699	1,864	2,268	1,736	0.01	0.02	0.05	150.2	52.3	3,154
2006	6,085	106,785	1,933	2,352	1,800	0.01	0.02	0.05	157.1	54.7	3,299
2007	6,241	113,026	1,982	2,412	1,846	0.01	0.02	0.05	164.2	57.2	3,448
2008	4,655	117,681	1,478	1,799	1,377	0.01	0.02	0.05	171.4	59.7	3,600
2009	5,552	123,233	1,763	2,146	1,642	0.01	0.02	0.05	174.9	60.9	3,673
2010	4,912	128,145	1,560	1,898	1,453	0.01	0.02	0.05	180.2	62.8	3,785
2011	4,994	133,139	1,586	1,930	1,477	0.01	0.02	0.05	184.0	64.1	3,864
2012	6,282	139,421	1,995	2,428	1,858	0.01	0.02	0.05	187.8	65.4	3,944
2013	4,417	143,838	1,828	1,083	1,506	0.01	0.02	0.05	194.3	67.6	4,080
2014	5,054	148,892	2,092	1,239	1,723	0.01	0.02	0.05	196.6	68.4	4,128
2015	4,387	153,279	1,816	1,076	1,496	0.01	0.02	0.05	200.2	69.7	4,204
2016	5,494	158,773	2,274	1,347	1,873	0.01	0.02	0.05	202.2	70.4	4,245
2017	5,548	164,321	2,296	1,360	1,891	0.01	0.02	0.05	206.5	71.9	4,336
2018	5,603	169,924	2,319	1,374	1,910	0.01	0.02	0.05	210.8	73.4	4,426
2019	5,663	175,587	2,344	1,388	1,930	0.01	0.02	0.05	215.0	74.9	4,515
2020	5,722	181,308	2,368	1,403	1,950	0.01	0.02	0.05	219.1	76.3	4,602
2021	5,781	187,089	2,393	1,417	1,971	0.01	0.02	0.05	223.3	77.7	4,689

Sources:
-Landfill Gas Generation Assessment Procedure Guidance Report, Conestoga-Rovers & Associates, March 2009
-Tonnage data obtained from 1987 to 1997: Estimate by CRA based on population, in Landfill Gas Generation Assessment Report dated June 2012
-Tonnage data obtained from 1997 to 2016: From Site waste receipts, as provided by CSRD
-Tonnage data obtained from 2017 to 2021: Estimated based on rate of increas of tonnage from six years previous
-Waste composition data from 1987 to 2012: 2006 Waste Composition Study
-Waste composition data from 2013 to 2021: 2013 Waste Composition Study

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