XCG CONSULTING LIMITED
T 780 432 5770 | edmonton@xcg.com
10455 - 84th Avenue, Edmonton, Alberta, Canada T6E 2H3

XCG File No. 4-2111-01-48
December 20, 2017

DESIGN, OPERATIONS, AND CLOSURE PLAN
SECHELT LANDFILL
SECHELT, BRITISH COLUMBIA

Prepared for:

SUNSHINE COAST REGIONAL DISTRICT (SCRD)
1975 Field Road
Sechelt, British Columbia
V0N 3A1

Attention: Ms. Robyn Cooper
Manager, Solid Waste Services

Breanna Martin, B. Sc., E.I.T.
Project Specialist

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
C. C. STONE
#40258
2017-12-20

Chloe Stone, B. Sc., P.Eng.
Project Engineer

ES 1. EXECUTIVE SUMMARY

XCG Consulting Limited (XCG) was retained by the Sunshine Coast Regional District (SCRD) to prepare a Design, Operations and Closure Plan (DOCP) for the Sechelt Landfill (Site). This DOCP has been prepared in accordance with the design, performance, and operational requirements of the Operational Certificate No. 106060 (OC) for the Site, and in general accordance with relevant British Columbia Ministry of the Environment (BC MOE) acts, regulations, and guidance documents. This document was developed based on an integrated development strategy which incorporates surface water, leachate, and landfill gas management controls into the landfill development plan to mitigate landfill derived impacts.

The key objectives of this document are to:

- Provide an updated fill plan which addresses the need to reduce leachate generation, optimize surface water controls and optimize available landfill airspace;
- Provide a closure plan including implementing a low permeability cover system;
- Provide a post-closure plan for the landfill; and
- Reduce long-term environmental impacts associated with the landfill area.

The resultant DOCP is a comprehensive and integrated design document which addresses all of the aforementioned objectives. The DOCP includes a detailed development strategy for the existing landfill footprint, providing approximately 172,800 cubic metres of airspace. Based upon population growth projections and fill rate assumptions presented herein, it is estimated that the Site will reach design capacity in 2025.

TABLE OF CONTENTS

TABLES

FIGURES

DRAWINGS

APPENDICES

1. INTRODUCTION

XCG Consulting Limited (XCG) was retained by the Sunshine Coast Regional District (SCRD) to prepare a Design, Operations and Closure Plan (DOCP) for the Sechelt Landfill (Site).

This DOCP has been prepared in accordance with the design, performance, and operational requirements of Operational Certificate No. 106060 for the Sechelt Landfill (issued July 8, 2014) (OC), and in general accordance with the following British Columbia Ministry of the Environment (BC MOE) acts, regulations, and guidance documents:

- Landfill Criteria for Municipal Solid Waste (June 2016);
- Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills (2006);
- Environmental Management Act (July 2004); and
- Landfill Gas Management Regulation (December 2008).

The purpose of this document is to provide the SCRD with an updated DOCP that meets the following objectives:

- Adopt the requirements of the OC for the Site:
- Provide a physical summary that describes the physical setting, including geology, hydrogeology, hydrology, and climate conditions;
- Summarize historic Site operations which impact future development and connections for existing infrastructure (e.g. surface water management systems);
- Identify key infrastructure and environmental control elements and tie them in to the ongoing development and operation, expansion, and progressive closure of the Site;
- Develop a fill strategy for design capacity of the landfill that takes into consideration environmental controls [i.e. surface water, leachate, and landfill gas (LFG) management] and optimizes the available airspace to maximize Site life;
- Update the lifespan analysis table that projects the annual waste tonnage to be received, reused, recycled, and landfilled, and the annual air space consumed;
- Develop a surface water management strategy which can be practically implemented within the existing property boundary and ensure that surface water run on to the Site is not impacted by landfill operations;
- Assess the LFG production at the Site;
- Review and update the environmental monitoring program;
- Provide a contingency plan to address environmental impact concerns and other non-compliance issues;
- Provide a facilities operation plan;

- Develop an emergency response plan that documents strategies for dealing with emergencies at the site;
- Provide a progressive closure plan, including a contingency closure plan (including funding) to close the landfill prior to design capacity being achieved in the event that the landfill is no longer supported by future SCRD solid waste management plans or is closed for any other reason; and
- Provide a post-closure plan including maintenance and environmental monitoring program.

1.1 Site Description

The Site is located at 4901 Dusty Road, Sechelt, approximately 6.5 kilometres northeast of the village of Sechelt (Figure 1.1). The Site is located on Crown Land under License of Occupation No. 237204. The legal description of the Site is Block C, District Lot 7613, Group 1, New Westminster District.

The Site property is bounded to the north, east, and west by Crown Land (DL 7613), and to the south by Northcote Properties (DL 2464).

Further, it is noted that Lehigh Hanson Materials Limited owns the mineral rights and currently operates its Sechelt Mine on the land south and west of the Site, with future expansion options for the Crown Land east and north of the Site.

The Site comprises a non-hazardous solid waste landfill that accepts municipal solid waste from the District of Sechelt, Town of Gibsons, Sechelt Indian Government District, and all of the electoral areas in the Sunshine Coast Regional District. In addition, as of July 20, 2015, waste received at the Pender Harbour Transfer Station is landfilled at the Site. The landfill encompasses an area of approximately 7 hectares, within an overall Site area of approximately 9.5 hectares.

Existing facilities located at the Site include the following (Figure 1.2):

- Scale house and weigh scale;
- Recycling area;
- Contact water pond;
- Share shed;
- Public tipping area; and
- Maintenance shed.

Environmental controls were constructed in 2013 consisting of final cover over the north, east, and southeast slopes of the landfill, along with surface water controls for the Site. Surface water controls consisted of surface water ditching constructed on the east side of the site and along the south portion of the west side of the site, the addition of a stormwater pipe alignment discharging into Dusty Road Ditch on the west side of the site, and improvements to contact water detention pond and forebay on the west side of the site.

1.2 Background

The following represents a chronological sequence of the major historical events related to the development of the Site and municipal solid waste (MSW) management practices within the SCRD:

1971

- Operation of the Sechelt Landfill commenced, under a Ministry of Forests permit.

1973

- Level "B" Pollution Control Permit PR-02547 was issued to the SCRD by the Ministry of Environment, Lands and Parks (now the Ministry of Environment). The permit allowed for an authorized disposal quantity of 11.5 cubic metres per day from the Sechelt Townsite and surrounding area.

1985

- SCRD obtained an additional 4.8 hectares of land, increasing the total area of the Site to its current size of 9.5 hectares.
- Permit PR-02547 amended to reclassify the landfill as a Level "A" Permit with an authorized disposal quantity of 90 cubic metres per day. The service area for the Site was expanded to include Electoral Areas B, C, D, E, and F, as well as the District of Sechelt and Town of Gibsons.

1989

- Permit PR-02547 was amended as follows:
  - Allowed for the disposal of fish mortalities from fish farm operations and ash from open burning of selected non-putrescible waste;
  - Required a separate pit for the disposal of waste gypsum; and
  - Required an operating plan and surface water monitoring.

1993

- Permit PR-02547 was amended as follows:
  - Authorized discharge of 35 tonnes of waste per day;
  - Expanded service area to include District of Sechelt, Town of Gibsons, Sechelt Indian Government District, and all Regional District electoral areas;
  - Updated legal description for the Site;
  - Directed that only municipal solid waste, semi-solid waste, and organic sludges from sewage treatment plants, septic tanks, and holding tanks were acceptable for landfilling;
  - Directed that only digested sludge could be accepted;
  - Prohibited the landfilling of white goods, auto hulks, used tires, and used lead acid batteries;
  - Required management of recyclables and on-site composting;

  - Required installation of a weigh scale and groundwater monitoring wells; and
  - Require groundwater quality monitoring and assessment, a LFG assessment, a closure plan, maintenance of specified records at the landfill and preparation of annual reports.
- Ceased on-site composting of fish mortalities and by-products from fish processing plants due to odour and operational issues;
- Implemented tire and gypsum recycling;
- Installed nine groundwater monitoring wells along the perimeter of the Site; and
- Installed and commissioned weigh scale in July, 1993.

1994

- Implemented tipping fees for residential waste.
- Prohibited acceptance of undigested sludge from sewage treatment plants, package sewage treatment plants, and septic tanks.
- Introduced use of 40 yard roll-off bins for metal recycling.
- Replaced on-site burning of green waste and wood with onsite chipping.
- Implemented onsite Freon recycling.
- Installed six LFG monitoring stations.
- Permit PR-02547 amendment required the recycling of gypsum.
- The Sechelt Landfill included in the SCRD's Revised Solid Waste Management Plan operating under SCRD Bylaw No. 405.

1995

- Implemented cardboard and paint recycling.

1998

- Opened a reuse share shed.
- Opened special waste depot for flammables, pesticides, and gasoline recycling.

2013

- Environmental controls were constructed consisting of final cover over the north, east, and southeast slopes of the landfill.
- Two nested landfill gas monitoring probes were installed at the landfill.
- Two additional up-gradient groundwater monitoring wells were installed and added to the environmental monitoring program.
- Replaced three downgradient monitoring wells on the south boundary.

2014

- Operational Certificate 106060 was issued for the Site by the Ministry of Environment on July 8, 2014. The Operational Certificate included the following updates:

- Maximum rate of discharge of 15,000 tonnes per year; and
- Reporting requirements included a Design and Operating Plan, Geotechnical and Seismic Assessment, Hydrogeological Assessment, Landfill Gas Assessment, and Environmental Monitoring Plan.

2016

- Tarps added to northern half of the Stage A deck to minimize leachate generation.

2017

- Additional tarps added to Stage A deck to minimize leachate generation.

1.3 Previous Studies

The following reports were reviewed in support of the preparation of this DOCP:

- Braun Geotechnical Ltd., March 2013. "Sechelt Landfill Cover System Veneer Stability Assessment – Engineering Memo."
- Braun Geotechnical Ltd., April 2013. "Preliminary Geotechnical Report – Sechelt Landfill Slope Stability Assessment."
- Conestoga-Rovers & Associates Ltd., November 1994. "Sechelt Landfill – Gas Emissions and Migration Assessment (Draft)."
- Dayton & Knight Ltd., April 1995. "Sechelt Landfill – Groundwater Assessment."
- Dayton & Knight Ltd., December 1995. "Sechelt Landfill Closure Plan."
- Dillon Consulting Ltd., December 2014. "Waste Composition Audit - Sunshine Coast Regional District."
- Ecoplans, August 2010. "Hydrogeological and Environmental Monitoring Review Sechelt Landfill, Sunshine Coast Regional District."
- Golder Associates Ltd., October 2007. "Conceptual Contours at Landfill Closure – Sechelt Landfill, Sechelt, BC."
- Golder Associates Ltd., December 2008. "Final Reports on Sechelt Landfill and Biosolids Management Project – Sunshine Coast Regional District."
- Golder Associates Ltd., October 2007. "Review of Landfill Operations – Sechelt Landfill, Sechelt, BC."
- Piteau Associates Engineering Ltd., August 2007. "2005/2006 Annual Environmental Monitoring Review – Sechelt Landfill, Sunshine Coast Regional District."
- Piteau Associates Engineering Ltd., April 2009. "2007/2008 Annual Environmental Monitoring Review – Sechelt Landfill, Sunshine Coast Regional District."
- Sperling Hansen Associates, April 2002. "Sechelt Landfill Design and Operations Plan."

- Sunshine Coast Regional District, January 2005. "Sunshine Coast Regional District Revised Solid Waste Management Plan."
- XCG Consultants Ltd., July 2015. "Hydrogeological Characterization and Impact Assessment, Sechelt Landfill."
- XCG Consultants Ltd., December 2015. "Leachate Management Plan, Sechelt Landfill."
- XCG Consulting Limited, March 2016. "Landfill Gas Generation Supplementary Assessment Report, Sechelt Landfill."
- XCG Consulting Limited, September 2016. "Interim Stormwater Strategy, Sechelt Landfill."
- XCG Consulting Limited, March 2017. "2016 Annual Report, Sechelt Landfill."

2. REGULATORY SETTING

The following section provides an overview of the regulatory environment which governs landfill design, operations, and closure of the Site.

2.1 Provincial Regulations

There are currently four documents published by the BC MOE, which regulate landfill design, operations, and monitoring:

- Landfill Criteria for Municipal Solid Waste (June 2016);
- Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills (January 1996);
- Environmental Management Act (July 2004); and
- Landfill Gas Management Regulation (December 2008).

Key elements of these documents, addressed in the DOCP, are as follows:

Landfill Criteria for Municipal Solid Waste

This document applies to all MSW landfills. Sections 3, 5.2, 5.3, 5.4, and 5.5 of the criteria do not apply in this case. Key elements of the criteria which are applicable to this plan include:

- Current and planned future use of groundwater and surface water shall be identified within 1 kilometre of the landfill footprint. After considering the identified uses of groundwater and surface water, a Qualified Professional (QP) must recommend the appropriate water quality criteria, compliance locations, and provide related rationale and justification.
- As a minimum, the appropriate water quality criteria must be satisfied at and beyond the landfill site boundary, or 150 m from the landfill footprint, whichever is closer.
- At no time shall combustible gas concentrations exceed the lower explosive limit (LEL) (5 percent methane, on a volumetric basis) in soils at the property boundary, or 20 percent of the LEL (1 percent methane, on a volumetric basis) in any on-site structure or facility.
- Landfills exceeding 100,000 tonnes total capacity or receiving more than 10,000 tonnes of waste per year, are to submit a Landfill Gas Generation Assessment Report. Landfills determined to be generating more than 1,000 tonnes of methane per year are required to prepare a Landfill Gas Management Facilities Design Plan and to have a LFG management system in place four years after the plan submission.
- All components of a surface water management system, including stormwater retention ponds, are to be designed to promote settling of sediment and infiltration of retained storm water for groundwater recharge where possible.
- Surface water ditches and retention ponds shall be designed for the control and retention of a 1:100-year, 24-hour storm event.

- Surface water runoff generated from active landfill areas shall be managed as leachate. Run-on diversion ditches and other control structures are to be used where required to minimise clean surface water contact with active waste disposal areas.
- All ditch surfaces shall be armoured with appropriate protection to prevent erosion.
- All ditches are to maintain a minimum 1 percent grade to prevent sedimentation and maintain hydraulic design capacity. Ditches shall be designed to accommodate localized settlement (no grade reversals).
- Mid slope drainage ditches/swales shall be constructed on the final cover surface as required to intercept run-off and prevent erosion of final cover soils. The recommended spacing of such ditches is every 15 metres (vertical separation).
- The minimum final cover shall consist of a barrier layer (soil or geomembrane), providing a maximum hydraulic conductivity of 1×10^{-5} cm/sec for landfill sites located in arid and semi-arid regions and 1×10^{-7} cm/sec for landfill sites located in non-arid regions.
- The final cover soil barrier layer shall have a minimum compacted thickness of 0.6 metres measured perpendicular to the slope with a minimum 0.15 metre topsoil layer capable of establishment and sustained growth of the vegetative cover.
- The final cover using geomembrane as the barrier layer shall have a geomembrane or geocomposite equivalent to 1×10^{-7} cm/sec, with a geotextile (or sand) protection layer, with a minimum 0.45 metre common fill layer and minimum 0.15-metre topsoil layer capable of establishment and sustained growth of the vegetative cover.
- Final contours of the landfill shall be constructed at grades not steeper than 3H:1V (33 percent). The recommended design criteria for the top plateau of the landfill is a slope not less than 10H:1V (10 percent) for cover systems using a soil barrier layer. The grade for the top plateau can be reduced up to 25H:1V (4 percent) for cover systems using a durable geomembrane or composite barrier layer with an overlying drainage layer above the final landfill side slope.
- Security fencing shall be established around the entire perimeter of the operational footprint of the landfill. Minimum fence requirement is 1.2 metres post and wire fence. Where vehicle access is possible a minimum 2 metre chain link fence is recommended. Entrance gates shall have vandal proof locking mechanisms and shall be locked outside of landfill operating hours.
- Access roads shall be a minimum of 4 metres wide for one lane and 7 metres wide for two lanes.
- Roads for public and commercial traffic shall not exceed 8 percent grade.
- Roads for construction / internal off-road equipment traffic shall not exceed 15 percent grade.
- The landfill must be designed to satisfy the operation criteria in regards vector and wildlife management and nuisance controls.

Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills

These guidelines are intended to assist landfill owners and operators to design and implement an environmental monitoring program as required by the "Landfill Criteria for Municipal Solid Waste." Key elements of the guidelines are as follows:

Groundwater

Groundwater monitoring should include the following items:

- The location and installation of monitoring wells should address both existing and anticipated site development, including any predicted changes in groundwater flow;
- Up-gradient and down-gradient monitoring wells should be sampled at quarterly intervals as a minimum;
- The routine parameters monitored in groundwater include pH, redox potential, dissolved oxygen, specific conductivity, metals, ammoniacal nitrogen, chloride, and chemical oxygen demand; and
- For the monitoring of metals, the Environmental Protection Agency (EPA) recommends the following be monitored regularly; antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, nickel, selenium, silver, thallium, vanadium, and zinc.

Surface Water

Surface water monitoring locations should include the following locations:

- Upstream to establish background water quality;
- Immediately downstream to determine leachate impacts on water quality; and
- Downstream to document the extent of the mixing zone and distance required for the surface water to assimilate leachate and for water quality to recover to background levels.

Surface water should be monitored for pH, redo potential, specific conductance, temperature, and dissolved oxygen concentration.

Landfill Gas Management Regulation

The Landfill Gas Management Regulation applies to all regulated landfill sites that:

- Have 100,000 tonnes or more of municipal solid waste in place; or
- Receive 10,000 or more tonnes of municipal solid waste for disposal into the landfill site in any calendar year after 2008.

2.2 Landfill Operating Certificate

The landfill is currently approved to operate under Operating Certificate No. 106060 issued by the BC MOE on July 8, 2014. Key elements of this approval with respect to design, operation, and closure include the following:

- The maximum authorized rate of discharge is 15,000 tonnes per year.

- All refuse shall be confined to the smallest practical area and reduced to the smallest practical volume at the operating face of the landfill. A minimum of 0.15 metres of suitable cover material shall be applied on all exposed solid waste at the end of each day. The Regional Waste Manager may vary the frequency of covering when freezing conditions adversely affect normal operation.
- The operational certificate holder must take all practical measures to segregate for recycling and reuse of waste destined for disposal at this site. Recyclable materials must be managed in a manner to not cause pollution and in accordance with the Environmental Management Act and its regulations.
- Waste must not be discharged into water or within a buffer zone. The burning of waste is also prohibited.
- Soil meeting the commercial land use standard as set forth in the Contaminated Sites Regulation, may be utilized for berm construction, daily, intermediate, and final cover, top dressing and landscaping. Soil with any substance with a concentration exceeding the lowest applicable numerical soil standard commercial land may only be used for internal berms, or daily or intermediate cover.
- The operational certificate holder must apply final cover to any area of the landfill which will not receive any further waste. Final cover must be applied in accordance with the design and operating plan required and at a minimum must consist of a at least 1.0 metre of low permeability ($<1 \times 10^{-5}$ cm/s) compacted soil (or equivalent) cap plus a minimum of 0.15 metres of topsoil and suitable vegetative cover, or as approved by the Director.

A copy of the Operating Certificate is included as Appendix A.

3. REGIONAL AND SITE SETTING

3.1 Topography

The Site is located in the physiographic region referred to as the Georgia Lowlands which comprises the west coast of mainland British Columbia (Holland, 1976). The Site is located approximately 3 kilometres east of the Salish Sea and Sechelt Inlet (sea level). The Site is located on the north edge of a plateau at an approximate elevation of 200 metres above mean sea level (amsl). The majority of the plateau is used for aggregate extraction. From the plateau, the topography slopes steeply upward to the east toward the Coast Mountains.

The plateau is located on the drainage divide between the Irgens Creek watershed to the north and the Chapman Creek watershed to the south. As shown on Figure 1.1, the Site is located primarily within the Irgens Creek watershed.

Stormwater runoff from areas of the Site completed with final cover and interim final cover, as shown on Figure 1.2, is routed to the north and west by a series of ditches, pipes and culverts which discharge directly to the Dusty Road roadside ditch, which conveys water westward eventually draining into Irgens Creek. Irgens Creek runs in a westerly direction, eventually discharging to Porpoise Bay.

Stormwater run-off from active areas of the landfill is routed to the contact water pond which is allowed to infiltrate.

3.2 Hydrology

Surface water in the area of the Site drains from the northeast to the southwest, towards Chapman Creek, which runs in a southwesterly direction. Irgens Creek, which runs in a westerly direction, is located north of the landfill, as shown on Figure 1.1.

Stormwater runoff from areas of the Site completed with final cover and interim final cover, as shown on Figure 1.2, is routed to the north and west by a series of ditches, pipes and culverts which discharge directly to the Dusty Road roadside ditch, which conveys water westward eventually draining into Irgens Creek. Irgens Creek runs in a westerly direction, eventually discharging to Porpoise Bay.

Stormwater run-off from active areas of the landfill is routed to the contact water pond which is allowed to infiltrate.

3.3 Geology

The Georgia Lowlands is underlain by granitic rocks as well as by inliers of older formations (Holland, 1976). Geologic mapping indicates that locally the Site is underlain by a granodiorite intrusive rock (BCGS, 2013).

According to the Geological Survey of Canada Surficial Materials of Canada Map 1880A, the Site is located on the boundary between surficial deposits consisting of till veneer (thin and discontinuous till, may include extensive areas of rock outcrop) to the north, and lag (sand, gravel, and pockets of finer sediment) to the south (Fulton, 1995).

Greater detail is provided by Surficial Geology and Sand and Gravel Deposits of Sunshine Coast, Powell River, and Campbell River Areas, Bulletin 65" which indicates that:

- Surficial deposits on and south, east and west of the Site are comprised of cobbles, gravel, sand, and silt (Capilano Sediments fluvial deltaic fan and channel deposits). The Capilano deposits are the sites of most of the aggregate pits in the area;
- Surficial deposits on and north of the Site are comprised of till which extends for approximately 1,000 metres (Vachon Drift ground moraine deposits); and
- Surficial deposits north of the till consist of bare rock with thin patches of overburden (McCammon, 1977).

Records for water wells nearest the Site indicate that overburden, consisting of sand and gravel with cobbles, with a layer of till or compact to dense silt (at various depths), extends to a depth of 60 to 120 metres below ground surface (bgs).

Overburden at the Site is comprised of silty sand and gravel to a maximum depth of 32 metres bgs. A dense silt (bouldery) till layer of varying thickness is present in the majority of deep boreholes from approximately 14 to 23 metres bgs. The dense silt till layer was not present, or was not noted, at deep boreholes located in the southeast portion of the Site (MW99-9, MW13-1, and MW9) (XCG, 2015a).

3.4 Geotechnical and Seismic Assessment

A veneer stability assessment of the proposed cover system for the Sechelt Landfill was conducted by Braun Geotechnical Ltd. (BGL) and submitted to XCG in the engineering memo, "Sechelt Landfill Cover System Veneer Stability Assessment," (BGL, 2013) and is included in Appendix E.

The proposed cover system comprises of 300 millimetres of topsoil, over a minimum 500 millimetres of till-fill over 50 LL Supergripnet geomembrane, over 300 millimetres of sand, over a minimum 100 millimetres thick existing cover, underlain by municipal solid waste. Stability under seismic loading conditions was carried out using a design horizontal acceleration of 0.222g associated with an earthquake event with a return period of 1 in 475 years (10% probability in 50 years).

As reported by BGL, the static factor of safety was determined to be 1.5, well above the 1.3 factor of safety generally accepted. Based on available site information, no stability concerns are anticipated for static and design seismic condition. The assessment also revealed that localized shallow sloughing may occur on surficial soils, especially under periods of extended rainfall prior to vegetation becoming established on the topsoil surface.

Additionally, a geotechnical exploration and slope stability assessment for the Site was also conducted by BGL to evaluate the stability of the proposed final grades (3H:1V and localized areas of 2.6H:1V) of the landfill for static and seismic loading conditions. The findings were included in the report, *"Preliminary Geotechnical Report – Sechelt Landfill Slope Stability Assessment – Sechelt Landfill,"* (BGL, 2013) and submitted to XCG. The assessment was completed in accordance

with the Landfill Criteria for Municipal Solid Waste (BC MOE, 1993), and included in Appendix F. The geotechnical work included:

- Review of available Site information;
- Site walkover review;
- Test pit exploration; and
- Review of geometry and cross section information provided by XCG.

Stability under seismic loading conditions was carried out using a design horizontal acceleration of 0.222g associated with an earthquake event with a return period of 1 in 475 years (10% probability in 50 years) for the proposed cover system. The results of the analysis completed by BGL indicated a static factor of safety greater than 1.3, which is the considered to be within an acceptable range for shallow sloughing type failure. The result of the seismic slope formation for the pseudo-dynamic analysis estimated the median permanent displacements along the slip surface from seismic loading at 15 centimetres. This is less than the typical acceptable limit of 30 centimetres.

3.5 Hydrogeology

Groundwater in the vicinity of the Site is reported to flow in a dominantly southward direction, along the surface of the compact silt. A groundwater investigation (Dayton & Knight, April 1995) indicated that there could potentially be a groundwater flow direction divide near the centre of the landfill which directs flow into minor westerly and easterly components. The groundwater investigation determined that depth to groundwater ranged from 2.5 metres bgs in the southwest corner of the Site, to over 16 metres bgs along the eastern property boundary.

Regionally, the Site is located within an area that has not been mapped or classified in the British Columbia aquifer classification system. This is likely due to the low number of residences, large area used for aggregate mining, and low usage of groundwater for drinking water in the area.

The area approximately 2 kilometres northwest of the Site is a classified aquifer. The aquifer is #566 and is classified as IIIA (lightly developed, high vulnerability) and ranked for hydrogeologic and water use as a 9 in a range of 1 to 25.

According to British Columbia water wells records, the nearest water wells to the Site are located approximately 1.7 kilometers west of, and cross-gradient to, the Site. The records for water wells near the Site indicate that the wells are completed in overburden at a depth ranging from 60 to 90 metres bgs, and groundwater is located at a depth of approximately 30 metres bgs.

Groundwater levels in the on-Site monitoring wells are monitored on a quarterly basis as part of the Environmental Monitoring Program to determine the depth to the water table, water table elevation, and the approximate direction of groundwater flow.

Based on the Site geology and the groundwater levels, perched groundwater appears to be present at the Site on top of the dense silt till layer (confining layer) from a depth of approximately 1 to 14 metres bgs (Piteau, 1999). The perched groundwater is

reflected in the water levels for monitoring wells where the confining layer is present, or monitoring wells instrumented above the confining layer. The perched groundwater appears to be relatively continuous at an elevation of approximately 210 masl (Piteau, 1999). Historic groundwater elevations indicate seasonal fluctuations which are more pronounced in monitoring wells instrumented in the perched aquifer.

Locally, groundwater flows along the bedrock surface from a depth of approximately 21 to 27 metres bgs (Piteau, 1999). The bedrock groundwater is reflected in the water levels for monitoring wells where the confining layer is not present, or monitoring wells instrumented below the confining layer. Groundwater is anticipated to concentrate along low points in the bedrock surface and flow in the direction of the bedrock surface gradient (Piteau, 1999). The bedrock groundwater elevation at the Site ranges from approximately 190 to 200 masl.

Groundwater levels measured as part of the monitoring program indicate that the perched groundwater beneath the Site flows in a dominantly south to south-westerly direction. It is anticipated that as perched groundwater migrates to the south it will percolate down to the bedrock aquifer. According to Ecoplans Ltd. (2010), vertical gradients between the shallow and deep monitoring wells indicate a strong downward gradient.

Measurement of leachate levels in LFG extraction wells EX1 and EX2 (Figure 1.2) in 2015 indicate that leachate is located from 10 to 12 metres below the landfill surface, and is mounded approximately 10 metres above the prevailing ground surface and approximately 15 metres above the perched groundwater (XCG, 2015a). This leachate mounding may cause radial groundwater flow in the perched groundwater around the perimeter of the landfill which may result in impacts to groundwater near the limit of waste.

3.6 Receptors

The primary environmental receptors include potential downstream uses of either surface water or groundwater, and the on-site buildings and adjacent property owners with respect to LFG.

As presented in Section 3.2, Chapman Creek, situated 1.5 kilometres south of the landfill, is the only surface watercourse located downstream of the Site.

3.7 Climate

The annual precipitation (Table 3.1) was approximated for the Site from Gibsons, British Columbia. Precipitation is reported to be approximately 1,355 millimetres with a mean annual temperature of 10.5 degrees Celsius (Environment Canada, Climate ID 1043152).

3.8 Leachate Management

Since its inception, the landfill has been operated as a natural control (attenuation) landfill. At present, there are no leachate controls at the Site. Considering that the Site will continue to operate within the existing limit of waste (i.e. no lateral expansion which would increase the waste footprint), and the lack of municipal infrastructure to

support leachate collection (nearby sanitary sewer), the Site shall continue to operate as an attenuation landfill with the primary focus being on source control/surface water management to reduce leachate generation potential.

3.9 Landfill Gas Management

There is currently no LFG management system on-Site.

4. DESIGN CRITERIA

The following section presents an overview of the design criteria, summarized in Table 4.1, that were used to prepare this DOCP. These criteria are consistent with the Landfill Criteria for Municipal Solid Waste (June 2016).

4.1 Design Constraints

The following design constraints were taken into account to prepare this DOCP:

- The final cover using geomembrane as the barrier layer shall have a geomembrane or geocomposite equivalent to 1 x 10^{-7} cm/sec, with a geotextile (or sand) protection layer, with a minimum 0.45 metre common fill layer and minimum 0.15-metre topsoil layer capable of establishment and sustained growth of the vegetative cover;
- Maximum 3 horizontal to 1 vertical slope (33 percent);
- Minimum slope at final closure of 10 percent, 4 percent is acceptable for cover systems using a durable geomembrane or composite barrier layer with an overlying drainage layer above the final landfill side slope;
- Maximum access road grade of 8 percent;
- Minimize leachate generation; and
- Address surface water control to reduce run-on from upstream areas, improve landfill operations, reduce leachate generation potential, and reduce the amount of groundwater recharge in the vicinity of the Site.

4.2 Area Served and Population

The Site accepts waste from the entire Sunshine Coast Regional District. Historically, the Site service area accounted for approximately 89.5 percent of the total population of the SCRD, and the remaining 10.5 percent was serviced by the Pender Harbour Landfill. In July of 2015 the Pender Harbour Landfill was closed and converted into a transfer station.

Total historic populations and future estimated populations for the SCRD are provided by BC Stats through the Ministry of Finance and Corporate Development, for the years of 1986 through 2036. Based on this data, the service area for the Site has an estimated population of approximately 29,243 in 2016.

Population data is provided in Table 4.2.

4.3 Waste Characterization

4.3.1 Waste Tonnage

Historic and future waste tonnages for the Site can be found in Table 4.2. These waste tonnages were estimated based upon the following factors:

- Between the years of 1971 and 1977, waste tonnages are assumed to be negligible due to waste burning practices;

- Between the years of 1977 and 1994, waste tonnages provided by Golder Associates Ltd. (February, 2008) "Inventory of Greenhouse Gas Generation from Landfills in British Columbia;"
- Tonnages of waste for the years of 1995 to 2016 were provided by the SCRD;
- After 2016, it was estimated that the landfill service population would generate a rate of 0.43 tonnes of solid waste per person per year (based on the actual waste generation rate for 2016); and
- No additional diversion is expected to take place, and waste generation was based on the status quo (conservative).

4.3.2 Waste Composition

An estimate of the waste composition for the Sechelt Landfill was carried out by Golder Associates Ltd in 2008, and Dillon Consulting Ltd. in 2014. A summary of the results from the study are presented in Table 4.3 and Table 4.4, respectively.

4.3.3 Waste Density

The apparent waste density was used to estimate landfill airspace consumption. The apparent waste density is not a true density, but is a relationship that represents the mass of waste that can be disposed in each cubic metre of landfill air space. The apparent waste density is a more accurate measure of the efficiency of landfilling since soil (used for daily and interim cover) is excluded from the tonnages used in the ratio. The apparent waste density is based on the comparison of the waste tonnage landfilled versus the air space consumed. Soil used as daily cover is excluded from the tonnage value since an increase in soil usage can increase the true density and provide a skewed representation of landfilling efficiency.

Efficient landfill compaction techniques employed at landfill sites utilizing waste compaction equipment typically attain an apparent waste density of 0.6 to 0.8 tonnes of waste per cubic metre of airspace consumed. This is comparable to a waste density of 600 to 700 kilograms of waste per cubic metre operating with very efficient cover soil usage. Alternative daily cover will be employed starting in early 2018 in the form of steel plates. Employing alternative daily cover and other efficiencies could increase the apparent density to as much as 1.0 tonne per cubic metre.

Based on a comparison of the November 30, 2015 and December 4, 2016 topographical contours, approximately 19,272 cubic metres of landfilled airspace was consumed at the Site in 2016. Based upon the reported 12,677 tonnes of waste which was landfilled in 2016, the apparent density for the waste is calculated to be 0.66 tonnes per cubic metre of landfill airspace.

4.3.4 Airspace Consumption

Using the annual air space consumption of approximately 19,272 cubic metres provides a monthly airspace consumption of approximately 1,606 cubic metres. It is important to ensure that the minimum size of active landfilling area provides a sufficient volume for a reasonable time period. Ideally, the active area will provide approximately one month of landfilling space.

Active area dimensions of 30 metres in length by 15 metres wide were chosen as follows:

- The width is based on allowing space for simultaneous unloading of two vehicles with adequate space between vehicles and access to the working face for the compactor and front end loader; and
- The length is kept to a minimum but still provides adequate space to turn around the compactor without accessing inactive areas.

4.4 Landfill Limit

The existing limit of waste is illustrated in Figure 1.2, and comprises an area of approximately 7 hectares. The existing conditions plan, derived from an aerial survey completed on December 4, 2016 by Aero Geometrics Ltd. forms the basis for the DOCP presented herein.

4.5 Buffer Zones

The permitted landfill area (property boundary) of the Site is shown on Figure 1.2, and encompasses an area of approximately 9.5 hectares.

The existing buffer zones (relative to the property boundary) for the landfill range from approximately 2 to 4.5 metres to the south, 10 to 98 metres to the west, 4 to 42 metres to the north, and 4 to 18 metres to the east.

The current buffer zones require that support facilities associated with site operations be concentrated in the undeveloped northwest corner of the property. These facilities include the following:

- Site entrance and access roads;
- Recycling area;
- Scale house and weigh scale;
- Maintenance shed;
- Share shed;
- Public tipping area;
- Equipment and haul roads; and
- Surface water management infrastructure.

4.6 Ingress/Egress

Access to the Site is provided from Dusty Road through the main gate located along the northern side of the Site.

5. SITE DEVELOPMENT

The following section provides a summary of the development plan from existing conditions illustrated on Drawing C-01 through to final contours illustrated on Drawing C-08. Typical details for infrastructure and controls included in the development of the Site are presented on drawing D-01.

5.1 Existing Conditions

Existing conditions presented on Drawing C-01 illustrates the site conditions as of December 4, 2016 and were used as the basis for generating the drawings presented herein. Drawing C-01 illustrates the existing contours and surface water controls which form the basis of the DOCP drawings as well as the current infrastructure.

5.2 Key Development Considerations

Based on the design criteria presented in Section 4.0 and an assessment of the on-site infrastructure, the following key development issues were identified, which are addressed in the development sequence:

- Optimize available airspace;
- Minimize active area size and reduce infiltration by filling a small area to final contours, and completing areas with interim or final cover as soon as possible;
- Construct surface watercourses early in the development to collect and direct stormwater run-off away from the landfill footprint;
- Reduce leachate generation; and
- Implement an appropriate surface water management plan to improve surface water quality leaving the Site.

The proposed final development contours are illustrated on Drawing C-08.

Adequate global static slope stability of the waste mass during the active operational phase shall be maintained by ensuring that final grades and temporary slopes on the active phase are maintained at or below 33 percent (i.e. 3 to 1) as per the Landfill Criteria for Municipal Solid Waste. In addition, source reduction of water infiltration into the waste mass shall be optimized, thereby reducing the risk of leachate mounding, by implementing progressive closure.

In the event of a seismic event resulting in slope deformation prior to the final closure of the slope, the landfill owner shall regrade the slope and remediate the intermediate cover system as soon as possible.

5.3 Footprint and Buffer Zones

The proposed final limit of waste (landfill footprint) illustrated on Figure 5.1 will remain consistent with the existing limit of waste, with a total area of 7 hectares. Therefore, the proposed buffer zones will also remain unchanged.

5.4 Fill Progression

The following section provides a narrative description of the fill sequence illustrated on Drawings C-02 to C-08. As indicated previously, the existing conditions and start of development are based on topographical surveys completed in December 2016. The contours for each stage are representative of the landform at the end of that stage. An apparent density of 0.66 is assumed for the remainder of the Site life. This is consistent with what was calculated for apparent density in the 2016 Annual Report (XCG, 2017). The apparent density is expected to increase with the implementation of steel plates as alternative daily cover in early 2018; however, site life estimates have been estimated using the 2016 apparent density for the Site to provide a more conservative representation.

Based on the existing Site conditions presented on Drawing C-01 and the proposed final contours presented on Drawing C-08, the total remaining landfill capacity (airspace) is estimated to be 172,800 cubic metres as of the beginning of December 2016. Currently, landfilling is occurring in a combination of Stage F and Stage G.

The Site life calculations presented herein are based on an apparent waste density of 0.66 tonnes of waste per cubic metre of airspace. Daily/intermediate soil requirements were estimated based on waste to soil ratio of 4:1.

Based on the design concept, fill plan, and density parameters presented herein, a development summary for each development phase is presented in Table 5.1.

5.4.1 Stage F

The proposed Stage F contours and works are presented on Drawing C-02. The objectives of this stage of the development sequence are as follows:

- Fill the western portion of the landfill; and
- Promote positive drainage off the landfill.

These objectives will be achieved by implementing the following:

- Landfilling will take place in the western portion of the Site; and
- Waste will be landfilled in order to construct a slope of 33 percent (3H:1V).

In conclusion, this stage will:

- Provide 10,800 cubic metres of air space;
- Accept 7,128 tonnes of waste;
- Require approximately 2,160 cubic metres of daily/intermediate cover; and
- Provide approximately seven months of Site life.

5.4.2 Stage G

The proposed Stage G contours and works are presented on Drawing C-03. The objectives of this stage of the development sequence are as follows:

- Fill the central portion of the landfill; and

- Promote positive drainage off the landfill.

These objectives will be achieved by implementing the following:

- Landfilling will take place in the central portion of the Site; and
- Waste will be landfilled in order to construct a slope of 33 percent (3H:1V).

In conclusion, this stage will:

- Provide 21,600 cubic metres of air space;
- Accept 14,256 tonnes of waste;
- Require approximately 4,320 cubic metres of daily/intermediate cover; and
- Provide approximately 13 months of Site life.

5.4.3 Stage H

The proposed Stage H contours and works are presented on Drawing C-04. The objectives of this stage of the development sequence are as follows:

- Fill the central portion of the landfill;
- Promote positive drainage off the landfill; and
- Decrease leachate generation.

These objectives will be achieved by implementing the following:

- Landfilling will take place in the central portion of the Site;
- Waste will be landfilled in order to construct a slope of 33 percent (3H:1V); and
- Construct final cover on portions of the north, west and south slopes of the Site.

In conclusion, this stage will:

- Provide 42,700 cubic metres of air space;
- Accept 28,182 tonnes of waste;
- Require approximately 8,540 cubic metres of daily/intermediate cover;
- Require approximately 18,420 square metres of final cover; and
- Provide approximately 26 months of Site life.

In addition, the temporary interior stormwater ditch along the southwest corner of the landfill will be filled in during construction of the final cover and the exterior ditch will be directed to the contact water pond on Site. It is anticipated that final grade for Stage H will be reached in fall 2020. Construction of the final cover for Stage H will occur during summer 2021.

5.4.4 Stage I

The proposed Stage I contours and works are presented on Drawing C-05. The objectives of this stage of the development sequence are as follows:

- Fill the central portion of the landfill; and

- Promote positive drainage off the landfill.

These objectives will be achieved by implementing the following:

- Landfilling will take place in the central portion of the Site; and
- Waste will be landfilled in order to construct a slope of 33 percent (3H:1V).

In conclusion, this stage will:

- Provide 28,200 cubic metres of air space;
- Accept 18,612 tonnes of waste;
- Require approximately 5,640 cubic metres of daily/intermediate cover; and
- Provide approximately 17 months of Site life.

5.4.5 Stage J

The proposed Stage J contours and works are presented on Drawing C-06. The objectives of this stage of the development sequence are as follows:

- Fill the central portion of the landfill; and
- Promote positive drainage off the landfill.

These objectives will be achieved by implementing the following:

- Landfilling will take place in the central portion of the Site; and
- Waste will be landfilled in order to construct a slope of 33 percent (3H:1V).

In conclusion, this stage will:

- Provide 25,400 cubic metres of air space;
- Accept 16,764 tonnes of waste;
- Require approximately 5,080 cubic metres of daily/intermediate cover; and
- Provide approximately 15 months of Site life.

In addition, Stage J will require the removal of the temporary Type A and Type B LFG extractions wells on the central portion of the Site, as well as the tarps used as interim cover.

5.4.6 Stage K

The proposed Stage K contours and works are presented on Drawing C-07. The objectives of this stage of the development sequence are as follows:

- Fill the central portion of the landfill; and
- Promote positive drainage off the landfill.

These objectives will be achieved by implementing the following:

- Landfilling will take place in the central portion of the Site; and
- Waste will be landfilled in order to construct a slope of 33 percent (3H:1V).

In conclusion, this stage will:

- Provide 24,700 cubic metres of air space;
- Accept 16,302 tonnes of waste;
- Require approximately 4,940 cubic metres of daily/intermediate cover; and
- Provide approximately 14 months of Site life.

5.4.7 Final Stage

The proposed Final Stage contours and works are presented on Drawing C-08. The objectives of this stage of the development sequence are as follows:

- Fill the central portion of the landfill;
- Promote positive drainage off the landfill; and
- Decrease leachate generation.

These objectives will be achieved by implementing the following:

- Landfilling will take place in the central portion of the Site;
- Waste will be landfilled in order to construct a slope of 33 percent (3H:1V) up until elevation 238 masl, and a slope of 10 percent (10H:1V) for elevation 240 masl; and
- Construct final cover on the central portion of the Site.

In conclusion, this stage will:

- Provide 19,400 cubic metres of air space;
- Accept 12,804 tonnes of waste;
- Require approximately 3,880 cubic metres of daily/intermediate cover;
- Require approximately 28,800 square metres of final cover; and
- Provide approximately 11 months of Site life.

In addition, upon closure of the Site, the temporary stormwater diversion pipe diverting water from around the Phase 1 Closure area to Dusty Road shall be removed and all stormwater on site will be directed to the contact water pond on Site.

5.5 Cover

The following section provides an overview of the final cover design and design philosophy. Final cover will be completed on a progressive basis to fulfil the following objectives:

- Mitigate environmental risk (i.e. leachate generation and fugitive LFG emissions);
- Support post-closure land use; and
- Reduce long-term maintenance costs.

The final cover design is based on the following key criteria:

- Reduce leachate generation to mitigate potential off-site impacts; and
- Support the post-closure concept.

5.5.1 Final Cover

The proposed final cover is a composite final cover (Drawing D-01) composed of the following elements:

- Mixed vegetation;
- 150 millimetres organic soil;
- 500 millimetres native soil;
- Lateral drainage layer, consisting of DRAINTUBETM (a collection system consisting of small collection tubes surrounded by geotextile);
- Low-density polyethylene (LDPE) geomembrane;
- 300 millimetres sand (LFG collection layer); and
- 150 millimetres existing cover.

The final cover concept was developed to both reduce leachate generation in the landfill and to reduce the potential for off-site impacts. As a component of the final cover detailed design process, static and seismic stability analysis of the cover system was undertaken, the results of which can be seen in Section 3.4.

5.5.2 Daily Cover

Alternative daily cover (steel plates) will be used on a daily basis, weather permitting, with 0.15 metres of soil being used once a week.

Soil for daily cover should be granular and free draining in order to ensure a hydraulic connection throughout the waste mass (on-site native soil is considered appropriate for use as daily cover). Daily cover soil may be mixed with ground asphalt roofing and wood waste material.

Alternatively, finer grained, non-cohesive material could be utilized for daily cover with the provision that it is removed or scarified prior to placement of additional lifts of waste.

The efficient use of daily cover can result in an optimal waste to daily cover soil ratio of eight to one volume based on the use of soil one day per week and an alternative cover for the remainder of the week.

5.5.3 Interim Cover

Intermediate cover is constructed by placing an additional 150 millimetres of soil on areas that have already received 150 millimetres of daily cover. This provides 300 millimetres of soil to constitute intermediate cover for areas of the landfill that will be inactive for extended periods of time. If daily cover has not been placed or is not used, then 300 millimetres of soil will be placed to create the intermediate cover. The efficient operation of the Site will include the recovery (excavation and reuse) of

the top 150 millimetres of the intermediate cover soil. The recovered intermediate cover soil will be used for daily cover or future intermediate cover.

For the purpose of reducing leachate generation in interim closed areas, a lightweight woven LDPE laminated tarping system will be placed in conjunction with interim cover material (composite intermediate cover system) on slopes less than 10 percent grade. These tarps (typically available in 40 metre by 40 metre) can be placed manually by landfill operations staff and ballasted by the interim cover. The benefit of adopting such a composite interim cover system is the potential to substantially reduce leachate infiltration.

6. VOLUME AND SITE LIFE

6.1 Air Space

Total remaining landfill capacity (airspace) is estimated to be 172,800 cubic metres as of the beginning of December 2016.

6.2 Soil Balance

The following provides an estimate of the soil requirements for the completion of the filled areas and the development of the remainder of the Site. The soil required includes daily, interim, and final cover. A summary of the final cover soil requirements for the site or soil balance is provided in Table 6.1.

6.3 Design Site Life

Future waste tonnages for the Site were estimated based upon the 2016 waste deposition rate of 12,667 tonnes, an apparent waste density of 0.66 tonnes per cubic metre, BC Stat estimated future service populations, and a per capita waste generation rate of 0.43 tonnes per person per year. Based on these assumptions, the Site is estimated to reach design capacity in 2025. An airspace consumption summary and annual airspace consumption estimate is presented in Tables 6.2 and 6.3, respectively. Approximate completion dates for each stage are included in Table 5.1.

The remaining capacity and estimated site life should be reviewed annually as part of the Annual Operations and Monitoring Report described in Section 12.4.

- Options to maximize airspace include: The southwest corner of the Site, as well as the ditching around the contact water pond is currently underfilled. In order to maximize capacity, efforts could be made to regrade these areas to a 3:1 slope. These activities could potentially increase airspace by 2,500 cubic metres (approximately two months of filling at the current rate).
- Approximately, 11,000 cubic metres of airspace could be gained by filling in the ditch and forebay west of the Stage F filling area. This would amount to 11,000 cubic metres of airspace, lasting approximately six months. However, this option is not recommended because it would decrease the capacity of the pond which is already smaller than originally planned.
- Ensuring that grading along the road leading to the active face is graded to a 3:1 slope as the Site is being filled.

6.4 Contaminating Lifespan

The contaminating life span of the landfill cannot be accurately calculated at this time. A contaminating lifespan of 100 years will be assumed for the site based on the Landfill Criteria for Municipal Solid Waste (June 2016) for sites with less than 1,000,000 tonnes of municipal solid waste landfilled on-site. It is recommended that environmental monitoring and post-closure monitoring and maintenance be continued until concentrations measured at the Site are not considered a concern.

7. SURFACE WATER MANAGEMENT

7.1 Objectives

The goal of surface water management is to minimize the impact of the landfill on the downstream environment, while preserving the hydrologic cycle. These complimentary objectives can be achieved by taking into account the following design considerations:

- Development of surface water management works to control both the quality and quantity of surface water run-off;
- Control surface water run-off to minimize flow into the active disposal area in order to minimize surface water contacting waste; and
- Minimize the potential for on-site erosion and sediment loading to the downstream receiving watercourses.

Primary objectives of the surface water management plan are as follows:

- Convey run-off from active area to contact water pond;
- Convey run-off from closed areas off site to north Dusty Road ditch alignment prior to final closure; and
- Convey all surface run-off to the pond after final closure.

7.2 Hydrologic Model

The following section presents the results of the hydrologic modelling undertaken to prepare the DOCP. The purpose of this modelling was to ensure the above stated objectives were met, and that the Site infrastructure is properly sized to mitigate potential environmental impacts resulting from severe storm events.

7.2.1 Climatic Data

The Environment Canada rainfall intensity-duration-frequency (IDF) data set (Gibsons, British Columbia), presented in Appendix B, was used as the basis for the hydrological analysis presented herein.

7.2.2 Model Results

An analysis of the existing conditions and post development surface water run-off flow rates and total run-off volumes was undertaken utilizing the Hydraulic Engineering Centre – Hydraulic Modelling System (HEC-HMS). The sub-catchments for the existing Site conditions and post-development Site conditions are presented on Figures 7.1 and 7.2, respectively. As shown in Table 7.1 the proposed design meets the objective of reducing post-development peak flow. The detailed analytical results are included in Appendix B.

7.3 Existing Drainage

Existing surface water drainage systems are based upon the following primary flow paths (Figure 7.1):

- Run-off from the western interim closed portion of the Site is directed via a combination of ditches and culverts to a contact water pond on the western portion of the Site;
- Run-off from the active face is directed via ditches and culverts to the contact water pond;
- Run-off from the public tipping area drains into a catch basin. The surface water is then conveyed to the contact water pond;
- Run-off north of the perimeter fence runs into a ditch along Dusty Road;
- Run-off south of the limit of waste is contained by a soil stock pile located immediately south of the fence structure;
- Run-off from the Phase 1 Closure Area, north of the haul road, is directed via a combination of ditches and culverts into a ditch along Dusty Road;
- Run-off from the Phase 1 Closure area, southern and eastern extents, is directed via a combination of ditches and culverts around the perimeter road into a ditch along Dusty Road west of the Site;
- Run-off from the south central interim closed portion of the site is directed via a combination of ditches and culverts around the perimeter road into a ditch along Dusty Road west of the Site; and
- Run-off from the interim closed tarped area is directed via a combination of ditches and culverts around the perimeter road into a ditch along Dusty Road west of the Site.

7.4 Existing Drainage Stage F/G

Existing drainage represents anticipated worst case conditions due to the construction of perimeter ditching and bare soil conditions in the interim closed area (high runoff velocities, little to no reduction in runoff volumes due to evapotranspiration). The retention capacity of the contact water pond is approximately 5,200 cubic metres, though once the pond reaches approximately 3,500 cubic metres water will begin to flow through the emergency overflow pipe which discharges into Lehigh property. Under existing conditions, the contact pond will begin to discharge through the emergency overflow pipe in the event of a 1:100 year storm after reaching 3,500 cubic metres.

7.5 Post-Development Drainage

Post-development surface water management is based upon the diversion of surface water flow to the surface water pond (previously the contact water pond prior to closure) situated on the western portion of the Site. The proposed pond location is shown on Figure 7.2. The design retention capacity of the proposed pond will remain at approximately 5,200 cubic metres. The emergency overflow pipe discharging to Lehigh property will be slightly raised, and a new overflow pipe from the pond to the ditching on Dusty Road will be constructed at its previous elevation, thus maintaining the pond's capacity of 3,500 cubic metres before discharge occurs. Under post-closure

conditions, the contact pond can handle the estimated 2,787 cubic metres of flow represented by the 1:100 year storm event.

8. LEACHATE MANAGEMENT

8.1 Objectives

The objectives of leachate management are to minimize the impact of landfill operations on the environment (e.g. groundwater and surface water courses) and improve the performance of environmental controls. These objectives can be achieved by taking into account the following design considerations:

- Minimize off-site migration of leachate; and
- Minimize the amount of water percolating/infiltrating into the waste mass.

The site is operated as a natural attenuation landfill with no engineered leachate management systems in place. Considering that the site will continue to operate within the existing limit of waste, (i.e. no lateral expansion which would increase the waste footprint) and the lack of municipal infrastructure to support leachate management, the site shall continue to operate as an attenuation landfill with the primary focus being on source control/surface water management to reduce leachate loading. As discussed in this section, the primary source control measures to be implemented to reduce infiltration shall be progressive closure of the Site with a composite cover system.

8.2 Leachate Overview

Leachate is defined by the BC MOE as any liquid which has percolated through or drained from a municipal solid waste disposal facility (BC MOE, 2016). The generation of leachate is dependent on a number of factors including the amount of precipitation, the landfill area footprint, degree of saturation of the waste mass, and the various stages of landfill development (e.g. areas within the landfill footprint covered with daily cover, interim cover, and final cover and their respective grades).

In order to estimate the amount of annual precipitation at the Site, meteorological data for the region was obtained from Environment Canada. As indicated in Section 3.8 and Table 3.1, the total annual precipitation in the vicinity of the Site is approximately 1,355 millimetres.

It is generally assumed that all precipitation, which infiltrates through the landfill cover (daily, intermediate, and final cover), will constitute leachate once the Site has reached field capacity.

The field capacity is the moisture content beyond which any increases in moisture content will result in leachate generation. As a result, newly landfilled waste provides a large potential storage volume, resulting in delayed leachate generation.

8.2.1 Leachate Quality

The mass of waste stored in a landfill represents a finite source of pollutants, with the mass of pollutants available for leaching being largely a function of the physio-chemical nature of the waste, the extent of waste stabilization, and the volume of infiltration into the landfill (Lu et al., 1984).

Factors affecting the composition of leachate include the following (McBean et al., 1995):

- Solid waste composition;
- Age of waste;
- Landfill operations;
- Climate and hydrogeological conditions; and
- Conditions within the waste mass (e.g. moisture content, temperature, and pH).

Due to the fact that these factors vary significantly from cell to cell in a landfill, leachate characteristics can vary significantly.

Landfill leachate is typically composed of a number of elements, which generally include the following constituent elements:

- Organics;
- Nitrogen;
- Chlorides;
- Phosphates;
- Metals (e.g. iron, sodium, potassium, calcium, manganese, and zinc); and
- Dissolved solids.

8.2.2 Indicator Parameters

A number of leachate parameters can be used as indicators of leachate derived impacts associated with municipal landfills. Chemical constituents transported in landfill leachate are attenuated by numerous processes including dilution, dispersion, sorption, ion exchange, and biological degradation.

An indicator parameter of municipal waste derived impacts should ideally be a chemical which is subject to minimal affects attributed to attenuation so that it can signal the early migration of a leachate plume (i.e. a conservative chemical parameter). Chloride, an inorganic ion, is a preferred indicator parameter as it is typically present in landfill leachate at elevated concentrations and is attenuated only by dilution and dispersion.

8.3 Leachate Generation

Leachate generation is calculated using a water balance model which is a numerical modelling technique for estimating percolation through the cover system (e.g. daily, intermediate and final cover systems). The water balance model tracks moisture inputs (i.e. precipitation), soil moisture storage, moisture outputs and landfill surface factors which influence leachate generation (i.e. percolation).

The leachate generation potential was calculated for the existing conditions, final contours, and key development stages associated with progressive closure using the Hydrological Evaluation of Landfill Performance (HELP) Model (USACE, 1997) using site-specific climate data and the landfill vertical profile (layers). The HELP

model uses this information to compute runoff, evapotranspiration, percolation/leakage, leachate head, and lateral drainage values. The results of this analysis are summarized in Tables 8.1 and 8.2. Data output from the HELP model runs are included as Appendix C.

It should be noted that the estimates of infiltration generated by the HELP model are generally conservative, due to the fact that the model assumes that the Site has reached field capacity and the full amount of infiltration through the cover will generate leachate. These conservative estimates are used to ensure that the design of engineered controls is completed using maximum anticipated leachate generation rates.

As indicated in Table 8.1, areas of the landfill which are completed with daily cover are anticipated to generate an annual leachate volume of approximately 478 millimetres of infiltration per square metre of landfill area at a 3 percent slope, and 474 millimetres of infiltration at a 12 percent slope. The annual leachate generation rate in the areas of the landfill which are completed with interim cover is approximately 467 millimetres of infiltration at a 3 percent slope, 444 millimetres of infiltration at a 12 percent slope, and 448 millimetres of infiltration at a 33 percent slope. The annual leachate generation of the landfill haul road, at an 8 percent slope is 465 millimetres of infiltration.

Areas of the landfill completed with the proposed final cover are anticipated to generate an annual leachate volume corresponding to approximately 1 millimetre of infiltration at a 10 percent slope and a 33 percent slope over the area of final cover.

As shown in Table 8.2, the annual estimated volume of leachate generated under current conditions is approximately 24,851 cubic metres. The total volume of leachate generated at the Site will decrease to approximately 2,058 cubic metres per year upon final closure of the landfill. Estimated leachate generation rates at key stages of the landfill development (i.e. Stage H) associated with site regrading and progressive closure are also included in Table 8.2 for the purpose of demonstrating how the progressive closure strategy will result in reduced leachate generation.

8.4 Existing Leachate Controls

The landfill was designed as a natural attenuation Site and as such there are no existing leachate controls on Site.

8.5 Proposed Leachate Management Strategy

The proposed leachate management strategy will focus on source control (i.e. limit infiltration). As such, the fill plan presented herein will implement progressive closure of the site using interim and final cover (see Section 5.5.1).

8.6 Leachate Seepage

In the event that seepage is identified, the Site operations staff will immediately undertake remedial measures to contain the seepage, to prevent impacts to surface watercourses, and repair the cover (e.g. final, intermediate, or daily cover) in the area where seepage is observed.

In the event that leachate seepage has impacted surface watercourses, temporary controls, such as berming, should be implemented to prevent the migration of impacted surface water downstream. Where possible, the impacted surface water should be redirected into the active landfill area.

If the leachate seepage is deemed by operations staff to be substantial or chronic, prior to repairing the cover system, a vertical stone drain should be installed immediately up-gradient of the seep. This vertical stone drain is constructed by excavating through the uppermost lift of waste and the underlying soil (e.g. fire break or interim cover layer), to the underlying waste. This will provide a hydraulic connection to lower lifts of waste and allow the perched leachate to dissipate and prevent further seepage. The excavation is then backfilled with course stone to ensure the hydraulic connection to underlying waste is maintained upon completion of remediation measures. The cover is then restored using un-impacted soil and regraded to pre-seepage contours. A detail for repair of leachate seepage is provided on Drawing D-01.

9. LANDFILL GAS MANAGEMENT

9.1 Objectives

The objectives of LFG management are to reduce fugitive emissions, control odour, mitigate potential subsurface lateral migration, and reduce GHG emissions to the atmosphere.

9.2 Overview

LFG is composed of approximately 50 percent methane and 50 percent carbon dioxide (volumetric basis) and is produced in the landfill environment as a result of the biological decomposition of organic waste material. In addition, LFG is composed of trace gases, which may include nitrogen, oxygen, hydrogen sulphide, disulphides, mercaptans, and various volatile organic compounds (VOCs).

Municipal solid waste is composed of both organic and inorganic matter. The organic component of municipal solid waste is reported to contain approximately 40 to 50 percent cellulose, 10 to 15 percent lignin, 12 percent hemicellulose, and 4 percent protein (Booker and Ham, 1982), with cellulose and hemicellulose being readily biodegradable.

LFG is produced by bacterial decomposition, which occurs when organic waste is broken down by bacteria naturally present in the waste and in the soil used as daily, interim, and final cover. Organic wastes include food, garden waste, street sweepings, textiles, and wood and paper products. Bacteria decompose organic waste in the following four stages, as illustrated in Figure 9.1 (US EPA, 1997):

1. Aerobic, Non-Methanogenic;
2. Anoxic, Non-Methanogenic;
3. Anaerobic, Methanogenic, Unsteady; and
4. Anaerobic, Methanogenic, Steady.

The aerobic, non-methanogenic stage occurs at the time of waste placement with air entrained in the void spaces. The duration of this phase is short due to the limited air supply. The anoxic non-methanogenic phase results in an increase in carbon dioxide generation due to acid fermentation with hydrogen gas also being generated; however, it is generally consumed during the methanogenic stage. The anaerobic unsteady methanogenic phase marks the commencement of methane production in the waste mass with declining carbon dioxide production. The anaerobic steady methanogenic stage represents steady state methane and carbon dioxide production. Subsequent to the anaerobic steady methanogenic stage, methane and carbon dioxide production decline as the supply of organics in the waste mass is depleted.

It is noted that nitrogen and hydrogen sulphide may also be produced during the anaerobic decomposition phase with nitrogen being generated from the microbial process of denitrification and hydrogen sulphide being produced by sulphate reducing micro-organisms.

9.2.1 Conditions Affecting Landfill Gas Generation

The rate of LFG generation is a function of several key physical and environmental factors which include the following:

- Waste composition;
- Age of waste;
- Moisture content;
- pH;
- Temperature; and
- Nutrients.

Waste Composition:

The quantity of LFG generated per tonne of waste is a function of the quantity and quality of organic matter present in a landfill.

Age of Waste:

Generally, more recently buried waste produces more LFG through bacterial decomposition than does older waste.

Moisture Content:

The presence of moisture in a landfill increases gas production by encouraging bacterial decomposition. Moisture provides the aqueous environment necessary for anaerobic LFG production, as well as serving as a medium for the transportation of nutrients and bacteria.

pH:

The optimal pH for methanogenic bacteria is in the range of 6.7 to 7.5.

Temperature:

The anaerobic decomposition process, which occurs in the waste mass, is an exothermic process resulting in the elevation of temperatures. As the landfill's temperature rises, bacterial activity increases, resulting in increased gas production. Increased temperature may also increase rates of volatilization and chemical reactions. LFG temperature typically ranges from 30 to 60 ˚C.

Nutrients:

Bacteria in the waste mass require nutrients for development. The nutrients are primarily carbon, hydrogen, oxygen, nitrogen, and phosphorus. In general, the greater the quantity of nutrients, the greater the rate of gas generation.

9.2.2 Landfill Gas Characteristics

The following section provides an overview of the general characteristics of LFG as they pertain to the implementation of an LFG management plan and general health and safety issues. In general, these relevant characteristics are as follows (UK Environment Agency, 2002): density, solubility, flammability, asphyxiation, toxicity, corrosion, odour, ecotoxicity, and greenhouse gas emissions.

Density

The density of LFG is highly variable as a function of composition. The two dominant constituent elements of LFG (methane and carbon dioxide) have specific densities of approximately 0.72 kg/m^3 and 1.98 kg/m^3, respectively. Hence, depending upon the gas composition, LFG can either be lighter or heavier than air. As a result, LFG can accumulate in either low lying regions (e.g. utility vault boxes) or high regions (e.g. building roof peaks and attics).

It is further noted that gas stratification can occur under stagnant conditions, such as that present in monitoring wells or soil gas probes. This propensity for gas stratification, with methane accumulating at the top of a sealed enclosure must be taken into account when developing LFG monitoring protocols.

Solubility

The constituent elements of LFG can dissolve in aqueous solutions to varying degrees. Methane is only slightly soluble in water while carbon dioxide is significantly more soluble. As a result, LFG lateral migration generally only occurs in the vadose zone (unsaturated zone), above the groundwater table, with groundwater acting as a relatively impermeable barrier to the migration of methane.

Flammability

A primary constituent of LFG is methane which is a highly flammable gas. Methane gas is explosive in air at concentrations ranging from 5 percent on a volumetric basis (lower explosive limit or LEL) and 15 percent on a volumetric basis (upper explosive limit or UEL). The minimum oxygen content that is required for methane ignition is approximately 14 percent on a volumetric basis.

Asphyxiation

The accumulation of LFG in enclosed, confined spaces, or low lying regions with poor circulation (i.e. excavation trenches) can pose a risk to human health and safety due to the potential for asphyxia. This condition can result from the displacement of oxygen by LFG when its composition results in a gas which is denser than air.

Toxicity

Some constituents of LFG (both major and trace elements) can result in acute toxicity if exposure occurs at adequately high concentrations. These constituents include, but are not necessarily limited to, carbon dioxide, hydrogen sulphide, and vinyl chloride. It is noted that the trace elements typically do not represent a health hazard when LFG is diluted in the atmosphere (UK Environment Agency, 2002). However, carbon dioxide can have adverse physiological effects in concentrations exceeding 2 percent.

Corrosion

Some elements of LFG have the potential to cause corrosion. This potential should be taken into account when designing and specifying equipment and infrastructure at landfill sites. As indicated above, carbon dioxide is soluble in water and can form carbonic acid.

Odour

Trace elements present in LFG are responsible for some of the odours associated with landfill operations. LFG odours are primarily caused by hydrogen sulphide and mercaptan (thiol) compounds, which are present in trace quantities in LFG. These compounds may be detected by sense of smell at very low concentrations (0.005 and 0.001 parts per million, respectively).

Ecotoxicity

The lateral sub-surface migration of LFG can cause damage to vegetation and crop die-back (chlorosis) due to the displacement of oxygen in the soil and the resultant oxygen deprivation of the plant roots. Deterioration of vegetation on or near landfills may present both aesthetic and practical issues. In areas of the landfill cover system where vegetation is stressed or diminished, erosion may occur. This may result in a "cascade" effect, due to increased percolation through the cover system (resulting from decreased evapotranspiration), and increased moisture content in the waste mass, resulting in increased LFG emissions.

Greenhouse Gas Emissions

Carbon dioxide and methane have been identified as greenhouse gases which permit solar radiation to pass through the atmosphere while absorbing part of the infrared radiation that is reflected back from the Earth's surface. Methane is a potent GHG, which has 21 times the global warming potential of carbon dioxide. LFG represents more than 20 percent of Canada's anthropogenic methane production and is, therefore, a significant contributor to total GHG emissions.

9.2.3 Landfill Design Factors

Landfill design can have a significant affect with respect to the potential impacts of LFG generation within the waste mass. Key factors that affect the nature of LFG related impacts are as follows:

- Site configuration;
- Cover system; and
- Daily operations.

The spatial orientation/configuration of a landfill may be a significant factor associated with potential LFG impacts. Landfills developed above-ground may have increased potential for fugitive air emission impacts (i.e. odour), while sites located primarily below the ground surface may have a greater propensity for subsurface related impacts (i.e. lateral soil gas migration).

Landfill cover systems can also have a significant affect associated with LFG fugitive emission due primarily to the cover permeability, which impacts both the ability of moisture to percolate into the waste mass and for LFG to migrate to the atmosphere.

A relatively permeable cover system, composed of non-cohesive soil (i.e. sands and silty sands), promotes percolation of precipitation through the cover system and into the waste mass. This increased moisture content in the waste mass may result in increased LFG production rates, while reducing the overall duration of LFG

generation. Permeable final cover systems also permit passive venting of LFG to the atmosphere which can result in lower gas pressures within the waste mass, thereby reducing the potential for lateral migration.

Relatively impermeable cover systems composed of cohesive soil (i.e. clay) or geosynthetic/geocomposite cover systems hinder the percolation of precipitation into the waste mass. The resultant decreased moisture content in the waste mass can result in lower LFG production rates while increasing the duration of LFG generation. Inversely to permeable cover systems, low permeability systems will typically reduce fugitive emissions to the atmosphere while increasing gas pressures within the waste mass. As a result, low permeability covers have a greater propensity for lateral migration.

9.2.4 Non-methane Organic Compounds

Non-methane organic compounds (NMOCs) are produced in the waste mass by volatilization or chemical processes and can include various organic hazardous air pollutants, greenhouse gases, and compounds associated with stratospheric ozone depletion. NMOCs can be created when certain wastes, particularly organic compounds, change from a liquid or a solid into a vapour (i.e. volatilization). In addition, NMOCs can be created by the reactions of certain chemicals present in waste.

VOCs are a form of NMOCs that include chemicals containing carbon and hydrogen atoms that can react to form other chemicals. VOCs are environmentally relevant due to their ability to react with nitrogen oxide in the presence of sunlight to form ozone.

9.3 LFG Production Assessment

The following section presents the Site LFG production assessment based upon the development sequence outlined previously.

9.3.1 LFG Production Model

The LFG generation potential of the landfill was estimated using the LFG generation model prescribed in the landfill guidelines (BC MOE, 2016). This model, commonly referred to as the Scholl Canyon model, is a first-order kinetic function which is the accepted industry standard model to evaluate LFG production and emission rates.

The Scholl Canyon model is used to estimate LFG production as a function of the following parameters:

- LFG generation constant (k);
- Methane generation potential (Lo); and
- Mass of waste (M).

Typical values of k range from 0.006 per year for dry sites to 0.1 per year for wet sites. Methane generation potential generally ranges from approximately 10 cubic metres to 350 cubic metres of methane per tonne of waste as a function of organic content.

The formula for the Scholl Canyon model can be expressed as follows:

$Q_T = \Sigma_{t=1,n} 2 L_o k M_t e^{-kt}$

Where:

Q_T = total LFG emissions (50 percent CH_4 and 50 percent CO_2 by volume)

k = LFG generation constant ($year^{-1}$)

L_o = methane generation potential (m^3 CH_4 /tonne of waste)

M = mass of waste (tonnes) placed in year t

t = time in years

The NMOC generation rate is estimated utilizing the following formula:

$Q_{NMOC} = \Sigma_{t=1,n} 2 L_o k M_t (e^{-kt}) (C_{NMOC}) (3.595*10^{-9})$

Where:

Q_{NMOC} = total emission rate of NMOCs (tonnes/year)

k = LFG generation constant ($year^{-1}$)

L_o = waste methane generation potential (m^3 CH_4 per tonne of waste)

M = mass of waste (tonnes)

t = time in years

C_{NMOC} = concentration of NMOCs reported as hexane (ppmv)

9.3.2 Model Input Parameters

The historic tonnages for waste landfilled at the Site were obtained from the report "Inventory of Greenhouse Gas Generation from Landfills in British Columbia" (Golder, 2008), or were provided by the SCRD. Future projected mass inputs are based upon a per capita waste generation rate of 0.43 tonnes per person per year with an estimated population growth rate provided by BC Stats (Table 4.2). Waste was divided into three categories (decomposable, relatively decomposable, and relatively inert materials) as per Appendix A of the published guidance document (CRA, 2009). The methane generation potential (Lo) for each waste category is presented in Table 9.1. These values were selected in accordance with Section 5.2 of the aforementioned guidance document.

An estimate of the waste composition for the Sechelt Landfill was carried out by Golder Associates Ltd. in 2008. A summary of the results from the study are presented in Table 4.3. As indicated in Table 4.3, approximately 52 percent of the total waste landfilled at the Site in 2008 was composed of decomposable waste, approximately 30 percent was composed of moderately decomposable waste, and approximately 18 percent of the waste was composed of relatively inert material.

A second study of the waste composition for the Sechelt Landfill was carried out by Dillon Consulting Ltd. in 2014. A summary of the results from the study are presented in Table 4.4. As indicated in Table 4.4, approximately 49 percent of the total waste landfilled at the Site in 2014 was composed of decomposable waste, approximately 27 percent was composed of moderately decomposable waste, and approximately

25 percent of the waste was composed of relatively inert material. It is noted that the estimated percent mass weighting reported in the aforementioned Dillon Report totalled to 101 percent. This is attributed to an error in rounding. In order to adjust the percent mass weighting to equal 100 percent, the relatively inert material fraction was adjusted down to 24 percent. This adjustment is considered to be conservative (high) for the purpose of assessing the methane generation potential for the Site.

Dillon Consulting Ltd. completed an additional waste composition for the Sechelt Landfill in 2015. This study was not included as part of the LFG generation calculation as the study was performed on the Sechelt roll off bins as opposed to curbside waste. The change in study location yielded much higher percentages of inert material then the previous two studies. The results of the 2014 compositions study were used for 2015 and the projected future waste composition, as a much more conservative assumption.

The LFG generation rate (k), for each waste category is presented in Table 9.1. These values, selected in accordance with Section 5.3 of the published guidance document (CRA, 2009), were selected based upon the following factors:

- Annual total precipitation of approximately 1,355 mm; and
- Site predominantly covered with interim cover.

9.3.3 Results

The LFG generation model indicates that peak LFG generation will occur at a rate of approximately 304 cubic metres per hour.

The peak NMOC emission rate was estimated to be less than 6 tonnes per year. This value is significantly lower than the 150 tonnes per year trigger value specified in the Operational Certificate that would require the Site to incorporate a LFG collection system.

The peak methane emission rate was estimated to be approximately 874 tonnes per year. Current 2017 methane emissions are estimated to be approximately 793 tonnes per year. This value is below the 1,000 tonnes per year BC MOE Landfill Gas Regulation trigger value (BC MOE, 2008), and therefore a LFG collection system is not required.

A summary of LFG production data is presented in Appendix D.

9.4 Landfill Gas Migration Assessment

9.4.1 Landfill Gas Migration Overview

As indicated above, LFG is composed primarily of carbon dioxide and methane. Although several properties of LFG can pose risk to human health and safety, the primary element of concern is methane, which is flammable in air from concentrations ranging from 5 percent (LEL) to 15 percent (UEL) on a volumetric basis.

LFG migration through soil voids and bedrock fractures is of potential concern when receptors are present (i.e. buildings, structures and utility corridors). Due to its relatively low solubility, groundwater acts as a barrier to LFG migration; as a result

only unsaturated soil and bedrock are considered to be primary pathways for LFG migration. Consequently, a clear understanding of the geological and hydrogeological conditions present beneath and adjacent to the landfill is critical to evaluating LFG migration potential.

Three key factors which influence the migration of LFG away from the limits of waste are as follows:

- Advection;
- Diffusion; and
- Permeability.

LFG accumulates within the waste mass, resulting in a zone of high pressure (relative to atmospheric conditions). Differential pressure results in LFG migrating from areas of high pressure to areas of low pressure by means of convection. As pressure increases in the waste mass due to on-going LFG generation, gas tends to migrate up through the landfill cover, resulting in airborne fugitive emissions, and/or through the adjacent subsurface soil, resulting in lateral migration.

Diffusion is the process by which a gas attains chemical equilibrium by moving from areas of high concentration to areas of lower concentration. This process contributes to LFG migration due to differential chemical gradients in the waste mass relative to the surrounding soil.

Permeability has a significant impact on LFG migration due to a liquid or gases' propensity to move via the "path of least resistance." Waste, soil, and fractured bedrock all contain void spaces (i.e. porosity). These voids are generally interconnected; therefore, they provide a conduit for LFG to migrate.

Migration of LFG through soil poses two primary concerns that are related to the build-up of gases within or below structures near the landfill site; the accumulation of LFG in or around a subsurface structure may expose those required to enter the structure to an oxygen deficient environment, and the accumulation of LFG introduces the risk of an explosion if a source of ignition is present.

9.4.2 Factors Affecting Lateral Migration Potential

The ability of LFG to migrate laterally from the landfill limit of waste into the surrounding soil is dependent on the following primary factors:

- Leachate management systems;
- Landfill cover system;
- Geological conditions;
- Hydrogeological condition;
- Meteorological conditions; and
- Civil works.

Modern landfill design typically includes a liner system constructed of low permeability non-cohesive clay, geosynthetic materials (e.g. HDPE) or a composite

system incorporating both materials. These liner systems present a barrier to LFG lateral migration to the surrounding environment unless tears in the liner system are present. Hence, the detection of LFG in the vadose zone immediately adjacent to the liner landfill cell is indicative of damage to the liner system.

The landfill cover system may have a significant impact on the potential for LFG migration. In landfills with a low permeable cover system, gases may exhibit greater propensity for lateral migration relative to a landfill cover with a more permeable material.

Soil stratigraphy beneath and in the immediate vicinity of the landfill can significantly impact LFG migration potential. Highly permeably, non-cohesive soil or fractured rock tend to act as preferential pathways for migration of LFG, while fine grained or cohesive soil tend to impede the movement of LFG. Non-cohesive, high permeability soil, bound between two lower permeability soil layers can also significantly impact LFG migration potential. This geologic condition can result in higher pressure gradients which increase the lateral migration potential.

Hydrogeological conditions also impact the migration potential of LFG. As discussed in Section 9.2, methane is only slightly soluble in water. As a result, methane migration (the constituent of primary concern) is precluded by saturated soil which acts as a barrier to gas migration.

Meteorological conditions may also affect LFG migration potential. Precipitation can saturate the soil cover, resulting in reduced LFG venting to the atmosphere; thus, resulting in increased surficial lateral pressure gradients. During the winter, frozen ground conditions may also impede LFG venting to the surface and also result in increased lateral pressure gradients.

Civil works adjacent to the landfill may also impact migration potential. Paved areas provide a barrier to venting; thus, increasing the potential for lateral migration of LFG. In addition, utility corridors, backfilled with non-cohesive and free draining bedding material, may provide a conduit for migration to adjacent civil works, buildings or structures.

An additional consideration, when undertaking an assessment of potential LFG migration impacts, is the potential for methane oxidation in the shallow surficial soil. It is recognized that microbial oxidation of methane in aerobic soil can play a significant role in reducing the emission of methane to the atmosphere (Lelieveld et al., 1998). As a result of oxidation, the concentration of methane in the soil gas matrix is attenuated; thereby, reducing the risk of concentrations exceeding trigger levels.

The rate of oxidation in surficial soil is dependent upon both biochemical and physical processes (Hettiaratchi and Hansen, 1996). In an aerobic atmosphere, methane can be decomposed by methanotropic bacteria, which result in the generation of carbon dioxide and water as follows:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

Hence, the oxidation of methane results in a decrease in the ratio of methane to carbon dioxide in the soil gas.

9.4.3 Soil Gas Triggers

LFG trigger concentrations are based upon the exceedance of combustible gas concentrations (i.e. methane) in the soil matrix voids. The Landfill Criteria for Municipal Solid Waste (June 2016) stipulate trigger concentrations of:

- 100 percent LEL of methane (5% gas by volume) for soil concentrations at the Landfill property boundary; and
- 20 percent of the LEL (1% gas by volume) in on-site building structures.

The Operational Certificate stipulates trigger concentrations of:

- 100 percent LEL of methane (5% gas by volume) for soil concentrations at the Landfill property boundary;
- 25 percent of the LEL (1.25% gas by volume) in on-site building structures; and
- 25 percent of the LEL (1.25% gas by volume) off-site building structures.

This criteria is presented in Table 9.2.

9.4.4 Migration Potential Assessment

As discussed previously, the surficial soil in the vicinity of the Site primarily consists of sand and gravel, or silty sand. Due to the high permeability of the overburden soils, the potential for lateral LFG migration is low. However, no evidence of vegetative stress was noted adjacent to the limit of waste.

An additional migration pathway is granular engineered fill which may have been utilized to construct the existing roads and scale house facility.

Two nested LFG monitoring wells were installed in the public tipping area in 2013 near the on-Site receptors to monitor any potential LFG migration. One new nested LFG monitoring well was installed adjacent to the maintenance shed in Summer 2017. These locations as presented in Figure 9.1. In the event that any future potential receptors are identified adjacent to the Site, it is recommended that additional soil gas probes be installed along the property boundary.

9.5 LFG Collection System

Based on the peak methane emission rate for the landfill of 853 cubic tonnes per year, an active LFG collection system is not required for the Site. A passive LFG system is present on the closed portion of the landfill. The passive LFG system will be extended as the Site progressively closes.

Currently two LFG extraction wells (EX-01 and EX-02) are installed on–Site as part of a pilot project to determine LFG generation feasibility. The recommendation was that LFG extraction on-Site not be continued. These wells will remain on-Site until the commencement of Stage J.

10. SITE FACILITIES

10.1 Existing Infrastructure

The following section provides a description of the existing Site facilities.

10.1.1 Fencing

Chain-link fencing exists along the entire perimeter of the Site. Access to the Site is controlled by two gates along Dusty Road. The gates are locked outside of normal operating hours to prohibit vehicle entrance and uncontrolled disposal when the Site is closed. There is one service gate located at the southwest corner of the property. This gate is kept locked at all times except when in use.

The chain-link fence has been retrofitted with a minimum of four strands of electrified wires to prevent bears from entering the Site.

10.1.2 Maintenance Shed

The maintenance shed is located along the north property boundary, east of the Site entrance. The shed consists of a metal fabricated building on a concrete slab foundation. The maintenance shed provides secure storage for maintenance equipment and general storage for larger equipment and supplies.

10.1.3 Weigh Scale

A two-way truck weigh scale is located at the main Site entrance. The weigh scale is used to measure the mass of all waste haulage vehicles entering and leaving the Site.

The weigh scale consists of a 50-tonne capacity computerized weigh scale, a fabricated metal scale and building structure.

10.1.4 Special Waste Depot

A Product Care Paint Plus depot is located at the Site. Items accepted at these facilities include the following consumer products:

- Flammable liquids;
- Pesticides (domestic);
- Gasoline in approved ULC containers;
- Household paints; and
- Paint aerosols.

Tipping fees are not levied for these items.

Paint is stored in tub skids located inside two locking trailers. Flammables, pesticides, and gasoline are stored in tub skids located in locking steel containers. Aerosols are stored in 40-gallon steel drums with locking lids. Tub skids and drums are removed regularly by Product Care for recycling or proper disposal.

10.1.5 Public Tipping Area

A well-signed public tipping area, equipped with eight roll off bin lock block bays, is located west of the weigh scale. The roll-off bins are used for garbage collection, and storage of materials being diverted from the Site including; uncontaminated gypsum, scrap metal, and textiles. Small drop off containers are also located at the north end of the transfer station, and are used for storage of materials being diverted from the Site including; cardboard and refundable containers.

The public tipping area also includes a recycling area for appliances that contain ozone depleting substances, propane tanks, tires, yard waste, roofing and construction demolition wood waste. As well, there is a 53 foot transport trailer for storage and transportation of mattresses and box springs for processing recycling, and a lock block bay for a 53 foot transport trailer for storage of mattresses and box springs.

10.1.6 Share Shed

A share shed is located on-site, and is used to house re-usable items that the public drop off. These items can be purchased for a nominal fee that helps to cover the cost of the facility. There is also an area for storage of polystyrene foam (i.e. Styrofoam) packaging waste, accepted under the Recycle BC Program.

10.1.7 Access Roads

Access roads include a paved road to the scale house. The Site has gravel access roads located:

- Around the perimeter of the site;
- From the scale house to the public tipping area;
- From the scale house to the maintenance shed; and
- From the scale house to the active landfill area.

SCRD staff applies road mulch to all access roads as required, in order to maintain Site accessibility during inclement weather.

11. SITE OPERATIONS

The Site is currently operated under Operational Certificate No. 106060 issued by the British Columbia Ministry of Environment, Environmental Management Act, on July 8, 2014. The Site accepts municipal solid waste from the approved service area, as well as other waste approved by the Regional Waste Manager. Key elements from the Operational Certificate and Landfill Criteria for Municipal Solid Waste are as follows:

- The landfill shall not contain hazardous waste.
- In the event of an emergency or a condition beyond the control of the Operational Certificate holder, the Operational Certificate holder must take appropriate remedial action and notify the Director immediately.
- The Operational Certificate holder must inspect the authorized works regularly and maintain them in good working order.
- Litter must be controlled by compacting the waste, minimizing the work face area, applying cover at required frequencies, providing litter control fences and instituting a regular litter pickup.
- Vectors must be controlled by the application of cover material at the required frequency.
- Dust releases should be controlled on site. Roads on the landfill surface shall be watered as necessary or otherwise treated to control dust emissions.
- Site operations should minimise noise by making use of natural and/or constructed features such as vegetated buffers, soil berms, and material stockpiles, constructing haul roads at 8 percent grade or less to minimize engine noise and scheduling potentially noisy activities during hours that will minimize impacts on the community.
- The Operational Certificate holder must maintain an electric bear fence, at a minimum around the landfill footprint.
- The Operational Certificate holder must take all reasonable measured necessary to prevent fires and must provide adequate fire breaks.
- Appropriate traffic control signage shall be posted inside the landfill site boundaries directing public and commercial waste haulers to drop-off, material recovery, and disposal areas of the landfill site.
- The Operational Certificate holder must take measured to minimize leachate generation.
- Landfill owner and/or operator shall record and maintain all relevant records for the entire contaminating lifespan of the landfill.
- All landfills shall be supervised and operated by trained qualified personnel. All landfill operators and managers are encouraged to have specialized professional training.

11.1 Site Access and Information

Access to the Site is provided via Dusty Road, approximately 6.5 kilometres northeast of the District of Sechelt. Access gates control entrance and/or exit from the Site at this location. The gates are locked outside of normal operating hours to prohibit vehicle entrance and uncontrolled disposal when the Site is closed.

Signage is provided at the Site entrance and throughout the Site as follows:

- Site owner;
- Traffic control and directions;
- Hours of operation;
- Tipping fees;
- Contact information;
- Emergency contact information; and
- Acceptable and unacceptable waste.

11.2 Hours of Operation

The Site hours of operation are from 8:30 AM to 5:00 PM Tuesday to Saturday, and 12:00 PM to 5:00 PM on Sunday. The Site is closed on statutory holidays from Thanksgiving weekend to Easter weekend, and closes at 3:30 pm on Christmas Eve and New Year's Eve.

11.3 Site Supervision

The SCRD operates the Sechelt Landfill. SCRD staff handles the front end of the operations with a contractor responsible for supplying and operating heavy equipment.

The SCRD staff undertakes the following tasks at the landfill:

- Weigh all incoming vehicles and collect fees;
- Monitor incoming loads;
- Direct customers to proper drop off locations;
- Monitor recyclable material;
- Report operational problems and emergencies;
- Prevent scavenging or burning;
- Visually inspect waste loads for unacceptable waste, liquid, or hazardous waste;
- Maintain secure Site entrances;
- Maintain landscaping and vegetated buffers;
- Pick litter;
- Complete operational diaries and records; and
- Maintain electric fence.

The contractor handles the following tasks:

- Place and compact the waste;
- Monitor and visually inspect loads delivered to the landfill face;
- Empty Public Drop Off bins at landfill face;
- Apply daily or alternative daily cover;
- Apply intermediate cover;
- Place final cover, topsoil and seeding as required;
- Maintain stormwater and drainage infrastructure;
- Maintain landscaping and vegetated buffers;
- Maintain haul roads;
- Maintain Site equipment;
- Report operational problems and emergencies; and
- Complete operational diaries and records.

The weigh scale operator maintains a daily record of weighing operations. Tipping fees are charged for waste entering the Site based on weight or number of units (e.g. fridges, tires, etc.) according to SCRD Bylaw No. 405.

11.4 Fire Prevention Measures

As part of fire prevention management for the site the landfill shall be operated in a manner that reduces the risk of landfill fires from occurring. As such, the following activities take place on Site to mitigate these risks:

- Daily and intermediate cover is placed and compacted on waste in cells by specified thickness;
- Fire breaks at least 15-metre-wide are maintained within the buffer zone within the 20 metres closest to the landfill footprint, where possible;
- Landfill crew and contractor are screening loads when they enter the site and as they are delivered to the public drop off area and active face, as well as completing day end inspections;
- Sechelt Landfill does not have water on-Site, but access to year-round immediate water is available from a 4,000 gallon capacity water truck and a 1,500 gallon water tank owned by the Contractor. Both of these are available to contractor and site staff for firefighting;
- The Sechelt Landfill is outside of the Fire Protection District, therefore the SCRD has an agreement with the Sechelt Fire Department (SFD) to provide emergency fire fighting services at the landfill. This is on a fee for service basis. The SFD brings their own water tanker truck when responding; and
- All landfill equipment working on the active face of the landfill is equipped with fire suppression measures.

In the event of an unauthorized fire the landfill staff and site contractor shall immediately make all reasonable efforts to extinguish the fire, including reporting the fire to the Sechelt Fire Department. Any large fires posing a threat to public health or neighbouring property shall be reported to the Provincial Emergency Program.

Further details are included in the Emergency Response and Contingency Plan in Appendix G.

11.5 Special Waste Depot

The types of materials managed at this facility are typical household hazardous wastes from sources within the Sunshine Coast Regional District. Materials must be stored in accordance with the Hazardous Waste Regulation and is limited to the registration quantity as a return collection facility.

The facility is located on a portion of Block C, District Lot 7613, Group 1, New Westminster District. The operational certificate holder must record the quantity of materials received at the collection facility, as well as the quantity of that removed from the facilities, including the name of the company and the location the recyclable material was sent.

11.6 Recyclable Materials

The SCRD is authorized to manage recyclable material at the Sechelt Landfill. A public drop off and recycling area is available for recyclable materials from sources within the Sunshine Coast Regional District. The type of materials that may be managed in this area include the following:

- Scrap metal;
- Residential appliances containing ozone depleting substances;
- Used small passenger and medium truck tires;
- Gypsum wallboard;
- Corrugated cardboard;
- Wood waste;
- Green waste;
- Asphalt roofing;
- Mattresses and box springs;
- Materials regulated under BC's Recycling Regulation;
- Materials which may be identified by SCRD for diversion; and
- Materials which may be designated by the Director when alternative disposal becomes available.

The quantity of recyclable materials stored is limited to the capacity that can be reasonably handled on Site. The operational certificate holder must record the quantity of recycling received at the landfill, as well as the quantity of that removed from the

facilities, including the name of the company and the location the recyclable material was sent.

11.7 Waste and Cover Soil Placement

Landfilling, as specified in the development sequence, will be completed using the area method of landfilling.

Waste hauling vehicles will unload at the working face and the landfill compactor will spread and compact the waste. The waste will be placed and compacted in layers of approximately 0.6 metres. The waste will receive a minimum of five passes with a landfill compactor in order to achieve maximum density. Completed lifts will have a minimum height of 3 metres, with a minimum 2 percent grade. Daily cover consisting of tarps, steel plates, native soil, suitable imported material, or ground asphalt shingles (or wood chips when available) blended with soil, will be placed at the end of each working day. Steel plates will be employed at the site as a form of alternative daily cover starting in the early 2018.

11.7.1 Daily Cover Soil

Daily cover helps to minimize litter migrating from active areas and will also help to control odours, vectors, and vermin. Typical daily cover is composed of 150 millimetres of permeable non-cohesive soil. Alternative cover systems, such as steel plates, can be used on the working face six out of seven working days. On the seventh working day, cover soil is applied to the working face. Whenever possible, the daily cover should be removed and reused or scarified prior to placement of subsequent lifts of waste to promote a hydraulic connection to the underlying waste and to reduce the likelihood of lateral leachate breakouts.

11.7.2 Intermediate Cover

Certain areas of the landfill may be completed with intermediate cover to allow additional settlement and consolidation of the waste prior to final waste placement to final contours. Intermediate cover should be placed over areas that will remain inactive for an extended period of time (over 30 days). Intermediate cover should consist of a 300-millimetre layer of soil placed over the waste graded to promote surface water run-off.

As mentioned in section 5.5.3, lightweight woven LDPE laminated tarps will be placed in conjunction with interim cover material (composite intermediate cover) on slopes less than 10 percent grade for the purpose of reducing leachate generation in interim closed areas. These tarps (typically available in 40 metre by 40 metre) can be placed by landfill operations staff and either weighed down by the interim cover (areas with slope smaller than 10 percent to be closed for more than one year) or anchored with poly propylene sand bags (areas with slope greater than 10 percent to be closed for over a year).

Interim cover removal, prior to resumption of landfilling, should be performed to promote hydraulic connections between waste lifts.

11.7.3 Final Cover

Progressive final cover placement will be carried out in areas of the landfill that have reached final contours. The progressive placement of final cover will reduce leachate generation by promoting surface run-off thereby reducing infiltration into the landfill. As a component of the detailed design of the final cover system, a geotechnical assessment was undertaken to address static and seismic stability of the cover system. This is included in Section 3.4.

The final cover design for the landfill is presented in Section 5.5.1.

11.8 Surface Water Control

Surface water control will be conducted through the construction of temporary berms and ditches to control surface water run-off. Surface water will be directed away from the active disposal areas in order to minimize the volume of surface water contacting waste, and the resulting leachate production.

11.9 Litter Control

Preventative litter control measures are steps taken to minimize the blowing of litter from the active area of a landfill. The following measures will be used at the Site to control and minimize windblown litter:

- All vehicular traffic transporting waste to and around the Site will be tarped to prevent litter from blowing out of the vehicle;
- Daily cover or steel plates will be used to cover exposed waste and to confine light weight material;
- The working face location will be selected based on the direction and intensity of the wind to provide maximum shelter for the active area. The areal extent of the working face will be kept to a minimum on windy days;
- Temporary, moveable, litter control fencing will be utilized at the active face of the Site, as required; and
- The landfill operator is required to collect litter at the Site at least once per year.

Regular cleanup of litter on and adjacent to the site by site crew and site contractor.

11.10 Noise Control

Potential noise impacts from the Site may result from the operation of the landfill equipment. The operation of this equipment will be conducted to ensure that noise emission standards are adhered to.

11.11 Odour Control

In general, landfills have the potential to emit two types of odours, waste odour and LFG odour. Waste odour is generated by recently disposed waste and is controllable by the application of daily cover. LFG odour is generated during the anaerobic decomposition of organic waste material.

Should LFG odours become a problem at the Site, then an investigation into the issue is required and a solution implemented. The investigation will address such items as gas generation rates, the location of odour problems around the Site, and potential methods to reduce odours.

11.12 Dust Control

Dust generation is common at most landfill sites due to the handling of soils, dry waste such as demolition waste, plaster and concrete, and the movement of vehicles along gravel and soil roads.

- Dust mitigation measures will be employed on an as-needed basis and may include the following:
- Paved roads;
- Use of water to control dust;
- Seeding programs; and
- The proper placement of stockpiles to minimize dispersion.

Soil stockpiles that will not be used for more than one year, will be seeded.

11.13 Vector and Wildlife Control

The terms vector and wildlife refer to objectionable insects, rodents, birds and bears that sometimes establish habitat at a landfill. Common landfill vectors are flies, rats, and gulls. The impact of these species is examined from a health perspective and from a social or psychological perspective.

The most significant vector identified at the Site has been identified as gulls. Gulls are opportunistic feeders, which have been noted to develop a strong attachment to an area which readily provides a food source.

The management of gulls at the Site should consider the following elements:

- Active face control;
- Stockpiles; and
- Standing water.

The active face shall be kept to the minimum size required to facilitate daily operations. Daily cover or alternative daily cover must be placed over the active area at the end of each operating day.

Material stockpiles at the landfill site may attract loafing gulls. Stockpiles should be kept to a minimum at the Site. Flagging tape attached to stakes can be placed on top of stockpiles used by gulls to discourage loafing.

Standing water, which can attract gulls, should be minimized at the Site. Vegetation should be allowed to grow in the contact water pond and other drainage features. If required, the contact water pond can be fitted with over wires across the pond.

11.14 Emergency Response and Contingency Plan

An emergency response and contingency plan for the Site is included in Appendix G.

12. MONITORING, INSPECTION, AND REPORTING

12.1 Environmental Monitoring Program

As referenced in the approved Site Environmental Monitoring Program (EMP), the requirements of the EMP are outlined in the following documentation issued by the BC MOE:

- Operational Certificate No. 106060;
- Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills (January 1996); and
- Landfill Criteria for Municipal Solid Waste (June 2016).

12.1.1 Monitoring

The objective of the monitoring program is to detect the extent and magnitude of the migration of contaminants derived from landfill activities. The data compiled from the groundwater monitoring program is utilized to confirm that adequate attenuation of leachate-impacted groundwater is occurring prior to migration from the landfill property.

Environmental monitoring is currently undertaken on an annual basis, as per the XCG Consulting Limited report "2016 Annual Report" prepared for the District, dated March 24, 2017.

Groundwater Monitoring

The current groundwater monitoring program includes the quarterly monitoring and sampling of thirteen monitoring wells for water levels, pH, conductivity, temperature, dissolved oxygen and redox. Laboratory analyses of water samples is performed for the following chemical parameters: pH, electrical conductivity, hardness, chemical oxygen demand (COD), dissolved organic carbon (DOC), turbidity, nutrients, dissolved metals, sulfate, dissolved chloride, VOCs, alkalinity, bicarbonate, carbonate, and hydroxide.

The current groundwater monitoring locations are illustrated on Figure 12.1.

Since inception, the groundwater monitoring program results have remained consistent. The primary receptor for the Site is the bedrock aquifer. Results indicate that attenuation is occurring as the shallow perched aquifer percolates down into the deep bedrock aquifer as groundwater flows across the Site in a south to south-westerly direction. Risk to off-Site groundwater users is deemed low.

Surface Water Monitoring

The current surface water monitoring program includes the sampling of four monitoring locations (quarterly in conjunction with the groundwater monitoring program) for pH, conductivity, temperature, dissolved oxygen, and redox. Laboratory analyses of water samples was performed for the following chemical parameters: pH, electrical conductivity, hardness, COD, DOC, nutrients, dissolved chloride, and total metals. The current surface water monitoring locations are illustrated on Figure 12.2.

Since inception, the surface water monitoring program results have remained consistent. There are no evidence of leachate impacts at the four monitoring locations and risk to surface water receptors is deemed to be low.

12.1.2 Leachate Monitoring

The objective of the leachate monitoring program is to provide data with respect to leachate indicator parameters, which will enable the accurate assessment of the potential impacts derived from landfill related activities as well as provide analytical data for disposal of collected leachate.

12.1.3 Soil Gas Monitoring

The objective of soil gas monitoring is to ensure the subsurface migration of LFG does not pose a risk the surrounding environment.

As discussed previously, the lateral migration of soil gas (i.e. LFG) poses three primary concerns associated with the accumulation of gases within the soil matrix or below building structures in close proximity to a landfill Site:

- The accumulation of LFG in subsurface structures (e.g. manholes and vault boxes) which may create an oxygen deficient atmosphere;
- The accumulation of LFG as concentrations exceeding the LEL, thereby posing a risk of explosion; and
- Vegetation stress effects due to displacement of oxygen in the root zone.

The soil gas monitoring program has been devised to monitor for the presence of lateral LFG migration through the subsurface adjacent to identified potential on-site receptors (i.e. on-site building structures).

Soil gas monitoring shall be undertaken to monitor the following parameters:

- Soil gas pressure;
- Methane concentration;
- Oxygen concentration;
- Carbon dioxide concentration; and
- Groundwater level.

The following trigger levels will necessitate the implementation of contingency measures:

- Concentration of methane at the property boundary exceeding 100 percent LEL;
- Methane from LFG present in on-site enclosed structures;
- Methane from LFG present in off-site enclosed structures;
- Vegetative stress related to LFG impacts; and
- LFG emissions from the landfill resulting in odour issues and/or impacts to the air quality in the area.

12.2 Inspection and Record Keeping

Regular site inspections will be conducted to verify that nuisance issues associated with ongoing landfill operations (i.e. dust, litter, and odour) are adequately controlled, thereby preventing nuisances from developing into more serious environmental issues.

The inspections presented herein shall be undertaken by adequately trained landfill personnel on a weekly basis. Landfill personnel shall maintain records of the inspections and associated action items that require attention.

Weekly inspection records shall be filed on Site and archived for future reference in the event of an environmental release.

12.2.1 Surface Water Management Systems

Maintenance of the surface water management systems will include the maintenance of surface watercourses and contact water pond.

Grass lined surface watercourses shall be periodically inspected, while undertaking inspection of the cover system, for signs of deterioration and erosion. Maintenance will include periodic trimming of grass, repairs to side-walls, and dredging of sediment build-up.

Rip-rap should be periodically inspected for signs of erosion. If erosion has occurred, the deteriorated section shall be regraded and rip-rap restored.

The pond will also require periodic inspection and maintenance. Inspections shall be undertaken for evidence of erosion and side-slope sloughing or tension cracks forming along the crest of the side-slope berms. Regular maintenance will include dredging of sediments to ensure the structure maintains the required capacity.

12.2.2 Leachate Management

The landfill is primarily a natural attenuation Site, and as such was not constructed with an engineered liner. Therefore, the primary task associated with leachate management is the regular inspection of the final cover for evidence of leachate surface seeps.

In the event that leachate seepage is identified, remedial measures will be immediately undertaken to contain the seepage in order to prevent impacts to surface watercourses, and affect repair to the final cover in the area where seepage is observed.

In the event that leachate seepage has impacted surface watercourses, temporary controls, such as berming, should be implemented to prevent the migration of impacted surface water downstream. Where possible, the impacted surface water should be redirected to the landfill by excavating a vertical channel into the waste mass and allowing the leachate to infiltrate into the waste.

12.2.3 Buffer Zones

Buffer zones should generally be vegetated with native species and should be self-supporting. As such, with the exception of potential remedial measures to address landfill derived impacts, maintenance should generally not be required. In the event of landfill derived impacts (i.e. vegetative stress associated with LFG, sediment

accumulation or leachate seepage) an assessment of the cause of the impact shall be undertaken and appropriate measure put in place.

12.2.4 Fencing and Site Security

All fencing and gates should be maintained. If fencing/gates are found to be damaged or in disrepair, then the existing fence/gate should be repaired or replaced as needed to ensure the protection of the Site's environmental controls. The need for existing fencing and/or additional fencing should be reviewed on an annual basis.

12.2.5 Access Roads

Access roads shall be repaired should any erosion, rutting, or potholes occur. Snow clearing of the access roads shall be performed on an as-required basis.

12.2.6 Environmental Monitoring Infrastructure

Existing groundwater and LFG monitoring wells should remain in place and operational throughout the post-closure care period of the landfill. Monitoring wells should be inspected at the time of monitoring for proper operation, and any broken valves or fittings should be replaced immediately. Should existing or any new monitoring wells be damaged beyond repair, they will be properly decommissioned/abandoned and replaced with new wells, as required, on an as-soon-as reasonably possible basis.

In the event of ponding or surface water accumulation at the base of a monitoring well, the area around the monitoring well will be regraded to promote positive drainage away from a well and vegetation will be re-established. Alternatively, consideration can be given to abandoning the monitoring well and replacing it at an adjacent location, which will not be impacted by surface water ponding.

12.3 Airspace Consumption

A survey of the active landfill area shall be conducted annually during operation of the Site to determine annual airspace consumption. The annual volume of airspace consumed will be used to estimate the remaining Site life. In addition, the volume calculation will be used in conjunction with the annual tonnage landfilled to calculate the apparent waste density.

It is noted that the annual landfill survey should be undertaken at the same time each year to ensure that the annual airspace consumption calculation is representative of actual conditions.

12.4 Annual Operations and Monitoring Report

As stipulated in Section 4.6 of the landfill's Operational Certificate, the SCRD shall submit to the Regional Director of Environmental Protection by March 31 of each calendar year, an Annual Report.

Key elements of the Annual Report are as follows:

- Review and interpretation of the analytical data from receiving environment monitoring for the calendar year;

- Summaries of waste and recyclable material records, with the amount of waste landfilled reported as a volume and tonnage;
- Total weight of recyclable materials shipped off-site, including the name of company and location the materials were sent to;
- Summary of commercial quality soil brought on Site;
- Remaining Site life and capacity;
- Revised design and operating plan and planned improvement if applicable for minor revisions;
- Updated closure plan with associated estimated costs, if changes warranted; and
- Recommendations for alteration to the approved EMP if warranted.

13. CLOSURE

The following section provides a general overview of closure activities and requirements associated with closure of the Site. It is noted that detailed analysis of these elements will be undertaken upon detailed design of the proposed end-use concept and in the Landfill Closure Plan.

- The operational certificate holder must accrue a dedicated reserve fund sufficient to finance closure and environmental contingencies related to the landfill;
- Estimated costs of closure and post-closure activities must be updated annually and submitted to the Director as part of the annual report; and
- A Closure Plan is required for all landfill sites. The Closure Plan shall be prepared identifying a special post-closure land use proposed for the landfill site.

13.1 Design Criteria

Final closure of the Site will be based on the final slopes and design elevations presented in Table 4.1, as illustrated in Figure 5.1.

13.2 End Use

After closure, the Site may potentially continue to receive commercial waste as a transfer station; however, the Site will likely need to be expanded to accommodate the additional bins and stockpile areas needed for a commercial waste transfer station. The northwest corner of the site could be transitioned into a transfer station, while the rest of the Site would be restricted to passive use, such as wildlife habitat area, community trails, or green space. The SCRD may also consider building a transfer station closer to Sechelt and limit use of the Site to passive use.

13.3 Closure Schedule

The Site life is governed by numerous factors which include the following:

- Available airspace;
- Annual waste tonnage landfilled;
- Compactive effort;
- Daily cover practices;
- Removal of interim cover prior to landfilling; and
- Settlement of the refuse mass prior to closure.

Based upon a current airspace availability of approximately 172,800 cubic metres and the assumptions presented in Section 6.2, the current estimated closure date is 2025. The Site life will be updated in the Annual Operations and Monitoring Report discussed in Section 12.4.

13.4 Site Rehabilitation

The following section provides an overview of landfill rehabilitation measures to be undertaken as part of the closure of the Site.

13.4.1 Final Cover System

The proposed final cover system is presented in Section 5.5.1. The proposed cover system has been developed to significantly reduce leachate generation for the purpose of mitigating potential environmental issues associated with post-closure public access to the Site.

13.4.2 Site Facilities

The scale office, scale, and equipment shed will be maintained for the duration of the post-closure period and will be used for the following:

- Support of closure and post-closure activities; and
- Support for potential ongoing use of the Site as a transfer station.

The Site entrance and access roads are to be maintained in adequate condition to support ongoing use and post-closure maintenance and monitoring activities.

13.4.3 Surface Water Management

During the placement of final cover, surface water run-off will be controlled to minimize sediment deposition in the surface watercourses and pond. Final cover construction will be during the summer months to provide adequate time for a vegetative cover to be established prior to the winter season. Closure contracts shall include provisions for irrigation and fertilization to promote root growth and reduce the potential for erosion.

13.5 Post-Closure Maintenance

The post-closure maintenance program for the Site will generally consist of the maintenance elements outlined in Section 12.2, as well as ongoing maintenance and inspection of the final cover. Immediately after construction the final cover will be inspected on a weekly basis until the vegetative growth is adequately established to limit the potential for erosion. Thereafter, semi-annual inspections will be completed to assess the integrity of the final cover.

Visual inspections will include the assessment of the integrity of the final cover with respect to the following:

- Inspection for erosion and waste exposure;
- Inspection for vegetative stress which may be indicative of the presence of LFG; and
- Inspection for leachate seeps.

13.6 Post-Closure Environmental Monitoring

The environmental monitoring program will continue at the Site as per the approved EMP until groundwater, surface water and soil gas monitoring results indicate that the concentrations of contaminants of concern have sufficiently been reduced to either merit an amendment to the environmental monitoring program or to discontinue the program.

13.7 Long-term Capital Plan and Closure/Post-closure Costs

The Long-term Capital Plan as well as a summary of closure and post-closure costs associated with the Site is included in Appendix H.

13.8 Contingency Closure Plan

In the event that the Sechelt Landfill is no longer supported by the SCRD solid waste management and must be closed before reaching capacity, it is recommended that landfilling continue until minimum 10% slopes are achieved across the entire upper deck. The landfill will then be closed and the final cover system design shall be the same system described in Section 5.5.1, and illustrated in Drawing D-01. A cost of $4,654,197 is anticipated for this work. A detailed cost summary for an early closure is included in Table 8 of Appendix H.

14. REFERENCES

1. British Columbia Ministry of Environment, January 1996. "Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills."
2. Booker, T. J., and R. K. Ham. 1982. Stabilization of Solid Waste in Landfills. J. Environ. Eng. ASCE 108:1089-1100.
3. Braun Geotechnical Ltd., March 2013. "Sechelt Landfill Cover System Veneer Stability Assessment – Engineering Memo."
4. Braun Geotechnical Ltd., April 2013. "Preliminary Geotechnical Report – Sechelt Landfill Slope Stability Assessment."
5. British Columbia Geological Survey. "On-line Geoscience Map," Layer - Bedrock Geology by Lithology & Layer – Bedrock Geology by Age and Rock Class, 2013. http://www.empr.gov.bc.ca/Mining/Geoscience/MapPlace/MainMaps/Pages/geology.aspx
6. British Columbia Ministry of Environment, 1993. "Landfill Criteria for Municipal Solid Waste."
7. British Columbia Ministry of Environment, 2016. "Landfill Criteria for Municipal Solid Waste."
8. British Columbia Ministry of Environment, 2008. "Landfill Gas Management Regulation."
9. Conestoga-Rovers & Associates Ltd., March 2009. "Landfill Gas Generation Assessment Procedure Guidance Report."
10. Dayton & Knight Ltd., April 1995. "Sechelt Landfill – Groundwater Assessment."
11. Dillon Consulting Ltd., December 2014. "Waste Composition Audit - Sunshine Coast Regional District."
12. Ecoplans, August 2010. "Hydrogeological and Environmental Monitoring Review Sechelt Landfill, Sunshine Coast Regional District."
13. Fulton, R.J., "Surficial Materials of Canada, Map 1880A, 1:5,000,000, Geological Survey of Canada," 1995.
14. Golder Associates Ltd., October 2007. "Conceptual Contours at Landfill Closure – Sechelt Landfill, Sechelt, BC."
15. Golder Associates Ltd., December 2008. "Final Reports on Sechelt Landfill and Biosolids Management Project – Sunshine Coast Regional District."
16. Golder Associates Ltd., October 2007. "Review of Landfill Operations – Sechelt Landfill, Sechelt, BC."
17. Hettiaratchi, J.P.A., and Hansen, C., 1996. Evaluation of a Closed Flux Chamber Method to Measure Landfill Gas, Calgary, Canada.
18. Holland, S.S., "Landforms of British Columbia, A Physiographic Outline, Bulletin 48," 1976. The Government of the Province of British Columbia.

19. Lelieveld, J., P.J. Crutzen, and F.J. Dentener, 1998. Changing concentration, lifetime and climate forcing of atmospheric methane. Tellus 50B, 128-150.
20. Lu, J.C.S., Eichenberger, B., and Stearns, R.J., May 1984. Leachate Production and Management from Municipal Landfills: Summary and Assessment. U.S. Environmental Protection Agency EPA-600/2-84-092.
21. McBean, E., Rovers, F., and Farquhar, G., 1995. "Solid Waste Landfill Engineering and Design," Prentice-Hall Publishing Co., New Jersey.
22. McCammon, J.W., "Surficial Geology and Sand and Gravel Deposits of Sunshine Coast, Powell River, and Campbell River Areas, Bulletin 65" 1977, Province of British Columbia Ministry of Mines and Petroleum Resources.
23. Piteau Associates Engineering Ltd., "Replacement of Three Monitoring Wells," December 30, 1999.
24. Piteau Associates Engineering Ltd., August 2007. "2005/2006 Annual Environmental Monitoring Review – Sechelt Landfill, Sunshine Coast Regional District."
25. Piteau Associates Engineering Ltd., April 2009. "2007/2008 Annual Environmental Monitoring Review – Sechelt Landfill, Sunshine Coast Regional District."
26. Sperling Hansen Associates, April 2002. "Sechelt Landfill Design and Operations Plan."
27. Sunshine Coast Regional District, January 2005. "Sunshine Coast Regional District Revised Solid Waste Management Plan."
28. Sunshine Coast Regional District Sanitary Landfill Site Bylaw No. 405, 1994.
29. United Kingdom Environment Agency, 2002. Guidance on the Management of Landfill Gas (Draft).
30. United States Army Corp of Engineers, 1997. "Hydrologic Evaluation of Landfill Performance (HELP), Version 3.07."
31. United States Environmental Protection Agency, 1997. "Emission Factor Documentation for AP-42, Section 2.4, Municipal Solid Waste Landfills."
32. XCG Consultants Ltd., August 2012. "Interim Design and Operation Plan – Sechelt."
33. XCG Consultants Ltd., July 2015a. "Hydrogeological Characterization and Impact Assessment, Sechelt Landfill, Sechelt, British Columbia."
34. XCG Consulting Ltd., March 2017. "2016 Annual Report."

TABLES

Table 3.1 Climate Normals

Month	Daily Average Temperature (Celsius)	Average Total Precipitation (mm)
January	4.6	187
February	5.2	124
March	7.1	122
April	9.5	96
May	12.7	82
June	15.3	67
July	17.6	41
August	17.9	41
September	15.1	58
October	10.5	140
November	6.5	219
December	4.2	178
Annual	10.5	1,355

Note:
1. Source: Environment Canada, Climate ID 1043152 (1981-2010), Gibsons Gower Point.

Table 4.1 Landfill Design Criteria Summary

Item	Design Criteria	Sechelt Design
Site Area	N/A	Permitted area = 9.5 hectares
Waste Footprint Area	N/A	Existing area footprint =7 hectares Unlined area = 7 hectares Proposed area footprint = 7 hectares
Maximum Final Grade (horizontal:vertical)	Final contours 3H:1V	Final contours 3H:1V
Minimum Final Grade	Final contours 10H:1V for cover systems using a barrier, 25H:1V for cover systems using a durable geomembrane or composite barrier layer with an overlying drainage layer above the final landfill side	Final contours 10H:1V
Minimum Base Grade	2 percent	Unknown
Minimum Ditch Grade	0.5 percent	0.5 percent
Final Cover	0.15 metres vegetated organic soil	0.15 metres vegetated organic soil
Composite Liner	0.6 metres barrier of material that has a hydraulic conductivity less than 1 x 10-7 cm/sec, measured perpendicular to the slope with a minimum 0.15m topsoil layer capable of establishing vegetative cover	0.5 metres low permeability native soil Lateral drainage layer (DRAINTUBE[1M]) LDPE liner 0.3 metres landfill gas collection layer Existing cover
Maximum access road grade	8 percent	8 percent

Table 4.2 Waste Data

Year	SCRD Population	Sechelt Landfill Service Area Population [a]	Tonnes per Person per Year	Tonnes of Waste	Total Waste Landfilled (tonnes)
1977	15,848	14,184	0.71	10,000	10,000
1978	16,008	14,327	0.70	10,000	20,000
1979	16,169	14,472	0.69	10,000	30,000
1980	16,333	14,618	0.68	10,000	40,000
1981	16,498	14,766	0.74	11,000	51,000
1982	16,664	14,915	0.74	11,000	62,000
1983	16,833	15,065	0.73	11,000	73,000
1984	17,003	15,217	0.72	11,000	84,000
1985	17,175	15,371	0.72	11,000	95,000
1986	17,348	15,526	0.77	12,000	107,000
1987	17,666	15,811	0.76	12,000	119,000
1988	18,379	16,449	0.73	12,000	131,000
1989	19,212	17,195	0.70	12,000	143,000
1990	20,497	18,345	0.65	12,000	155,000
1991	21,337	19,097	0.63	12,000	167,000
1992	22,209	19,877	0.60	12,000	179,000
1993	23,270	20,827	0.82	17,062	196,062
1994	24,267	21,719	0.54	11,684	207,746
1995	24,945	22,326	0.52	11,574	219,320
1996	25,781	23,074	0.50	11,532	230,852
1997	26,101	23,360	0.51	11,884	242,736
1998	26,233	23,479	0.45	10,658	253,394
1999	26,178	23,429	0.47	11,054	264,448
2000	25,976	23,249	0.45	10,514	274,962
2001	25,947	23,223	0.48	11,036	285,998
2002	26,177	23,428	0.47	10,992	296,990
2003	26,450	23,673	0.49	11,647	308,637
2004	26,619	23,824	0.56	13,375	322,012
2005	27,349	24,477	0.56	13,741	335,753
2006	27,921	24,989	0.54	13,436	349,189
2007	28,198	25,237	0.50	12,630	361,819
2008	28,462	25,473	0.46	11,639	373,458
2009	28,528	25,533	0.46	11,784	385,242
2010	28,590	25,588	0.45	11,510	396,752
2011	28,918	25,882	0.43	11,108	407,860
2012	29,222	26,154	0.40	10,524	418,384
2013	29,270	26,197	0.35	9,071	427,455
2014	29,512	26,413	0.40	10,446	437,901
2015	29,390	27,498	0.40	11,067	448,968
2016	29,243	29,243	0.43	12,667	461,635
2017	29,903	29,903	0.43	12,858	474,493
2018	30,269	30,269	0.43	13,016	487,509
2019	30,620	30,620	0.43	13,167	500,676
2020	30,968	30,968	0.43	13,316	513,992
2021	31,308	31,308	0.43	13,462	527,454
2022	31,646	31,646	0.43	13,608	541,062
2023	31,985	31,985	0.43	13,754	554,816
2024	32,313	32,313	0.43	13,895	568,710
2025	32,638	32,638	0.43	14,034	582,745
2026	32,956	32,956	0.43	14,171	596,916
2027	33,273	33,273	0.43	14,307	611,223
2028	33,583	33,583	0.43	14,441	625,664
2029	33,891	33,891	0.43	14,573	640,237
2030	34,195	34,195	0.43	14,704	654,941
2031	34,490	34,490	0.43	14,831	669,771
2032	34,779	34,779	0.43	14,955	684,726
2033	35,065	35,065	0.43	15,078	699,804
2034	35,339	35,339	0.43	15,196	715,000
2035	35,604	35,604	0.43	15,310	730,310
2036	35,861	35,861	0.43	15,420	745,730

Notes:

a - Accounts for Pender Harbour Landfill from 1977 until its closure in July of 2015.

1. Historic and future (1985 - 2036) population data from BC Stats.
2. Population growth between 1977 and 1985 estimated to be 1 percent.
3. Service population for Sechelt Landfill estimated to be 89.5 percent of total SCRD population for the years of 1971 - 2014.
4. Service population for Sechelt Landfill in 2015 is calculated based on an estimated 89.5 percent of the total SCRD population up to July 20, 2015 and 100 percent of the population for the remainder of the year.
5. Waste tonnages (1971 - 1977) assumed to be negligible due to waste burning practices.
6. Waste tonnages (1977 - 1994) provided by Golder Associates Ltd. (2008), "Inventory of Greenhouse Gas Generation from Landfills in British Columbia."
7. Waste tonnages (1995 - 2016) provided by the SCRD.
8. Per capita waste generation (2017 - 2036) assumed to be 0.43 tonnes per year based on rate calculated for 2016.

Table 4.3 Waste Composition (2008)

Waste Category	Waste Composition Sechelt Landfill [a,b]
Relatively Inert	
Glass	1.6%
Metals	5.0%
Plastics	11.0%
Rubber and Leather	0.4%
Total	18.0%
Moderately Decomposable	
Paper	14.0%
Other	16.0%
Total	30.0%
Decomposable	
Organic Waste	45.0%
Textiles	7.0%
Total	52.0%

Notes:
a - Golder Associates Ltd., December 2008. "Sechelt Landfill and Biosolids Management Project."
b - Percent Mass.

Table 4.4 Waste Composition (2014)

Waste Category	Waste Composition Sechelt Landfill [a,b]
Relatively Inert	
Non-refundable glass (PPP)	2.0%
Refundables (glass and non-glass)	2.0%
Plastic [Film PPP EPR, Rigid PPP EPR, styrofoam (PPP EPR)]	11.0%
Plastic (Film - all other film plastic, other plastics, styrofoam - all other)	6.0%
Electronic Waste	1.0%
Metals	3.0%
Total	25.0%
Moderately Decomposable	
Paper	2.0%
Newsprint	1.0%
OCC	1.0%
Boxboard	2.0%
Other paper	2.0%
Building material	2.0%
Household hygiene	8.0%
Refuse	3.0%
Textiles	6.0%
Total	27.0%
Decomposable	
Food scraps and kitchen waste	35.0%
Yard and garden waste	1.0%
Pet waste	4.0%
Food soiled papers	9.0%
Total	49.0%

Notes:
a - Table 9 from Dillon Consulting Ltd., December 2014. "Waste Composition Audit - Sunshine Coast Regional District."
b - Percent Mass.

Table 5.1 Development Summary

Development Stage	Stage Air Space (m^3)	Cumulative Air Space (m^3)	Estimated Stage Life (months)	Cumulative Life (years)	Year Capacity Reached
Stage F	10,800	10,800	7	0.6	2,018
Stage G	21,600	32,400	13	1.6	2,019
Stage H	42,700	75,100	26	3.8	2,021
Stage I	28,200	103,300	17	5.2	2,022
Stage J	25,400	128,700	15	6.4	2,023
Stage K	24,700	153,400	14	7.6	2,025
Final Stage	19,400	172,800	11	8.5	2,026

Table 6.1 Final Cover Soil Requirements

Design Criteria		
Final Cover Organic Soil Thickness	0.15	m
Low Permeability Soil Thickness	0.5	m
Landfill Gas Collection (Sand) Layer Thickness	0.3	m
Total Final Cover Thickness	0.95	m
Soil Required		
Daily/intermediate Cover		
Total volume of native fill material required for daily/intermediate cover	34,560	m^3
Final Cover		
Volume topsoil required for final cover	7,083	m^3
Volume native fill material required for final cover	23,610	m^3
Volume sand required for final cover	14,166	m^3

Notes:
1. All calculations are based on proposed final contours.
2. Volume of soil based on a waste to daily/intermediate cover ratio of 4:1.

Table 6.2 Projected Airspace Consumption by Stage

Stage	Waste Landfilled (tonnes)	Cumulative Waste Landfilled (tonnes)	Airspace Consumed (m^3)	Cumulative Airspace Consumed (m^3)	Maximum Volume of Daily/intermediate Cover (m^3)	Cumulative Volume of Daily/intermediate Cover (m^3)
Stage F	7,128	7,128	10,800	10,800	2,160	2,160
Stage G	14,256	21,384	21,600	32,400	4,320	6,480
Stage H	28,182	49,566	42,700	75,100	8,540	15,020
Stage I	18,612	68,178	28,200	103,300	5,640	20,660
Stage J	16,764	84,942	25,400	128,700	5,080	25,740
Stage K	16,302	101,244	24,700	153,400	4,940	30,680
Final Stage	12,804	114,048	19,400	172,800	3,880	34,560

Notes:
1. Waste Landfilled based upon populations from BC Stats.
2. Airspace consumption after 2016 based upon an apparent density of 0.66 tonnes per cubic metre.
3. Daily/intermediate cover consumption in 2016 based upon a 4:1 waste to daily/intermediate cover ratio.

Table 6.3 Projected Airspace Consumption Summary

Year	Waste Landfilled (tonnes)	Cumulative Waste Landfilled (tonnes)	Airspace Consumed (m^3)	Cumulative Airspace Consumed (m^3)	Maximum Volume of Daily/intermediate Cover (m^3)	Total Maximum Volume of Daily/intermediate Cover (m^3)
2017	12,858	12,858	19,482	19,482	3,896	3,896
2018	13,016	25,874	19,721	39,203	3,944	7,841
2019	13,167	39,041	19,949	59,152	3,990	11,830
2020	13,316	52,357	20,176	79,328	4,035	15,866
2021	13,462	65,819	20,398	99,726	4,080	19,945
2022	13,608	79,427	20,618	120,344	4,124	24,069
2023	13,754	93,181	20,839	141,183	4,168	28,237
2024	13,895	107,075	21,052	162,235	4,210	32,447
2025	6,973	114,048	10,565	172,800	2,113	34,560

Notes:
1. Waste Landfilled based upon populations from BC Stats.
2. Airspace consumption after 2016 based upon an apparent density of 0.66 tonnes per cubic metre
3. Daily cover consumption after 2016 based upon a 4:1 waste to daily/intermediate cover ratio

Table 7.1 Runoff Volume Summary

Development Stage	5-Year (m^3)	10-Year (m^3)	100-Year (m^3)
Existing Conditions [a]	2,935	3,368	4,733
Proposed Final Conditions [b]	1,422	1,739	2,787

Notes:
a - 24-hour storm duration.
b - Published intensity duration data from Environment Canada (1983-2004), Gibsons, British Columbia.

Table 8.1 Infiltration Rate Summary

Cover Type	Model	Slope (%)	Infiltration Rate (mm/yr)
Existing Daily Cover	HELP	3%	478
Existing Daily Cover	HELP	12%	474
Existing Intermediate Cover	HELP	3%	467
Existing Intermediate Cover (Road)	HELP	8%	465
Existing Intermediate Cover	HELP	12%	444
Existing Intermediate Cover	HELP	33%	448
Proposed Final Cover	HELP	10%	1
Proposed Final Cover	HELP	33%	1

Note:
1. Hydrological Evaluation of Landfill Performance (HELP) Model (USACE, 1997)

Table 8.2 Leachate Generation Rate Summary

Development Stage	Total Leachate Generation Rate (m^3/yr)
Existing Conditions	24,851
Progressive Closure during Stage H	16,864
Proposed Final Conditions	2,058

Note:
1. Hydrological Evaluation of Landfill Performance (HELP) Model (USACE, 1997)

Table 9.1 LFG Generation Constants

Material Type	K (yr^{-1})	Lo (m^3/tonne)
Inert	0.02	20
Moderately Decomposable	0.06	120
Decomposable	0.11	160

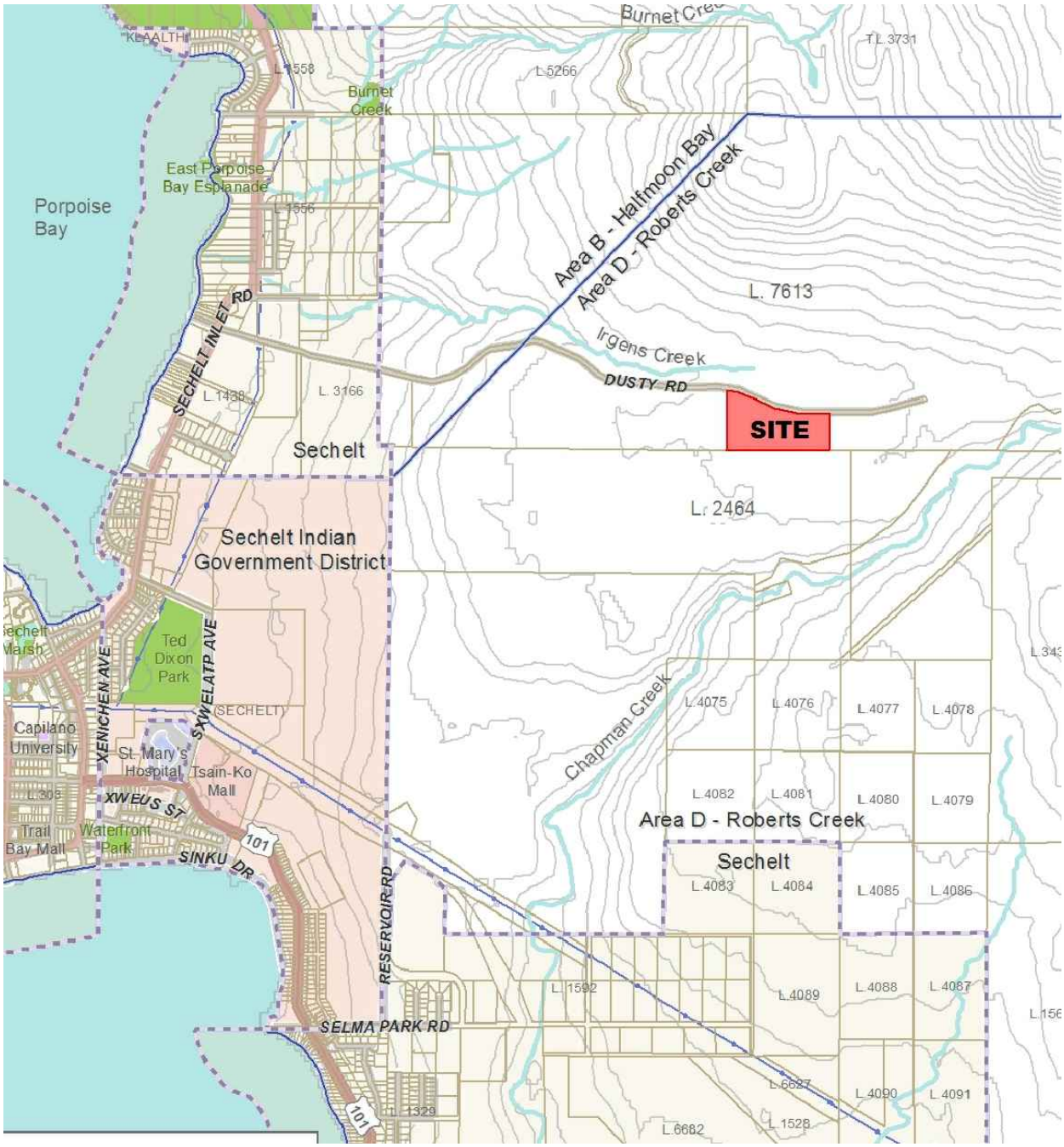
Note:
1. Source: CRA (2009).

Table 9.2 Soil Gas Trigger Concentrations

Location	Trigger (% LEL)
On-Site Structures	20
Off-Site Structures [(a)]	25
Property Boundary	100

Notes:
1. LEL - Lower Explosive Limit
2. Source: BC MOE, (2016). Landfill Criteria for Municipal Solid Waste
(a) Source: Operational Certificate No. 106060

FIGURES



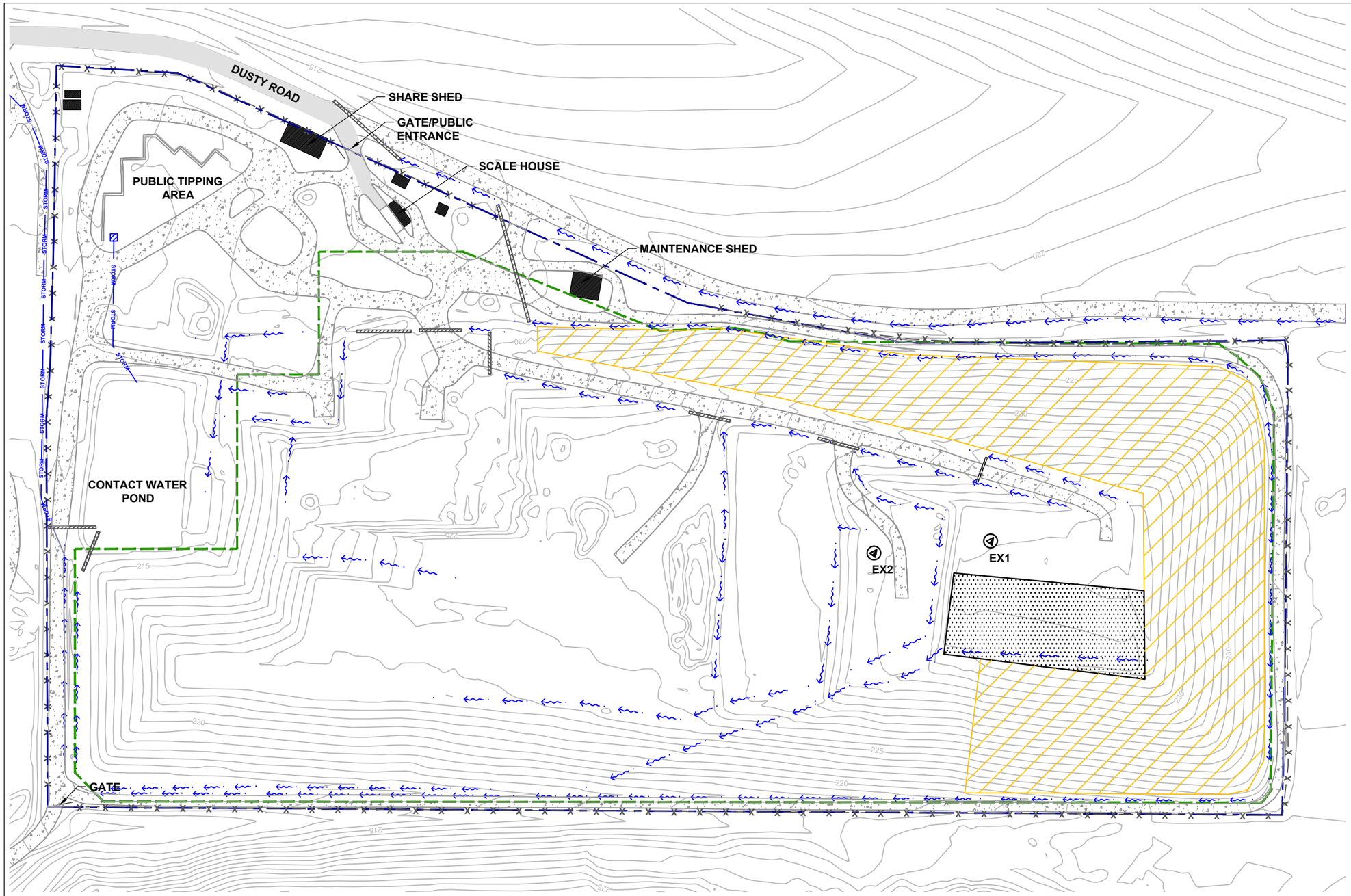
SITE LOCATION MAP

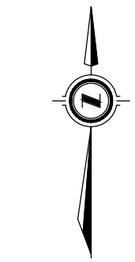
DESIGN, OPERATIONS AND CLOSURE PLAN
SECHELT LANDFILL
SUNSHINE COAST REGIONAL DISTRICT

XCG CONSULTING LTD.

DATE	JOB NO.	FIGURE NO.
DECEMBER 2017	4-2111-01-48	1.1

(file: R421110148001FIG1.1.dwg)





0 20 40 m

1 : 1500

LEGEND

- PROPERTY BOUNDARY
- APPROXIMATE LIMIT OF WASTE
- APPROXIMATE FENCE LINE
- EXISTING CONTOURS
- EXISTING ASPHALT ROAD
- EXISTING GRAVEL ROAD
- EXISTING BUILDING
- EXISTING TARPED AREA
- EXISTING FINAL COVER
- EXISTING CULVERT
- EXISTING SURFACE WATERCOURSE
- EXISTING STORMWATER GRAVITY MAIN
- EXISTING CATCHBASIN
- EX1 EXISTING LANDFILL GAS EXTRACTION WELL

NOTES: EXISTING CONDITIONS AS OF DECEMBER 4, 2016 (file: R421110148001FIG1.2.dwg)

SITE PLAN

DESIGN, OPERATIONS AND CLOSURE PLAN
SECHELT LANDFILL
SUNSHINE COAST REGIONAL DISTRICT

XCG CONSULTING LTD.

DATE	JOB NO.	FIGURE NO.
DECEMBER 2017	4-2111-01-48	1.2

DUSTY ROAD

SHARE SHED

GATE/PUBLIC ENTRANCE

SCALE HOUSE

PUBLIC TIPPING AREA

MAINTENANCE SHED

CONTACT WATER POND

GATE

0 20 40 m

1 : 1500

LEGEND

- PROPERTY BOUNDARY
- APPROXIMATE LIMIT OF WASTE
- APPROXIMATE FENCE LINE
- PROPOSED CONTOURS
- EXISTING ASPHALT ROAD
- EXISTING GRAVEL ROAD
- EXISTING BUILDING
- EXISTING STORMWATER GRAVITY MAIN
- EXISTING CATCHBASIN
- EXISTING CULVERT
- EXISTING SURFACE WATERCOURSE

(file: R421110148001FIG5.1.dwg)

SITE PLAN

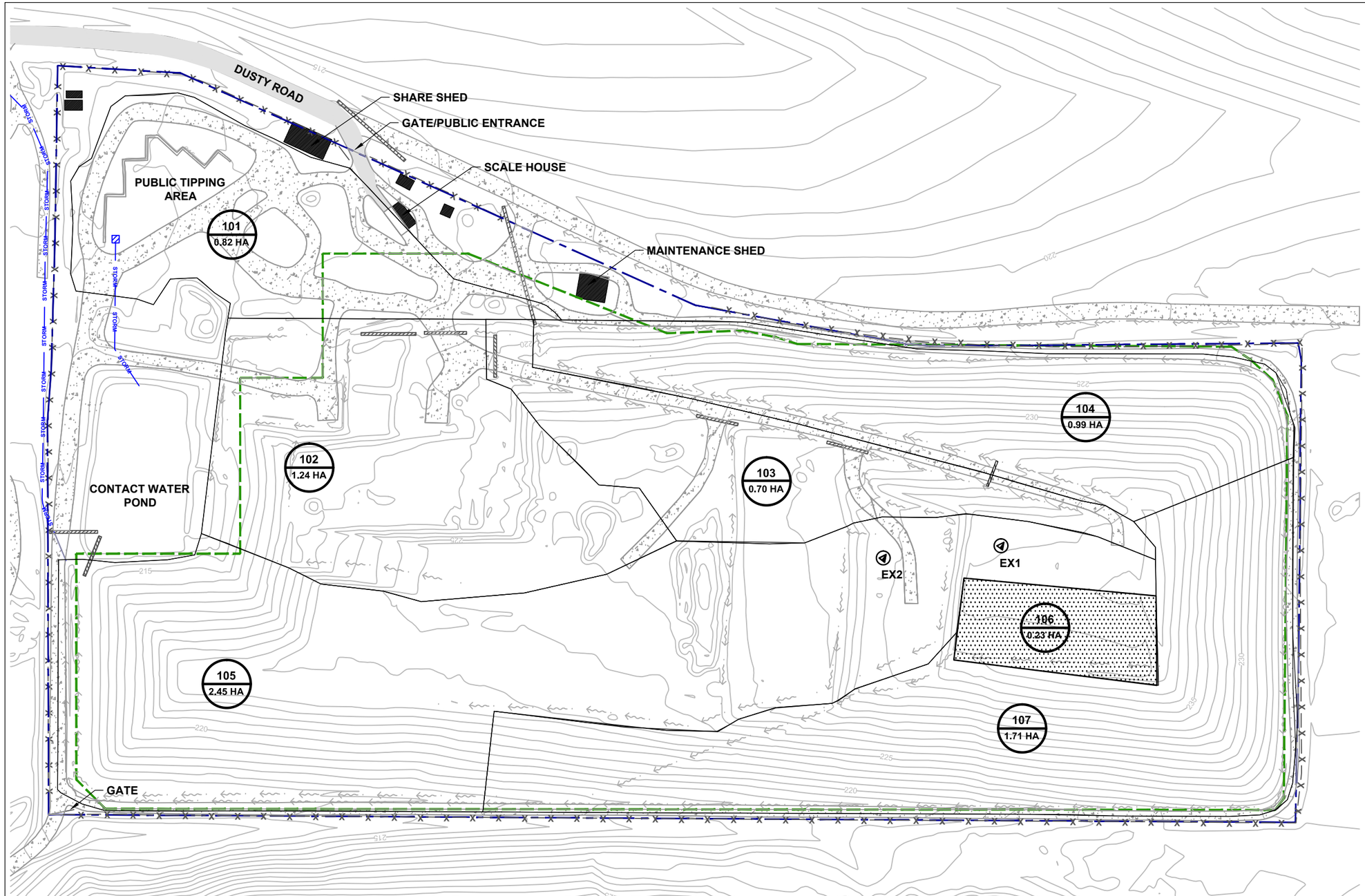
DESIGN, OPERATIONS AND CLOSURE PLAN

SECHELT LANDFILL

SUNSHINE COAST REGIONAL DISTRICT

XCG CONSULTING LTD.

DATE	JOB NO.	FIGURE NO.
DECMEBER 2017	4-2111-01-48	5.1



0 20 40 m

1 : 1500

LEGEND

- PROPERTY BOUNDARY
- APPROXIMATE FENCE LINE
- 230 EXISTING CONTOURS
- EXISTING ASPHALT ROAD
- EXISTING GRAVEL ROAD
- EXISTING BUILDING
- STORM STORM EXISTING STORMWATER GRAVITY MAIN
- EXISTING CATCHBASIN
- EXISTING CULVERT
- EXISTING SURFACE WATERCOURSE
- 101 0.82 HA SUBCATCHMENT
- EXISTING TARPED AREA
- EX1 EXISTING LANDFILL GAS EXTRACTION WELL
- EXISTING FINAL COVER

NOTES: EXISTING CONDITIONS AS OF DECEMBER 4, 2016 (file: R421110148001FIG7.1.dwg)

EXISTING SUBCATCHMENTS

DESIGN, OPERATIONS AND CLOSURE PLAN
SECHELT LANDFILL
SUNSHINE COAST REGIONAL DISTRICT

XCG CONSULTING LTD.

DATE	JOB NO.	FIGURE NO.
DECEMBER 2017	4-2111-01-48	7.1

DUSTY ROAD

SHARE SHED

GATE/PUBLIC ENTRANCE

SCALE HOUSE

MAINTENANCE SHED

PUBLIC TIPPING AREA

201
0.77 HA

202
2.05 HA

203
1.14 HA

204
4.23 HA

CONTACT WATER POND

GATE

N

0 20 40 m

1 : 1500

LEGEND

- PROPERTY BOUNDARY
- APPROXIMATE FENCE LINE
- EXISTING CONTOURS
- EXISTING ASPHALT ROAD
- EXISTING GRAVEL ROAD
- EXISTING BUILDING
- EXISTING STORMWATER GRAVITY MAIN
- EXISTING CATCHBASIN
- EXISTING CULVERT
- EXISTING SURFACE WATERCOURSE
- SUBCATCHMENT
- EXISTING FINAL COVER
- STORMWATER MANHOLE

(file: R421110148001FIG7.2.dwg)

POST DEVELOPMENT SUBCATCHMENTS

DESIGN, OPERATIONS AND CLOSURE PLAN

SECHELT LANDFILL

SUNSHINE COAST REGIONAL DISTRICT

XCG CONSULTING LTD.

DATE	JOB NO.	FIGURE NO.
DECEMBER 2017	4-2111-01-48	7.2

DUSTY ROAD

PUBLIC TIPPING AREA

SHARE SHED

GATE/PUBLIC ENTRANCE

SCALE HOUSE

GP13-01

GP13-02

MAINTENANCE SHED

GP17-01

CONTACT WATER POND

GATE

EX1

EX2

0 20 40 m

1 : 1000

LEGEND

- PROPERTY BOUNDARY
- APPROXIMATE LIMIT OF WASTE
- APPROXIMATE FENCE LINE
- EXISTING CONTOURS
- EXISTING ASPHALT ROAD
- EXISTING GRAVEL ROAD
- EXISTING BUILDING
- EXISTING STORMWATER
- EXISTING CATCHBASIN
- EXISTING CULVERT
- EXISTING SURFACE WATERCOURSE
- EXISTING TARPED AREA
- EXISTING LANDFILL GAS EXTRACTION WELL
- EXISTING FINAL COVER
- EXISTING LANDFILL GAS MONITORING WELL

NOTE: EXISTING CONDITIONS AS OF DECEMBER 4, 2016, MONITORING WELLS AS OF AUGUST 2017. (file: R421110148001FIG9.1.dwg)

LANDFILL GAS MONITORING LOCATIONS

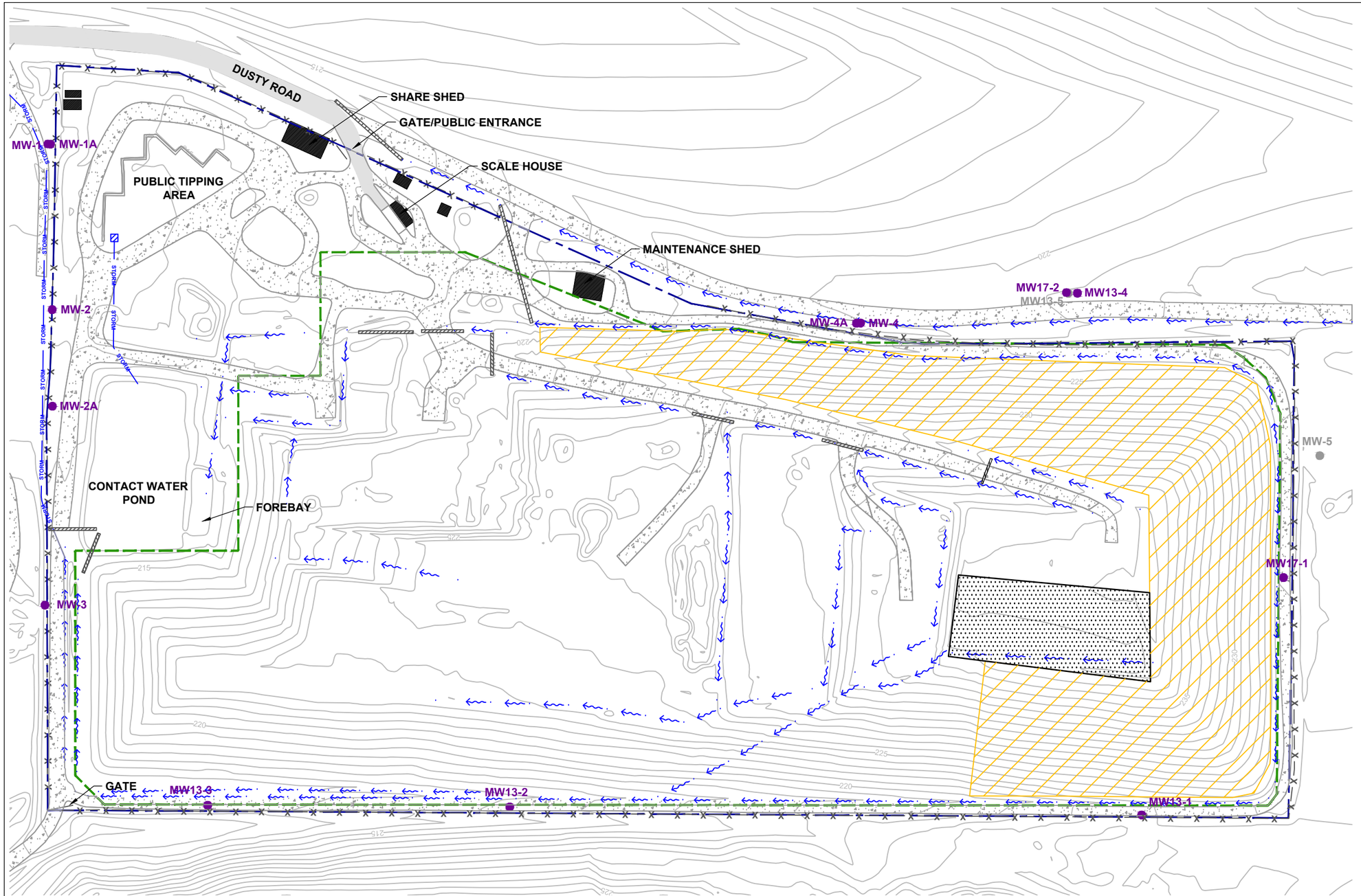
DESIGN, OPERATIONS AND CLOSURE PLAN

SECHELT LANDFILL

SUNSHINE COAST REGIONAL DISTRICT

XCG CONSULTANTS LTD.

DATE	JOB NO.	FIGURE NO.
DECEMBER 2017	4-2111-01-48	9.1



0 20 40 m

1 : 1500

LEGEND

- PROPERTY BOUNDARY
- APPROXIMATE LIMIT OF WASTE
- APPROXIMATE FENCE LINE
- EXISTING CONTOURS
- EXISTING ASPHALT ROAD
- EXISTING GRAVEL ROAD
- EXISTING BUILDING
- EXISTING TARPED AREA
- MW99-9 EXISTING GROUNDWATER MONITORING WELL
- MW99-9 DECOMMISSIONED GROUNDWATER MONITORING WELL
- EXISTING FINAL COVER
- EXISTING CULVERT
- EXISTING SURFACE WATERCOURSE
- STORM STORM EXISTING STORMWATER GRAVITY MAIN

NOTES: EXISTING CONDITIONS AS OF DECEMBER 4, 2016, MONITORING WELLS AS OF AUGUST 2017.

(file: R421110148001FIG12.1.dwg)

GROUNDWATER MONITORING LOCATIONS

DESIGN, OPERATIONS AND CLOSURE PLAN
SECHELT LANDFILL
SUNSHINE COAST REGIONAL DISTRICT

XCG CONSULTING LTD.

DATE	JOB NO.	FIGURE NO.
DECEMBER 2017	4-2111-01-48	12.1

0 500 1000 m

1 : 30000

LEGEND

SITE A SURFACE WATER SAMPLING LOCATION

WATERSHED BOUNDARIES

SURFACE WATER MONITORING LOCATIONS

DESIGN, OPERATIONS AND CLOSURE PLAN
SECHELT LANDFILL
SUNSHINE COAST REGIONAL DISTRICT

XCG CONSULTING LTD.

DATE	JOB NO.	FIGURE NO.
DECEMBER 2017	4-2111-01-48	12.2

(file: R421110147001FIG2.dwg)

DRAWINGS

KEY MAP

DRAWING INDEX

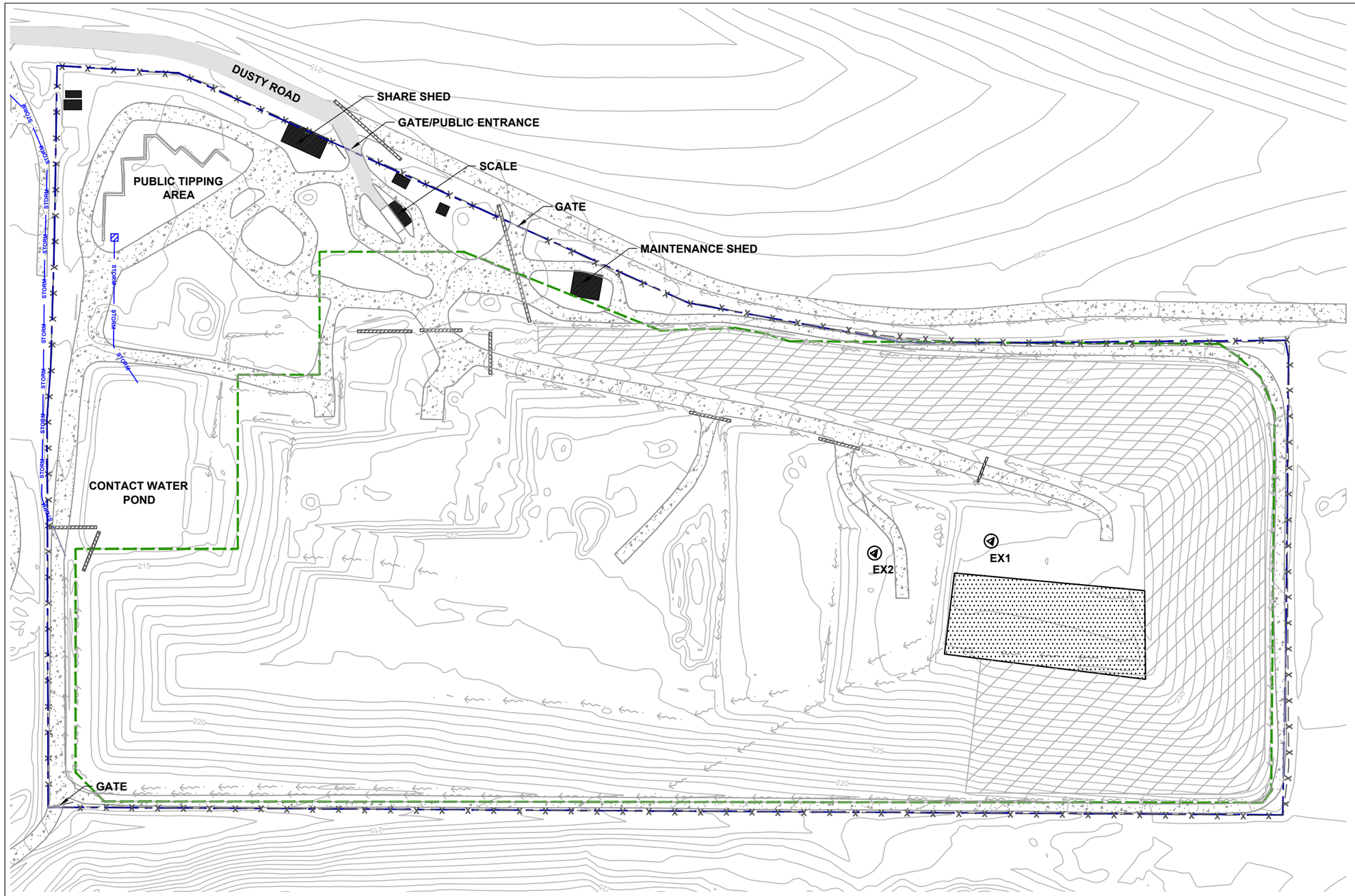
SHEET	REV. #	DATE	TITLE
D-01	1	DECEMBER 2017	EXISTING CONDITIONS
D-02	1	DECEMBER 2017	STAGE F
D-03	1	DECEMBER 2017	STAGE G
D-04	1	DECEMBER 2017	STAGE H
D-05	1	DECEMBER 2017	STAGE I
D-06	1	DECEMBER 2017	STAGE J
D-07	1	DECEMBER 2017	STAGE K
D-08	1	DECEMBER 2017	FINAL CONDITIONS
D-09	1	DECEMBER 2017	DETAILS I

DESIGN, OPERATIONS AND CLOSURE PLAN
SECHELT LANDFILL
SECHELT, BRITISH COLUMBIA

SUNSHINE COAST REGIONAL DISTRICT

XCG CONSULTING LTD.

(file: AB421110148001G01)



0 20 40 m

1 : 1500

LEGEND

- PROPERTY BOUNDARY
- APPROXIMATE LIMIT OF WASTE
- APPROXIMATE FENCE LINE
- EXISTING CONTOURS
- EXISTING ASPHALT ROAD
- EXISTING GRAVEL ROAD
- EXISTING BUILDING
- EXISTING STORMWATER GRAVITY MAIN
- EXISTING CATCHBASIN
- EXISTING CULVERT
- EXISTING SURFACE WATERCOURSE
- EXISTING TARPED AREA
- EX1 EXISTING LANDFILL GAS EXTRACTION WELL
- EXISTING FINAL COVER

NOTES: EXISTING CONDITIONS AS OF DECEMBER 4, 2016.

(file: R421110148001DWG01.dwg)

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
0	ISSUED FOR REVIEW	JULY 2017	JULY 2017
1	ISSUED FOR REVIEW	DEC. 2017	DEC. 2017
2	ISSUED FINAL	DEC. 2017	DEC. 2017

DESIGN, OPERATIONS AND CLOSURE PLAN

SECHELT LANDFILL

SUNSHINE COAST REGIONAL DISTRICT

VERIFY SCALE

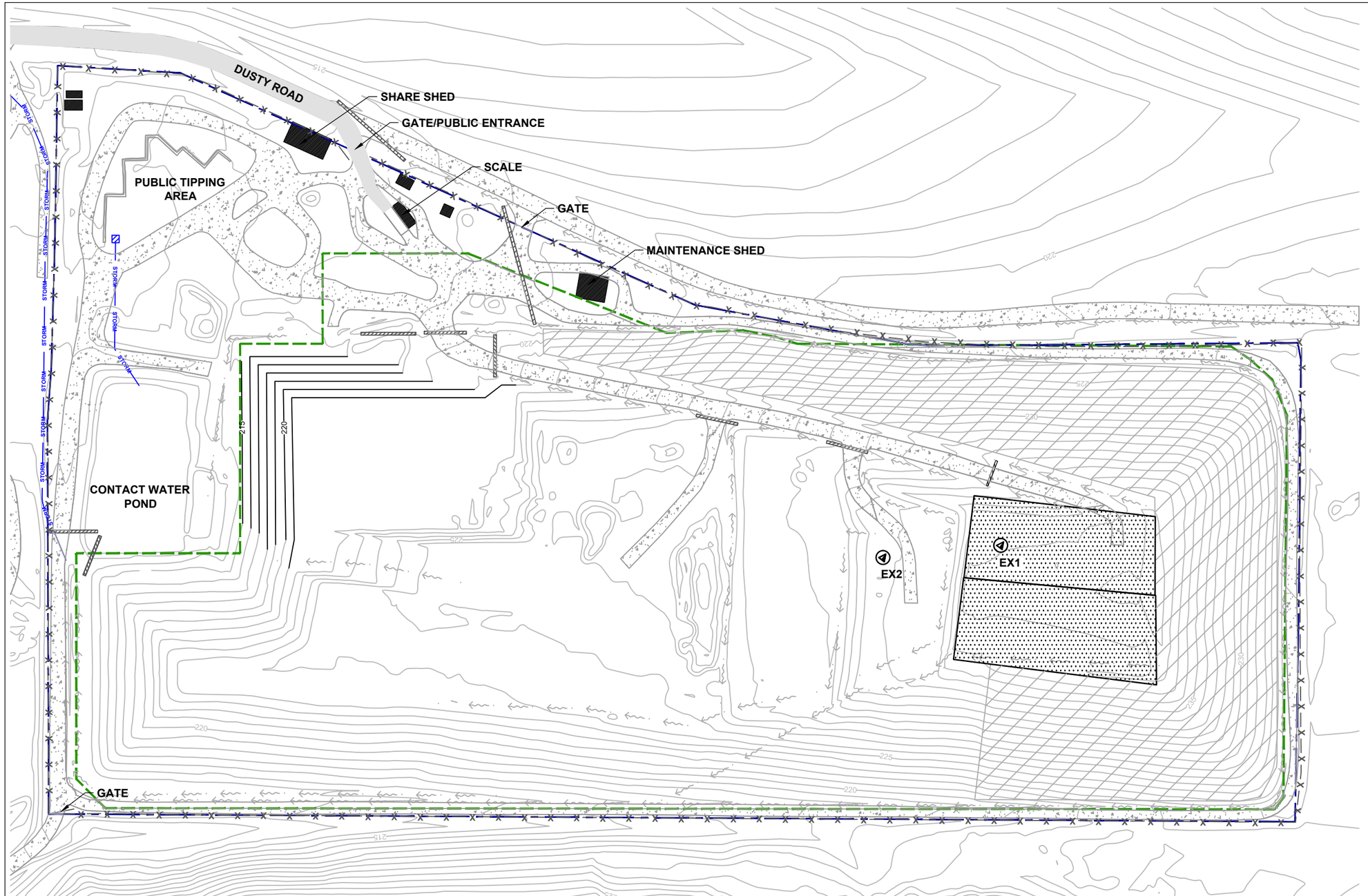
BAR IS 10 mm ON ORIGINAL DRAWING.
0 10 mm
IF NOT 10 mm ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

EXISTING CONDITIONS

XCG CONSULTING LTD.

Date:	Location:	Rev.
DECEMBER 2017	SECHELT, B.C.	2

Scale:		Sheet:
1 : 1500	4-2111-01-48	C-01



0 20 40 m

1 : 1500

LEGEND

- PROPERTY BOUNDARY
- APPROXIMATE LIMIT OF WASTE
- APPROXIMATE FENCE LINE
- EXISTING CONTOURS
- PROPOSED TOP OF WASTE CONTOURS
- EXISTING ASPHALT ROAD
- EXISTING GRAVEL ROAD
- EXISTING BUILDING
- EXISTING STORMWATER GRAVITY MAIN
- EXISTING CATCHBASIN
- EXISTING CULVERT
- EXISTING SURFACE WATERCOURSE
- EXISTING TARPED AREA
- EX1 EXISTING LANDFILL GAS EXTRACTION WELL
- EXISTING FINAL COVER

NOTES: EXISTING CONDITIONS AS OF DECEMBER 4, 2016.

(file: R421110148001DWG02.dwg)

REVISIONS

REV	DESCRIPTION	DATE	APPROVED
0	ISSUED FOR REVIEW	JULY 2017	JULY 2017
1	ISSUED FOR REVIEW	DEC. 2017	DEC. 2017
2	ISSUED FINAL	DEC. 2017	DEC. 2017

DESIGN, OPERATIONS AND CLOSURE PLAN

SECHELT LANDFILL

SUNSHINE COAST REGIONAL DISTRICT

VERIFY SCALE

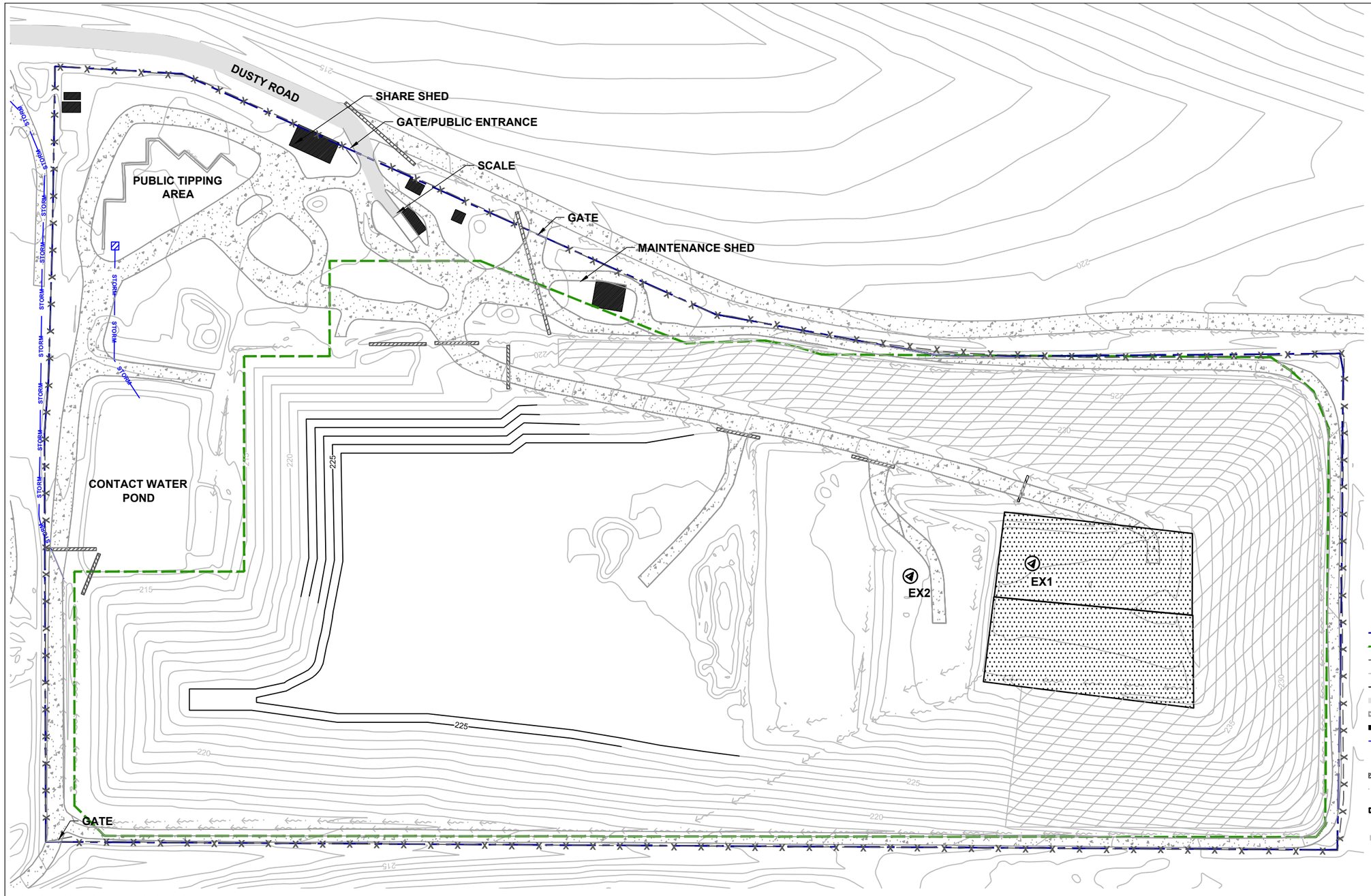
BAR IS 10 mm ON ORIGINAL DRAWING.
0 ▬▬ 10 mm
IF NOT 10 mm ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

STAGE F

XCG CONSULTING LTD.

Date:	Location:	Rev.
DECEMBER 2017	SECHELT, B.C.	2

Scale:		Sheet:
1 : 1500	4-2111-01-48	C-02



NOTES: EXISTING CONDITIONS AS OF DECMEBER 4, 2016.

(file: R421110148001DWG03.dwg)

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
0	ISSUED FOR REVIEW	JULY 2017	JULY 2017
1	ISSUED FOR REVIEW	DEC. 2017	DEC. 2017
2	ISSUED FINAL	DEC. 2017	DEC. 2017

DESIGN, OPERATIONS AND CLOSURE PLAN

SECHELT LANDFILL

SUNSHINE COAST REGIONAL DISTRICT

VERIFY SCALE

BAR IS 10 mm ON ORIGINAL DRAWING.
0 10 mm
IF NOT 10 mm ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

STAGE G

XCG CONSULTING LTD.

Date:	Location:	Rev.
DECEMBER 2017	SECHELT, B.C.	2

Scale:		Sheet:
1 : 1500	4-2111-01-48	C-03

DUSTY ROAD

SHARE SHED

GATE/PUBLIC ENTRANCE

SCALE

GATE

MAINTENANCE SHED

PUBLIC TIPPING AREA

REMOVE CULVERT

PROPOSED HAUL ROAD

CONTACT WATER POND

REMOVE CULVERT AND ALTER DITCH ALIGNMENT TO FLOW INTO POND

EX1

EX2

230

FILL IN DITCH

GATE

INSTALL FINAL COVER

01
D-09

0 20 40 m

1 : 1500

LEGEND

- PROPERTY BOUNDARY
- APPROXIMATE LIMIT OF WASTE
- APPROXIMATE FENCE LINE
- EXISTING CONTOURS
- PROPOSED TOP OF WASTE CONTOURS
- EXISTING ASPHALT ROAD
- EXISTING GRAVEL ROAD
- EXISTING BUILDING
- EXISTING STORMWATER GRAVITY MAIN
- EXISTING CATCHBASIN
- EXISTING CULVERT
- EXISTING SURFACE WATERCOURSE
- EXISTING TARPED AREA
- EX1 EXISTING LANDFILL GAS EXTRACTION WELL
- EXISTING FINAL COVER
- PROPOSED FINAL COVER

NOTES: EXISTING CONDITIONS AS OF DECEMBER 4, 2016.

(file: R421110148001DWG04.dwg)

REVISIONS

REV	DESCRIPTION	DATE	APPROVED
0	ISSUED FOR REVIEW	JULY 2017	JULY 2017
1	ISSUED FOR REVIEW	DEC. 2017	DEC. 2017
2	ISSUED FINAL	DEC. 2017	DEC. 2017

DESIGN, OPERATIONS AND CLOSURE PLAN

SECHELT LANDFILL

SUNSHINE COAST REGIONAL DISTRICT

VERIFY SCALE

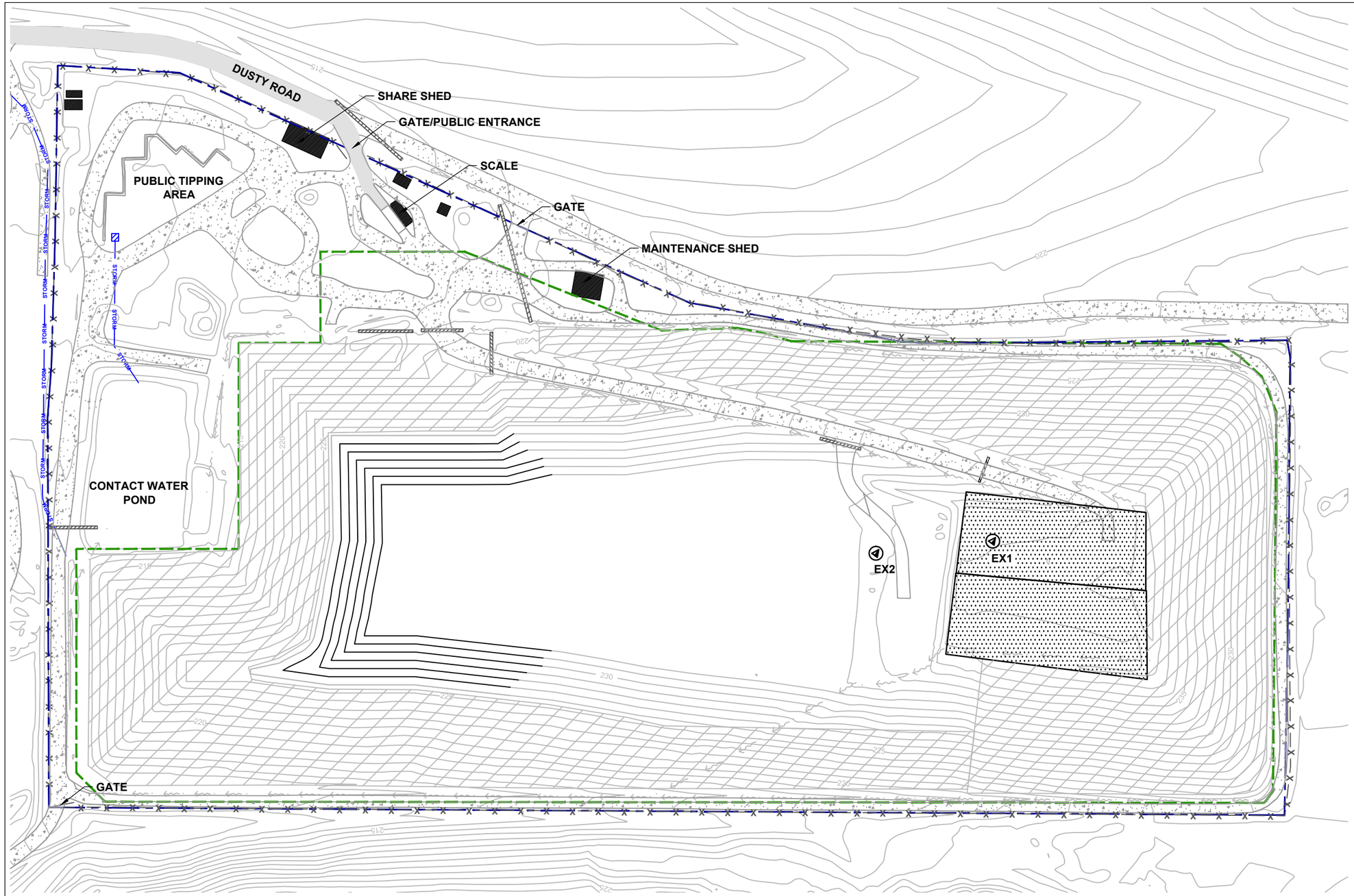
BAR IS 10 mm ON ORIGINAL DRAWING.
0 10 mm
IF NOT 10 mm ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

STAGE H

XCG CONSULTANTS LTD.

Date: DECEMBER 2017 | Location: SECHELT, B.C. | Rev. 2

Scale: 1 : 1500 | 4-2111-01-48 | Sheet: C-04



0 20 40 m

1 : 1500

LEGEND

- PROPERTY BOUNDARY
- APPROXIMATE LIMIT OF WASTE
- APPROXIMATE FENCE LINE
- EXISTING CONTOURS
- PROPOSED TOP OF WASTE CONTOURS
- EXISTING ASPHALT ROAD
- EXISTING GRAVEL ROAD
- EXISTING BUILDING
- EXISTING STORMWATER GRAVITY MAIN
- EXISTING CATCHBASIN
- EXISTING CULVERT
- EXISTING SURFACE WATERCOURSE
- EXISTING TARPED AREA
- EX1 EXISTING LANDFILL GAS EXTRACTION WELL
- EXISTING FINAL COVER

NOTES: EXISTING CONDITIONS AS OF DECEMBER 4, 2016.

(file: R421110148001DWG05.dwg)

REVISIONS

REV	DESCRIPTION	DATE	APPROVED
0	ISSUED FOR REVIEW	JULY 2017	JULY 2017
1	ISSUED FOR REVIEW	DEC. 2017	DEC. 2017
2	ISSUED FINAL	DEC. 2017	DEC. 2017

DESIGN, OPERATIONS AND CLOSURE PLAN

SECHELT LANDFILL

SUNSHINE COAST REGIONAL DISTRICT

VERIFY SCALE

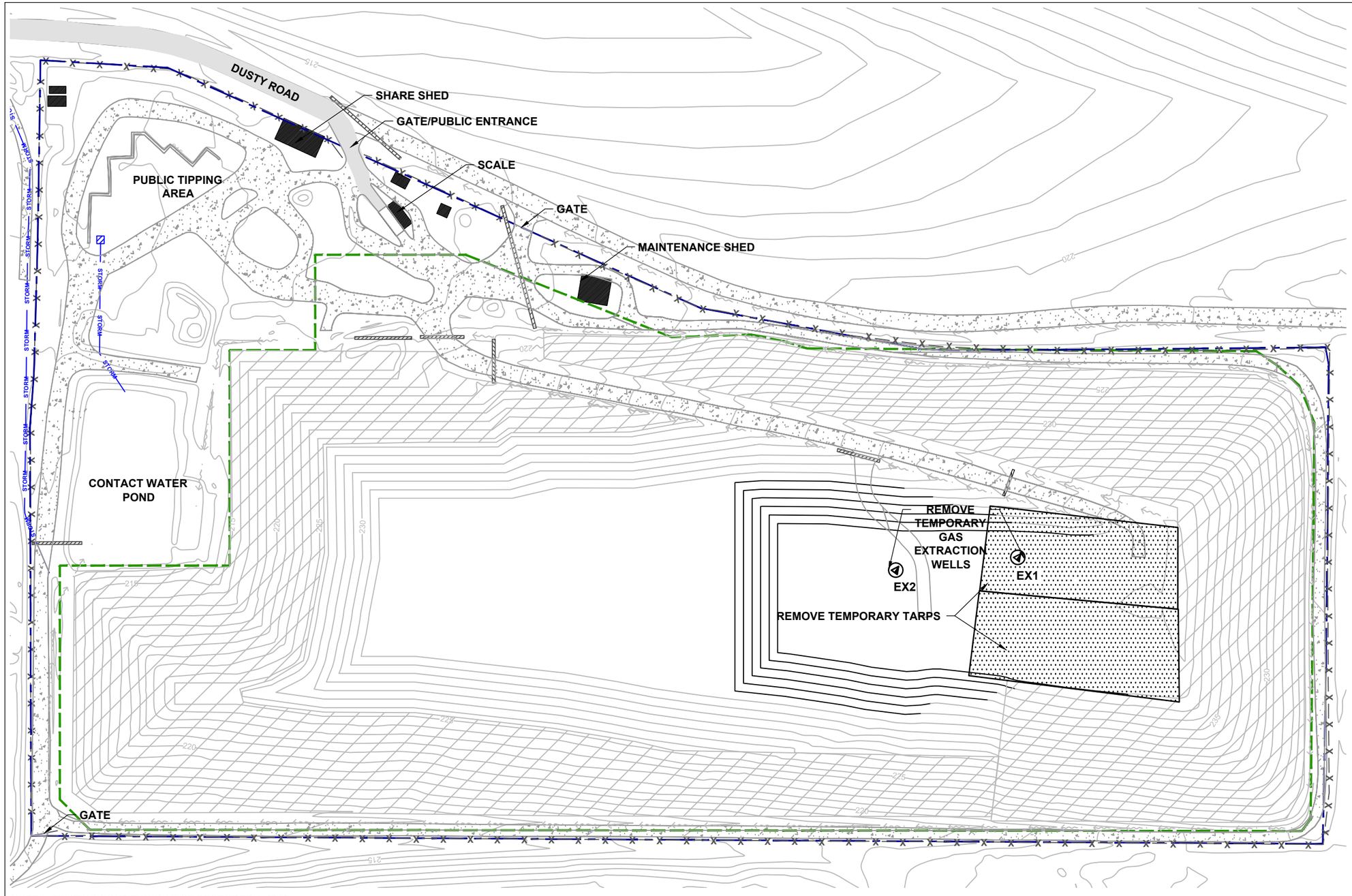
BAR IS 10 mm ON ORIGINAL DRAWING.
0 10 mm
IF NOT 10 mm ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

STAGE I

XCG CONSULTING LTD.

Date:	Location:	Rev.
DECEMBER 2017	SECHELT, B.C.	2

Scale:		Sheet:
1 : 1500	4-2111-01-48	C-05



0 20 40 m

1 : 1500

LEGEND

- PROPERTY BOUNDARY
- APPROXIMATE LIMIT OF WASTE
- APPROXIMATE FENCE LINE
- EXISTING CONTOURS
- PROPOSED TOP OF WASTE CONTOURS
- EXISTING ASPHALT ROAD
- EXISTING GRAVEL ROAD
- EXISTING BUILDING
- EXISTING STORMWATER GRAVITY MAIN
- EXISTING CATCHBASIN
- EXISTING CULVERT
- EXISTING SURFACE WATERCOURSE
- EXISTING TARPED AREA
- EX1 EXISTING LANDFILL GAS EXTRACTION WELL
- EXISTING FINAL COVER

NOTES: EXISTING CONDITIONS AS OF DECEMBER 4, 2016.

(file: R421110148001DWG06.dwg)

REVISIONS

REV	DESCRIPTION	DATE	APPROVED
0	ISSUED FOR REVIEW	JULY 2017	JULY 2017
1	ISSUED FOR REVIEW	DEC. 2017	DEC. 2017
2	ISSUED FINAL	DEC. 2017	DEC. 2017

DESIGN, OPERATIONS AND CLOSURE PLAN

SECHELT LANDFILL

SUNSHINE COAST REGIONAL DISTRICT

VERIFY SCALE

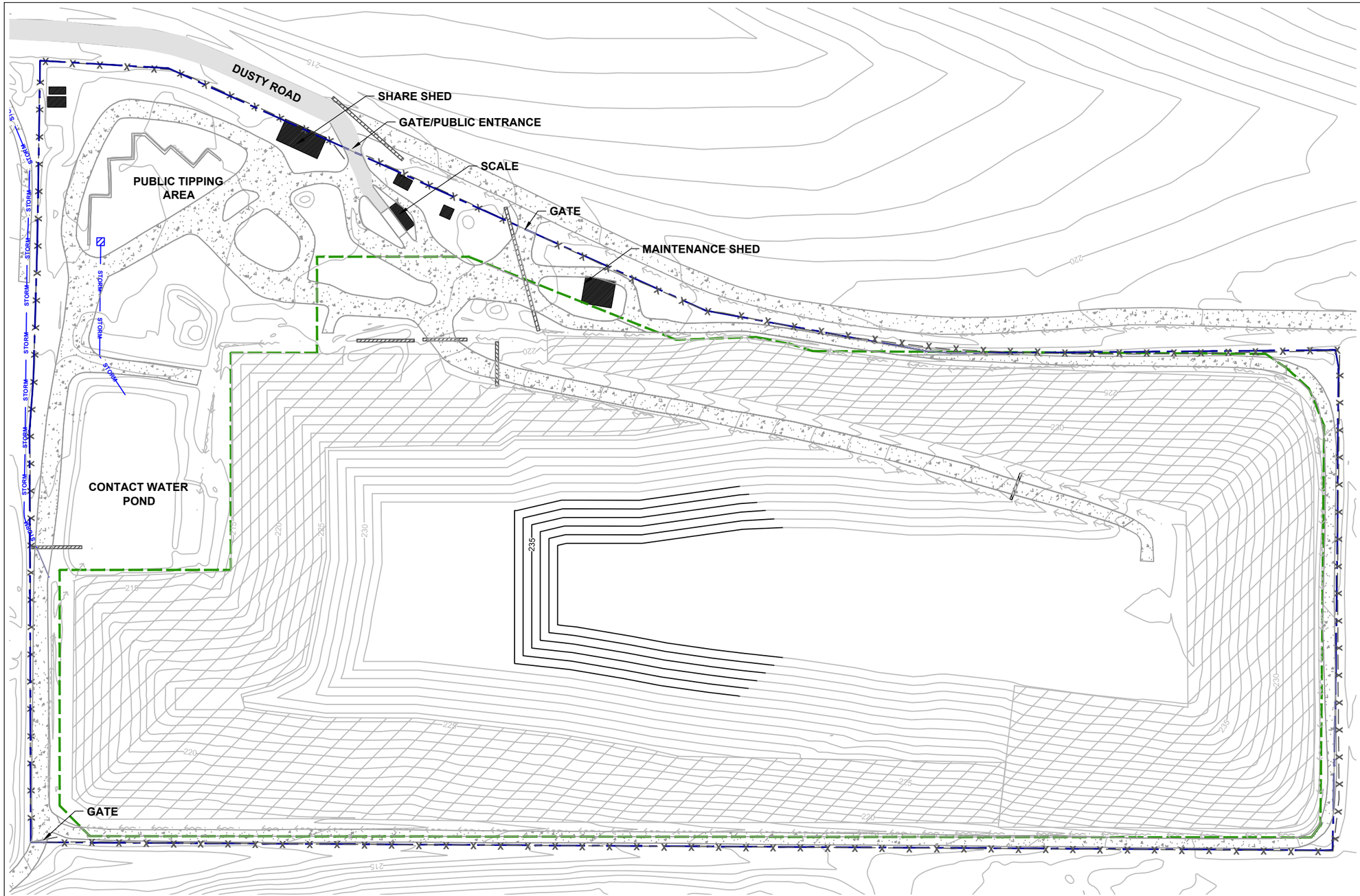
BAR IS 10 mm ON ORIGINAL DRAWING.
0 10 mm
IF NOT 10 mm ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

STAGE J

XCG CONSULTING LTD.

Date:	Location:	Rev.
DECEMBER 2017	SECHELT, B.C.	2

Scale:		Sheet:
1 : 1500	4-2111-01-48	C-06



0 20 40 m

1 : 1500

LEGEND

- PROPERTY BOUNDARY
- APPROXIMATE LIMIT OF WASTE
- APPROXIMATE FENCE LINE
- EXISTING CONTOURS
- PROPOSED CONTOURS
- EXISTING ASPHALT ROAD
- EXISTING GRAVEL ROAD
- EXISTING BUILDING
- EXISTING STORMWATER GRAVITY MAIN
- EXISTING CATCHBASIN
- EXISTING CULVERT
- EXISTING SURFACE WATERCOURSE
- EXISTING FINAL COVER

NOTES: EXISTING CONDITIONS AS OF DECEMBER 4, 2016.

(file: R421110148001DWG07.dwg)

REVISIONS

REV	DESCRIPTION	DATE	APPROVED
0	ISSUED FOR REVIEW	JULY 2017	JULY 2017
1	ISSUED FOR REVIEW	DEC. 2017	DEC. 2017
2	ISSUED FINAL	DEC. 2017	DEC. 2017

DESIGN, OPERATIONS AND CLOSURE PLAN

SECHELT LANDFILL

SUNSHINE COAST REGIONAL DISTRICT

VERIFY SCALE

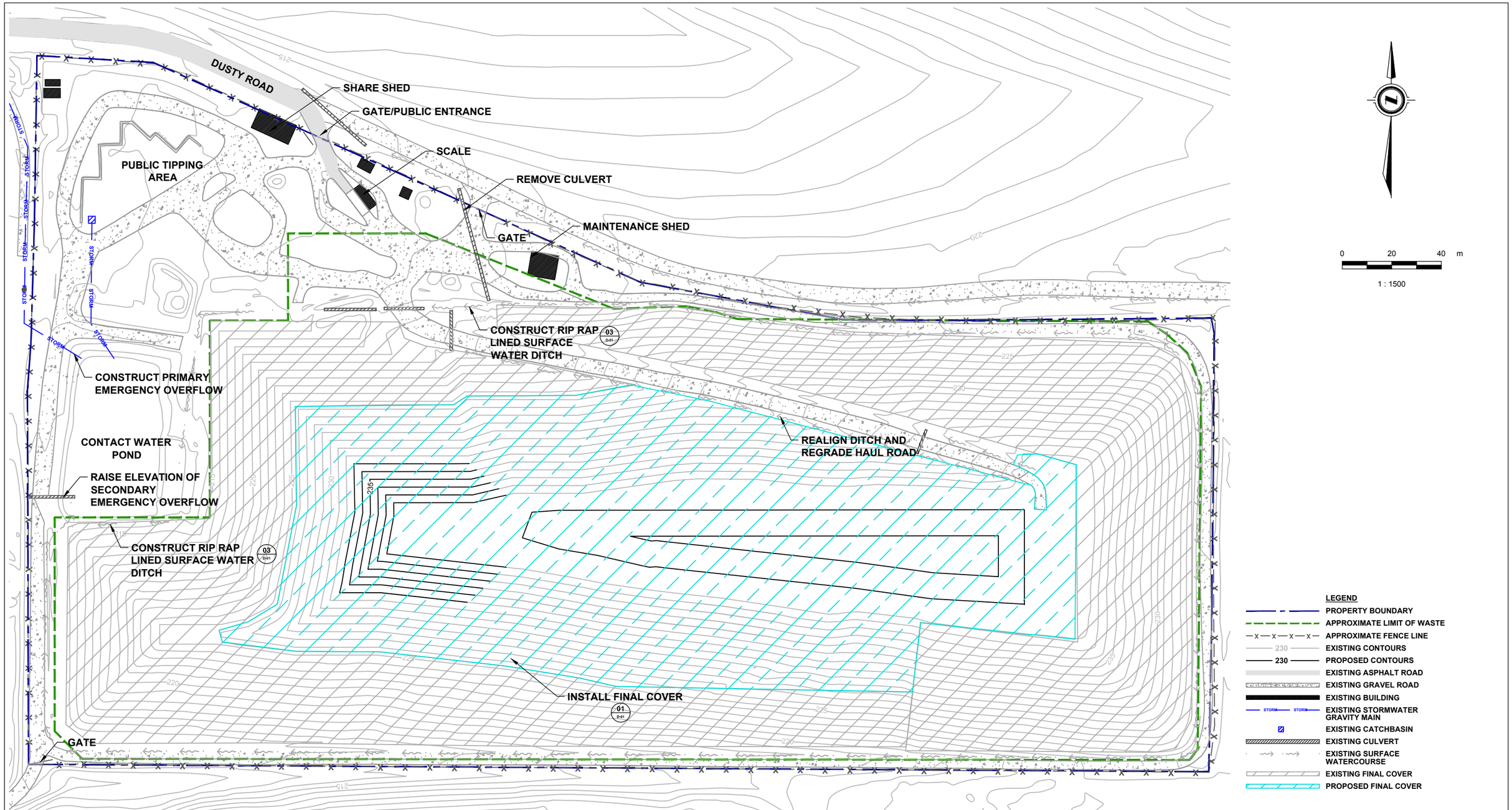
BAR IS 10 mm ON ORIGINAL DRAWING.
0 10 mm
IF NOT 10 mm ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

STAGE K

XCG CONSULTING LTD.

Date:	Location:	Rev.
DECEMBER 2017	SECHELT, B.C.	2

Scale:		Sheet:
1 : 1500	4-2111-01-48	C-07



NOTES: EXISTING CONDITIONS AS OF DECEMBER 4, 2016.

(file: R4211101480001DWG08.dwg)

REVISIONS

REV	DESCRIPTION	DATE	APPROVED
0	ISSUED FOR REVIEW	JULY 2017	JULY 2017
1	ISSUED FOR REVIEW	DEC. 2017	DEC. 2017
2	ISSUED FINAL	DEC. 2017	DEC. 2017

DESIGN, OPERATIONS AND CLOSURE PLAN

SECHELT LANDFILL

SUNSHINE COAST REGIONAL DISTRICT

VERIFY SCALE

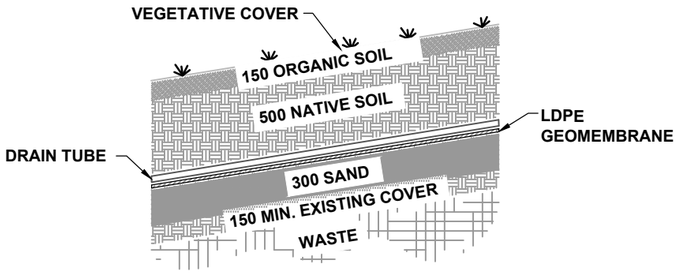
BAR IS 10 mm ON ORIGINAL DRAWING.
0 ▬ 10 mm
IF NOT 10 mm ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

FINAL STAGE

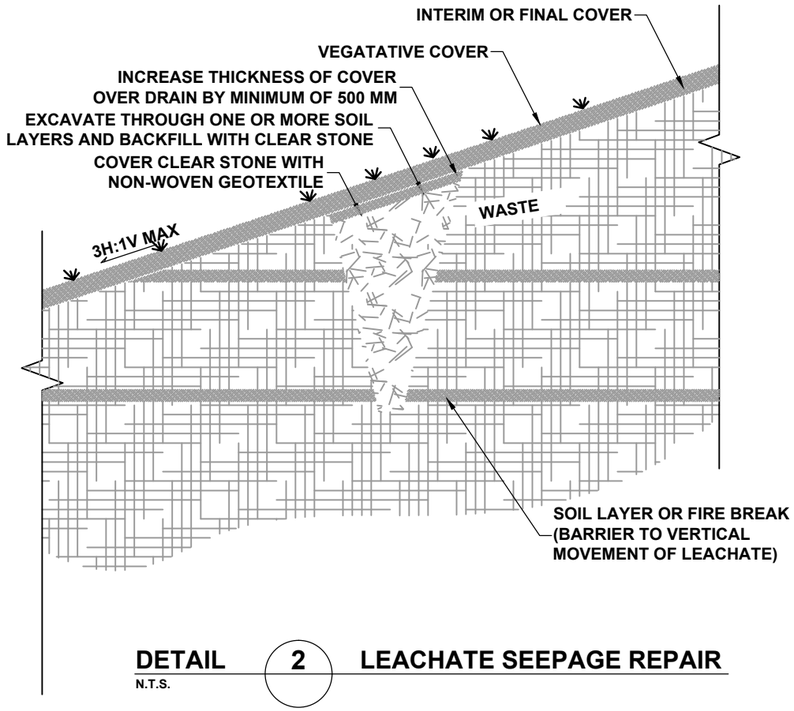
XCG CONSULTING LTD.

Date:	Location:	Rev.
DECEMBER 2017	SECHELT, B.C.	2

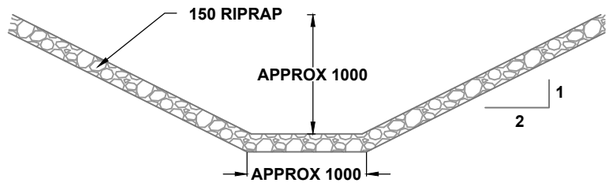
Scale:		Sheet:
1 : 1500	4-2111-01-48	C-08



DETAIL 1 FINAL COVER
N.T.S.
D-04/D-08



DETAIL 2 LEACHATE SEEPAGE REPAIR
N.T.S.



DETAIL 3 TYPICAL RIPRAP LINED SURFACE WATER DITCH
N.T.S.

(file: R421110148001DWG09+.dwg)

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
0	ISSUED FOR REVIEW	JULY 2017	JULY 2017
1	ISSUED FOR REVIEW	DEC. 2017	DEC. 2017
2	ISSUED FINAL	DEC. 2017	DEC. 2017

DESIGN, OPERATIONS AND CLOSURE PLAN

SECHELT LANDFILL

SUNSHINE COAST REGIONAL DISTRICT

VERIFY SCALE

BAR IS 10 mm ON ORIGINAL DRAWING.
0 10 mm
IF NOT 10 mm ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

DETAILS I

XCG CONSULTING LTD.

Date: DECEMBER 2017 | Location: SECHELT, B.C. | Rev. 2
Scale: NTS | 4-2111-01-48 | Sheet: D-01

APPENDIX A
OPERATING CERTIFICATE 106060

BRITISH COLUMBIA

July 8, 2014

Tracking Number: 243546
Authorization Number: 106060

REGISTERED MAIL

SUNSHINE COAST REGIONAL DISTRICT
1975 FIELD ROAD
SECHELT, BC
V0N 3A1

Dear Operational Certificate Holder:

Enclosed is Operational Certificate 106060 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.

Please be aware that the following documents are required for submission by the specified dates set forth in the operational certificate:

- A hydrogeologic characterization and impact assessment of the landfill by August 31, 2015;
- An updated design and operating plan by December 31, 2017;
- An geotechnical and seismic assessment by April 30, 2018
- An environmental monitoring plan by April 30, 2018
- A leachate management plan for the landfill, acceptable to the Director, by December 31, 2015; and
- An annual report for the preceding 12 month period from January 1 to December 31 must be submitted to the Regional Director, Environmental Protection, by March 31 of each year.

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.

.../2

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 Coast Region. Plans, data and reports pertinent to the operational certificate are to be submitted to the Regional Director, Environmental Protection, at Ministry of Environment, Regional Operations, Coast Region, 2nd Floor, 10470 - 152 Street, Surrey, BC V3R 0Y3.

Yours truly,

Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
Coast Region

Enclosure

cc: Environment Canada

BRITISH COLUMBIA

MINISTRY OF ENVIRONMENT

OPERATIONAL CERTIFICATE

106060

Under the Provisions of the Environmental Management Act and

in accordance with the Sunshine Coast Regional District's

Solid Waste Management Plan

SUNSHINE COAST REGIONAL DISTRICT
1975 FIELD ROAD
SECHELT, BC
V0N 3A1

is authorized to manage municipal solid waste / recyclable material and discharge residual solid waste to the ground at the Sechelt Landfill located at 4901 Dusty Road, Sechelt, British Columbia, subject to the conditions listed herein. Contravention of any of these conditions is a violation of the *Environmental Management Act* and may result in prosecution.

This Operational Certificate supersedes and cancels all previous versions of the permit PR-02547 issued under the authority of the *Environmental Management Act*.

1. AUTHORIZED DISCHARGES

1.1 This section applies to the discharge of municipal solid waste and contaminated soil to the Sechelt Landfill. The discharge of municipal solid waste must be restricted to sources within the Sunshine Coast Regional District. The site reference number for this discharge is E208123.

Date issued: July 8, 2014

Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
South Coast Region

1.1.1 The discharge is authorized by the Sunshine Coast Regional District's approved solid waste management plan. The maximum rate of discharge is 15,000 metric tonnes per year.

1.1.2 The characteristics of the discharge must be municipal solid waste as defined in the *Environmental Management Act* and include other material as specifically authorized by the Director. Waste asbestos may be discharged in accordance to Section 40 of the Hazardous Waste Regulation and in accordance with the Sunshine Coast Regional District's bylaws.

Materials prohibited from discharge include hazardous waste (excluding asbestos), liquids, semi-solid waste, biomedical waste and the following:

- Recyclable Materials including:
  a. used white goods,
  b. auto hulks and other large metallic waste,
  c. used tires,
  d. used lead acid batteries,
  e. gypsum wallboard, and
  f. corrugated cardboard.

- any other waste and/or recyclable material regulated under the Ministry's Recycling Regulation when alternate disposal options become available;

- other materials banned by the regional district in implementing the Sunshine Coast Regional District's solid waste management plan or bylaws; and

- other materials which may be designated by the Director when alternative disposal becomes available.

1.1.3 Waste must not be discharged into water or within a buffer zone as identified in Section 2.9, 2.10 and 2.11. The burning of waste is prohibited.

1.1.4 The authorized works common to this section and Section 1.2 and 1.3 are a sanitary landfill, locking gate to control access by the public, weigh scale and related appurtenances, approximately located as shown on Site Plan A.

Date issued: July 8, 2014

Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
South Coast Region

1.1.5 The authorized works specific to this section are those associated with a landfill operation and include berms, covering material, electrified bear fence, surface water diversionary works and environmental monitoring systems, approximately located as shown on attached Site Plan A and Site Plan B.

1.1.6 The authorized works must be complete and in operation while discharging.

1.1.7 The legal description of the location of the area of discharge is:

Block C, District Lot 7613, Group 1, New Westminster District.

1.1.8 The civic address of the Sechelt Landfill is 4901 Dusty Road, Sechelt, BC.

1.2 This section applies to a public drop off and recycling area for the management of municipal solid waste and recyclable material from sources within the Sunshine Coast Regional District.

1.2.1 The types of materials which may be managed in this area include waste as set out in Section 1.1.2, and typical recyclable materials.

1.2.2 The quantity of recyclable material that may be stored is limited to the capacity that can be reasonably handled on the site.

1.2.3 The authorized works are those associated with a public drop of and recycling area and include an access area, roll-off bins and related appurtenances approximately located as shown on Site Plan A.

1.2.4 The facility is located on a portion of Block C, District Lot 7613, Group 1, New Westminster District.

1.3 This section applies to a return collection facility for the management of household hazardous waste from sources within the Sunshine Coast Regional District.

1.3.1 The operational certificate holder must obtain the necessary approvals prior to commencement of operation of the return collection facility and ensure compliance with all applicable legislation. The operational certificate holder must notify the Director at least 30 days prior to commencement of operations.

Date issued: July 8, 2014

Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
South Coast Region

1.3.2 The types of material which may be managed at this facility are typical household hazardous wastes.

1.3.3 The quantity of household hazardous waste that may be stored must be in accordance with the Hazardous Waste Regulation and is limited to the registration quantity as a return collection facility.

1.3.4 The authorized works are those associated with a return collection facility and include an access area, a secured storage area for household hazardous waste and related appurtenances approximately located as shown on Site Plan A.

1.3.5 The facility location is proposed to be on a portion of Block C, District Lot 7613, Group 1, New Westminster District.

1.3.6 The operational certificate holder must submit an updated Site Plan A at least 30 days prior to commencement of operations.

2. DESIGN AND PERFORMANCE REQUIREMENTS

2.1 Design and Operating Plan

The operational certificate holder must operate the facilities authorized in Section 1 in accordance with a design and operating plan certified by a qualified professional. The operational certificate holder must submit an updated design and operating plan of the existing landfill authorized in Section 1, acceptable to the Director. The plan must address each of the subsections in the Landfill Criteria for Municipal Solid Waste (June 1993, or the most recent version) including performance, siting, design, operational, closure and post-closure criteria and the Guideline for Environmental Monitoring at Municipal Solid Waste Landfills (January 1996 or the most recent version).

The plan must include, but is not limited to, information regarding:

- A fill strategy for the design capacity of the landfill. The plan must incorporate the concept of progressive closure and take into consideration environmental protection measures and the proposed end use of the site.

Date issued: July 8, 2014

Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
South Coast Region

- A contingency plan (including funding) to close the landfill is to be developed prior to the design capacity being achieved should the landfill not be supported by future Sunshine Coast Regional District solid waste management plans or is closed for any other reason;
- Estimated elevations;
- Cell size, compaction details, daily, intermediate and final cover including types of materials used;
- Actions taken to ensure slope stability;
- Anticipated schedule for progressive closure activities;
- Measures to minimize leachate generation, including surface water diversion measures;
- A groundwater monitoring program in accordance with the requirements of Section 2.5;
- Recommended action plan to be undertaken as a result of the existing and subsequent leachate management assessment required in Section 3.13;
- A landfill gas management plan if required by Section 2.4 and updated in accordance with anticipated legislation changes;
- Recommended actions as a result of the existing and subsequent geotechnical, hydrogeological, landfill gas and any other assessments;
- Contingencies to address environmental protection issues, including leachate, landfill gas management and slope stability, in the event of an earthquake or any other emergency;
- Fire prevention measures;
- Operational requirements for the return collection facility for household hazardous waste, if applicable;
- List of recyclable materials accepted and how they are managed at the site;
- Incoming waste inspection, removal of unauthorized waste and staff supervision on the active face;
- Estimated closure/post closure-costs and details of how the closure/post-closure funds will be accrued;
- Measures to minimize hazards to public safety; and
- Measures to control vectors, odours, dust, wind-blown litter and scavenging.

The facilities must be developed, operated and closed in accordance with the design and operating plan. Should there be any inconsistency between this Operational Certificate and the design and operating plan, this Operational Certificate must take precedence unless otherwise agreed in writing by the Director.

Date issued: July 8, 2014

Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
South Coast Region

The Interim Design and Operating Plan was submitted in December 2012. The operational certificate holder must review the design and operating plan on an annual basis to determine if changes are required. Any revisions to the design and operating plan must be certified by a qualified professional and acceptable to the Director as part of the annual report required in Section 4.6.

The operational certificate holder must also submit an updated design and operating plan every five (5) years which includes, at a minimum, any revisions submitted as part of the previous five years of annual reporting. The next design and operating plan is required by December 31, 2017

2.2 Geotechnical and Seismic Assessment

The operational certificate holder must submit a geotechnical and seismic assessment for the landfill, acceptable to the Director, which meets the Landfill Criteria for Municipal Solid Waste (June 1993, or the most recent version). The assessment must address, at a minimum, slope stability during construction, operation, and post-closure is required. The geotechnical and seismic assessment must be reviewed and updated every five (5) years hereafter. The next assessment is required by **April 30, 2018** Actions recommended in the assessment and subsequent reviews must be incorporated into the design and operating plan as required in Section 2.1. A qualified professional must conduct the assessment and subsequent reviews.

2.3 Hydrogeological Assessment

The operational certificate holder must review the hydrogeology of the landfill authorized in Section 1.1 annually and submit the results with the annual report required in Section 4.6. Actions recommended in the annual reviews must be incorporated into the design and operating plan as required in Section 2.1 and form the basis of a recommended groundwater monitoring program as required in Section 2.5. A qualified professional must conduct the annual reviews.

The operational certificate holder must submit an updated hydrogeologic characterization and impact assessment of the landfill authorized in Section 1.1 acceptable to the Director, by **August 31, 2015.** The assessment must meet the Landfill Criteria for Municipal Solid Waste (June 1993, or the most recent version) and be reviewed and updated every five (5) years hereafter. A qualified professional must conduct the assessment and subsequent reviews.

Date issued: July 8, 2014

Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
South Coast Region

2.4 Landfill Gas Assessment

The operational certificate holder must submit to the Director supplemental landfill gas assessments and generation reports every five years as required under the Landfill Gas Management Regulation. Annual monitoring and reporting of landfill gas must be done in accordance with the Landfill Gas Management Regulation and the criteria set out in the Environmental Monitoring Program (EMP) in Section 2.5.

The landfill gas assessment must address, but is not limited to, each relevant subsection in the Landfill Criteria for Municipal Solid Waste (June 1993, or the most recent version) and the Guideline for Environmental Monitoring at Municipal Solid Waste Landfills (January 1996 or the most recent version). Should the assessment indicate that the nonmethane organic compounds (NMOCs) will exceed 150 tonnes/year, then the operational certificate holder must submit a landfill gas management plan, acceptable to the Director.

At any time, based on the assessment or any other information, the Director may require the installation and operation of gas recovery and pollution prevention works, including landfill gas monitoring wells. It should be noted that the Ministry of Environment has developed the Landfill Gas Management Regulation under the Greenhouse Gas Reduction (Emissions Standards) Statutes Amendment Act, 2008. The requirements of the Regulation and its guideline documents must be incorporated by the operational certificate holder into the landfill gas management plan and design and operating plan as they come into effect.

2.5 Environmental Monitoring Plan

The Operational Certificate holder must submit an Environmental Monitoring Plan acceptable to the Director by April 30, 2018. The plan must be prepared by a qualified professional and meet the requirements set forth in the Landfill Criteria for Municipal Solid Waste (June 1993, or the most recent version) and the Guideline for Environmental Monitoring at Municipal Solid Waste Landfills (January 1996 or the most recent version).

Date issued: July 8, 2014

Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
South Coast Region

The operational certificate holder must review the environmental monitoring plan on an annual basis to determine if changes are required. Any revisions to the plan must be prepared and certified by a qualified professional acceptable to the Director. The operational certificate holder must also submit an updated environmental monitoring plan every five (5) years, which includes, at a minimum, any revisions submitted as part of the previous five years of annual reporting required in Section 4.6.

2.6 Qualified Professionals

All facilities and information, including works, plans, assessments, investigations, surveys, programs and reports, must be certified by qualified professionals. Refer to Section 3.1 of the operational certificate for the definition of a qualified professional.

2.7 Additional Facilities or Works

The Director may require investigations, surveys, and the construction of additional facilities or works including, but not limited to, leachate and bear-proofing measures. The Director may also amend the requirements of any of the information required by this operational certificate including plans, programs, assessments and reports.

2.8 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.

2.9 Surface Water Diversion

Discharge of municipal solid waste into water is prohibited. The Operational Certificate holder must construct adequate surface water and groundwater diversion works to minimize surface water run-off and groundwater seepage from entering the landfill.

Date issued: July 8, 2014

Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
South Coast Region

2.10 **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.

If exceedances to the specified water quality criteria occur as a result of landfill operations, the Director may require that control measures or works be undertaken in addition to those outlined in Section 3.13.

2.11 **Buffer Zones**

The operational certificate holder must maintain the existing buffer zone relative to the property boundary of: 2 to 4.5 metres to the south, 10 to 98 metres to the west, 4.42 metres to the north and 4 to 18 metres to the east as shown in Site Plan A and Site Plan B.

The buffer zone must include an adequate firebreak. The firebreak must be maintained free of combustibles.

2.12 **Survey of the Landfill**

The Operational Certificate holder must conduct a legal survey which identifies the metes and bounds for both the limits of the landfill footprint and the boundaries of the landfill site. Copies of the land surveys are to be kept on file for review if requested by the Director. The corners and breakpoints of landfill footprint limits and landfill site boundaries are to be established and maintained in the field.

The operational certificate holder must also conduct an annual survey of the height, contour, surface area and settlement of the landfill and submit as part of the annual report required in Section 4.6.

3. OPERATIONAL REQUIREMENTS

3.1 **Definitions**

"**director**" means the Director or a person delegated to act on behalf of the Director, as defined in the *Environmental Management Act*;

Date issued: July 8, 2014

Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
South Coast Region

"**commercial quality soil**" means soil which does not contain any substance with a concentration exceeding the lowest applicable numerical soil standard for commercial land as set forth in the Contaminated Sites Regulation.

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

"**regional director**" means Regional Director, Environmental Protection;

"**qualified professional**" means an applied scientist or technologist specializing in a particular applied science including, but not necessarily limited to, agrology, biology, chemistry, engineering, geology, or hydrogeology and

- who is registered in British Columbia with their appropriate professional organization, acting under that association's Code of Ethics and subject to disciplinary action by that association, and

- who, through suitable education, experience, accreditation and knowledge, may be reasonably relied on to provide advice within their area of expertise;

"**return collection facility**" means a household hazardous waste collection facility or a mobile household hazardous waste collection facility;

"**suitable cover**" means soils utilized in accordance with Section 3.5 of this operational certificate or other material acceptable to the Director:

"**commercial quality soil**" means soil which does not contain any substance with a concentration exceeding the lowest applicable numerical soil standard for commercial land (CL) use as set forth in the Contaminated Sites Regulation.

3.2 Bypasses

The discharge of effluent which has bypassed site control works as listed in Section 1.1.5 is prohibited unless the prior approval of the Director is obtained and confirmed in writing. In the event of an emergency, Section 3.3 must be followed.

Date issued: July 8, 2014

Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
South Coast Region

3.3 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 operational certificate holder including, but not limited to, unauthorized fires ~~arising from spontaneous combustion or other causes, or detection of leachate~~ on the property, the operational certificate holder must take appropriate remedial action and notify the Director immediately. 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.

3.4 Inspections

The operational certificate holder must inspect the authorized works regularly and maintain them in good working order. The Director must be immediately notified of any malfunction of these works.

The operational certificate holder must inspect the property boundaries regularly and notify the Director of any visual evidence of environmental impacts on adjacent properties.

3.5 Soil Management

Soil meeting the commercial land use standard, as set forth in the Contaminated Sites Regulation, may be utilized for berm construction, daily, intermediate and final cover, top dressing and landscaping. Soil with any substance with a concentration exceeding the lowest applicable numerical soil standard for commercial land may only be used for internal berms or daily or intermediate cover. The utilization or discharge exceeding the industrial quality soil and hazardous waste soil is prohibited.

Soils utilized for berm construction, intermediate and final cover, top dressing and landscaping must not be included in determining the rate of discharge specified in Section 1.1.1.

Date issued: July 8, 2014

Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
South Coast Region

3.6 Waste Compaction and Covering

All waste must be placed in cells of a size determined by a qualified professional, and in accordance with the design and operating plan and must address each of the subsections in the Landfill Criteria for Municipal Solid Waste (June 1993, or the most recent version). The working face must be confined to the smallest practical area. The waste must be compacted and covered as per the design and operating plan.

Daily cover consisting of a minimum of 0.15 metres of suitable cover material or a functionally alternate cover material, as authorized by the Director, must be applied to the working face at the end of each operating day. If alternate cover is utilized, then the working face must be covered with a minimum of 0.15 meters of suitable cover at least once every week or as approved by the Director. Intermediate cover, consisting of a minimum 0.30 metre of suitable cover material must be applied within thirty (30) days to any area of the landfill which will not receive any further waste for thirty (30) days. The Director may vary the frequency of covering when freezing conditions adversely affect normal operation.

3.7 Completed Areas of the Landfill

The operational certificate holder must apply final cover to any area of the landfill which will not receive any further waste. Final cover must be applied in accordance with the design and operating plan required in Section 2.1 and, at a minimum, must consist of a minimum of 1.0 metre of low permeability ($<1 \times 10^{-5}$ cm/s) compacted soil (or equivalent) cap plus a minimum of 0.15 metre of topsoil and suitable vegetative cover, or as approved the Director.

With the written approval of the Director, the topsoil used for the final covering may be mixed with conditioning agents such as sludge (biosolids), compost and the like to add organics and improve the moisture holding capacity and nutrient value of the soil. Soil must be utilized in accordance with Section 3.5. Final cover must be constructed and maintained with adequate drainage and erosion controls and seeded with suitable grasses. Surface water runoff must be directed away from the landfill footprint. Soils must be in accordance with the Organic Matter Recycling Regulation (OMRR) and the Contaminated Sites Regulation (CSR).

Date issued: July 8, 2014

Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
South Coast Region

3.8 Wildlife and Vector Management

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 per Section 3.6 or by such additional methods as specified by the design and operating plan and the Director. 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.

Additional works may be required or other operating instructions may be issued by the Director should a wildlife nuisance or hazard arise.

3.9 Litter Control

Litter must be controlled by compacting the waste, minimizing the work face area, applying cover at the required frequencies, providing litter control fences and instituting a regular litter pickup and general good housekeeping program or as specified by the Director.

3.10 Electric Fencing

The operational certificate holder must maintain an electrified bear fence, at a minimum, around the landfill footprint, or implement alternative bear-proofing measures, acceptable to the Director, that will deter bears from entering that part of the site. The electric fence must be energized at all times, unless otherwise approved prior by the Director in writing. The fence must be maintained to the standards set out by the manufacturer until implementation of the landfill closure plan required in Section 5.2. Any penetrations through the electric fencing by bears must be immediately reported to the Ministry's Conservation Officer Service.

3.11 Fire Prevention and Control

The operational certificate holder must take all reasonable measures necessary to prevent fires from occurring at the site and is responsible for complying with all local fire safety requirements. The operational certificate holder must provide adequate fire breaks that are free of combustibles around the perimeter of the landfill footprint.

Date issued: July 8, 2014

Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
South Coast Region

The operational certificate holder must maintain firefighting equipment and materials as required. In the event of a landfill fire, immediately notify the local fire department, the Provincial Emergency Program and the Director.

3.12 Posting of Signs

The operational certificate holder must post signage, to the satisfaction of the Director, at the entrance of the landfill site with the following current information including:

- Site name;
- Owner and operator;
- Contact telephone number and address for the owner and operator;
- 24 hour telephone number in case of emergency;
- Hours of operation;
- Materials and wastes accepted for recycling and land filling;
- Prohibited materials and wastes; and
- Tipping fees.

3.13 Leachate Management

The operational certificate holder must, to the satisfaction of the Director, take measures to minimize leachate generation, including but not limited to, providing effective covering and surface water runoff. Actions taken and their effectiveness must be detailed in the annual report as required in Section 4.6.

The operational certificate holder must submit a leachate management plan for the landfill authorized in Section 1.1, acceptable to the Director, by **August 31, 2015**. The plan must meet the Landfill Criteria for Municipal Solid Waste (June 1993, or the most recent version) and the Guideline for Environmental Monitoring at Municipal Solid Waste Landfills (January 1996 or the most recent version) and must be reviewed and updated every five (5) years hereafter. The leachate management plan, prepared by a qualified professional, must review the adequacy of the existing works to protect the receiving environment and identify any necessary upgrades and include a schedule for their implementation. Once implemented, the upgraded works must form part of the authorized works identified in Section 1.1.5.

Date issued: July 8, 2014

Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
South Coast Region

3.14 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.

3.15 Management of Recyclable Materials

The operational certificate holder must take all practical measures to segregate for recycling and reuse of waste destined for disposal at this site.

Recyclable materials must be managed in a manner to not cause pollution and in accordance with the *Environmental Management Act* and its regulations.

3.16 Management of Household Hazardous Waste

The amount of household hazardous waste accumulated at the facility authorized in Section 1.4 must be stored in accordance with the Hazardous Waste Regulation and is limited to the registration quantity as a return collection facility.

4. MONITORING AND REPORTING REQUIREMENTS

4.1 Monitoring

The Operational Certificate holder must implement an environmental monitoring program as required in Section 2.5. The Operational Certificate holder must maintain records of all monitoring program data and analyses available for inspection. Based on the information submitted in the annual report, or any other information relevant to the site, the Director may vary the frequency, location and analyses of environmental monitoring as warranted.

4.1.1 Slope Stability Monitoring

The operational certificate holder must regularly monitor for evidence of slope instability as part of regular operations for evidence of tension cracking, veneer instability or failure.

Date issued: July 8, 2014

Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
South Coast Region

4.2 Sampling Procedures

Sampling is to be carried out in accordance with the procedures described in the "British Columbia Field Sampling Manual for Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples, 2003 Edition (Permittee)", or most recent edition, or by suitable alternative procedures as authorized by the Director.

A copy of the above manual is available on the Ministry web page at http://www.env.gov.bc.ca/wsd/data_searches/field_sampling_manual/field_man_03.html

4.3 Analytical Procedures

Analyses are to be carried out in accordance with procedures described in the "British Columbia Laboratory Manual (2009 Permittee Edition)", or the most recent edition, or by suitable alternative procedures as authorized by the Director.

A copy of the above manual is available on the Ministry web page at www.env.gov.bc.ca/epe/wamr/labsys/lab_meth_manual.html.

4.4 Waste and Recyclable Materials Recording

The operational certificate holder must record the quantity, in tonnes, of waste, recycling, and return collection received at the landfill. Also, the quantity of recyclable materials and household hazardous waste removed from these facilities must be recorded.

4.5 Records Management

The operational certificate holder must maintain the following information and records, current and suitably tabulated, at the landfill office or Regional District office for inspection:

- A copy of Operational Certificate 106060;
- Training procedures and personnel training records;
- Contingency plans and notification procedures;
- The current design and operating plan;
- Inspection records from staff and regulatory agencies;
- Most recent hydrogeological, geotechnical and landfill gas assessments;

Date issued: July 8, 2014

Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
South Coast Region

- Incoming waste and soil records;
- Records of recyclable material and household hazardous wastes shipped offsite including the name of company and location the recyclable material and household hazardous waste is sent;
- Environmental monitoring results and interpretations;
- Records of commercial quality soil used as cover material identified in Section 3.5 along with records of soil shipped offsite; and
- Annual operating and monitoring reports for the previous 5 years.

4.6 Reporting

The operational certificate holder must prepare an annual report which must include, but is not limited to, the following:

- A review and interpretation of the analytical data from receiving environment monitoring for the calendar year;
- Summaries of waste and recyclable material records, with the amount of waste landfilled reported as a volume and tonnage;
- Summary of recyclable material and household hazardous wastes shipped offsite including the name of company and location the recyclable material and household hazardous waste is sent;
- Summary of amount of commercial quality soil brought onsite;
- Updated estimates for the remaining capacity, closure date for the current phase and closure date for the current landfill footprint;
- Results of the annual survey required under Section 2.12;
- An evaluation of leachate generation control measures;
- Results of the landfill gas monitoring;
- Revised closure/post closure costs, confirmation of sufficient funds available, and a statement of the current dollar value of the Closure Fund and the amount earmarked for the Sechelt Landfill site;
- Revised design and operating plan and planned improvements if applicable for minor revisions;
- Revised environmental monitoring program;
- Identification of operating problems and corrective actions taken;
- An evaluation of the recycling programs including waste diversion;
- Summary of public complaint/resolutions for the landfill;
- In the event of any non-compliance with the conditions of this operational certificate, an action plan and schedule to achieve compliance; and

Date issued: July 8, 2014

Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
South Coast Region

- The results of all monitoring programs as specified in this Operational Certificate. Data interpretation and comparison to the performance criteria in the Landfill Criteria for Municipal Solid Waste, the Guidelines for Environmental Monitoring and Municipal Solid Waste Landfills. Trend analyses, as well as an evaluation of the impacts of the discharges on the receiving environment in the previous year must be carried out by a qualified professional.
- Monitoring data must be entered into EMS – Environmental Monitoring System electronically and submitted in electronic and printed format satisfactory to the Regional Director.

The annual report for the preceding 12 month period from January 1 to December 31 must be submitted to the Regional Director, Environmental Protection, by **March 31** of each year.

5. CLOSURE AND POST-CLOSURE REQUIREMENTS

5.1 Closure Plan / Funding

The operational certificate holder must accrue, during the life of the landfill, a dedicated reserve fund in a form acceptable to the Director, sufficient to finance closure and environmental contingencies related to the landfill. The estimated cost of carrying out closure and how the fund will be accrued must be included in the design and operating plan required in Section 2.1. The estimated costs of closure and post-closure activities must be updated annually and submitted to the Director as part of the annual report required in Section 4.6. Should the estimated costs of closure and post-closure increase then the operational certificate holder must increase the rate of accrual as

5.2 Progressive Closure

The operational certificate holder must submit a closure plan as part of a Design and Operating Plan for the facilities authorized in Section 1 by **December 31, 2015** acceptable to the Director. The plan must be reviewed and updated every 5 years as part of the Design and Operating Plan or until the site is decommissioned and a closure-plan under Section 5.3 is approved. The plan must be prepared by an independent qualified professional and include information regarding:

- Phasing plan showing areas to be progressively closed.
- Estimated total waste volumes and tonnage and the closure date;

Date issued: July 8, 2014

Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
South Coast Region

- A topographical plan showing the final elevation contours of the landfill and surface water diversion and drainage controls;
- Design of the final cover including the thickness and permeability of barrier layers and drainage layers and information on topsoil, vegetative cover and erosion prevention controls;
- Rodent and nuisance wildlife control procedures;
- Proposed end use of the property after closure;
- A post-closure monitoring program for groundwater, surface water, landfill gas, erosion and settlement for a minimum period of 25 years;
- Post-closure operation of pollution abatement engineering works such as leachate and landfill gas collection/treatment systems for a minimum period of 25 years; and
- Contingencies to address environmental impact concerns which may arise during the minimum post-closure period of 25 years.

5.3 Post-Closure Operation and Maintenance

A post-closure plan must be submitted not less than 2 years prior to decommissioning of the landfill. The closure plan must be reviewed every 5 years following closure and updated to encompass the next 10 years of post-closure activities. The post-closure plan and subsequent updates must be prepared by an independent qualified professional licensed to practice in the province of British Columbia and knowledgeable in such matters. The post-closure plan and subsequent updates must be submitted to the Director for approval and must include at least the following:

- a complete review and assessment report of the overall integrity of the landfill,
- Procedures for notifying the public about the closure and alternative waste disposal facilities;
- a detailed timetable for post-closure procedures and correction of any deficiency identified in the review and assessment report,
- a detailed schedule of inspection, monitoring and maintenance to be carried out for a minimum post-closure period of 25 years, and
- a process for the administration of the post-closure security fund required under Section 5.1 of this operational certificate.

Date issued: July 8, 2014

Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
South Coast Region

5.4 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 219 (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 registration of the charge or legal notification is to be submitted to the Regional Director.

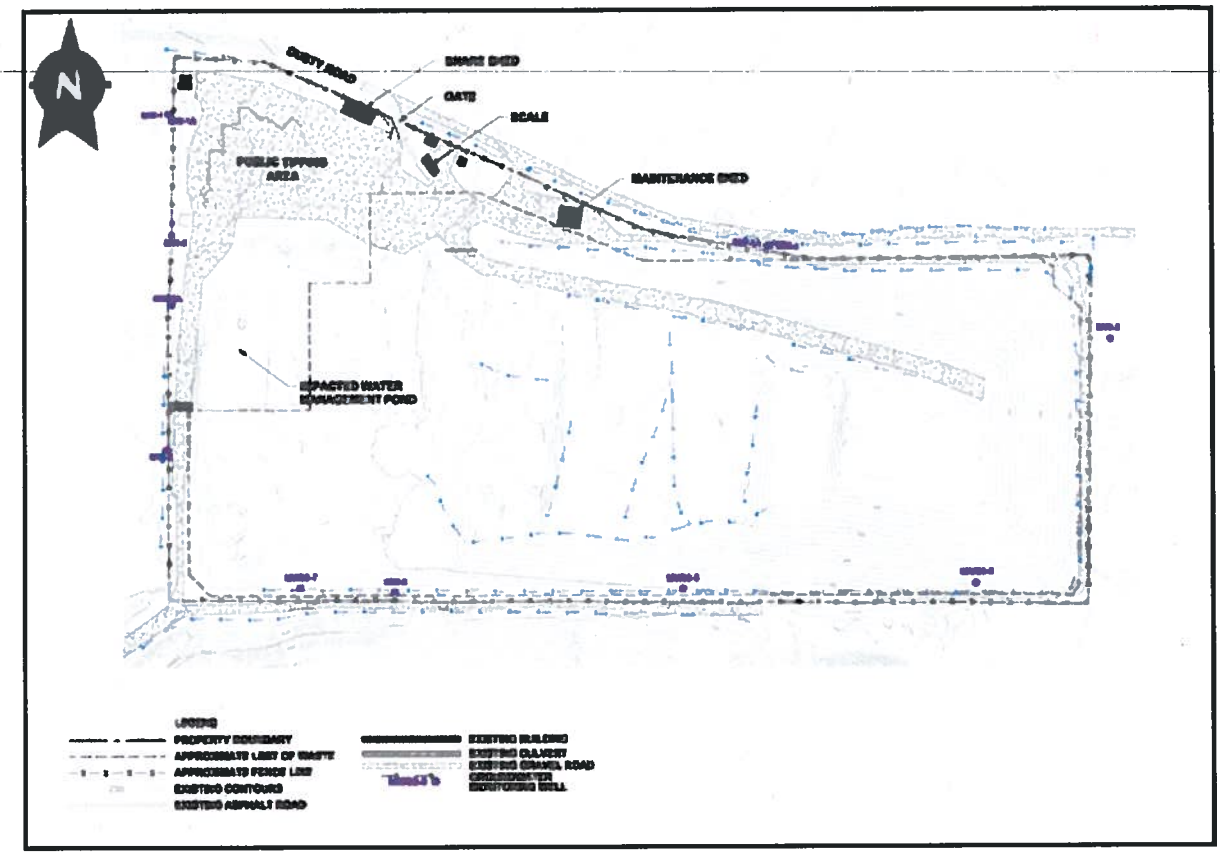
5.5 Site Decommissioning

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 Director not less than 10 days prior to decommissioning the facilities authorized in Section 1.

Date issued: July 8, 2014

Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
South Coast Region

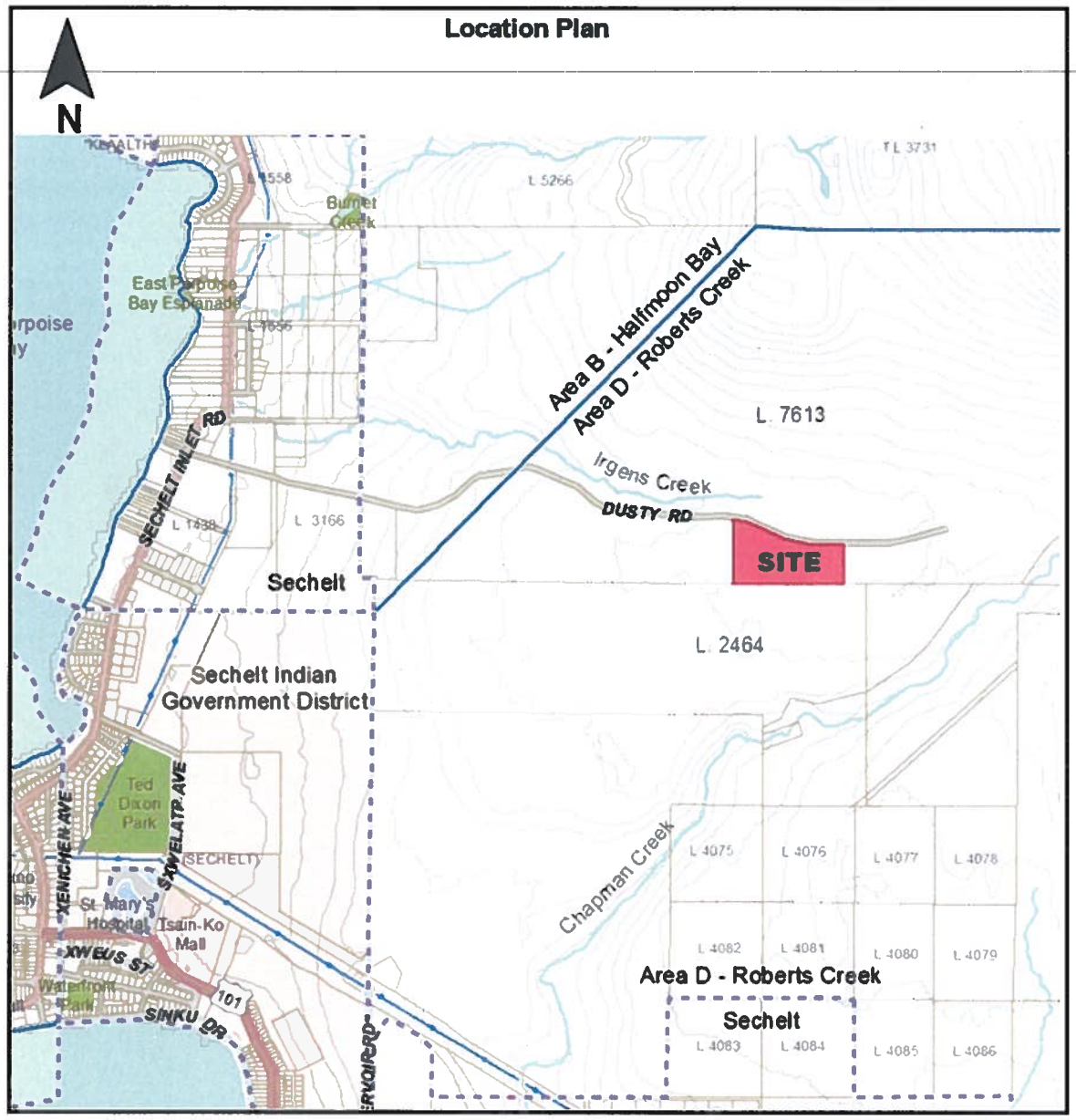
SITE PLAN A



Date issued: July 8, 2014

Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
South Coast Region

SITE PLAN B



Date issued: July 8, 2014

Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
South Coast Region

Operational Certificate Number: 106060

APPENDIX B
HYDROLOGIC MODEL

Table B2 Subcatchment Parameters

Subcatchment	Area (ha)	Flow Length (metres)	Slope (m/m)	Impervous Area (%)
Existing Conditions				
101	0.82	60	0.03	0
102	1.24	20	0.20	0
103	0.70	45	0.03	0
104	0.99	60	0.33	0
105	2.45	35	0.20	0
106	0.23	72	0.03	100
107	1.71	47	0.33	0
Post-Development Conditions				
201	0.77	132	0.03	0
202	2.05	81	0.33	0
203	1.14	62	0.33	0
204	4.23	80	0.33	0

Table B3 Soil Parameters

Subcatchment	Soil Group	Ground Cover	Hydrologic Condition	Roughness [1]	CN [1]
Existing Conditions					
101	C	Newly Graded		0.1	91
102	C	Newly Graded		0.1	91
103	C	Newly Graded		0.1	91
104	C	Newly Graded		0.1	91
105	C	Newly Graded		0.1	91
106	C	Tarped	Good	0.1	98
107	C	Grassland	Good	0.4	74
Post-Development Conditions					
201	C	Newly Graded		0.1	91
202	C	Grassland	Good	0.4	74
203	C	Grassland	Good	0.4	74
204	C	Grassland	Good	0.4	74

Note:

1. United States Department of Agriculture (1986). Urban hydrology for small watersheds (PDF). Technical Release 55 (TR-55) (Second ed.). Natural Resources Conservation Service, Conservation Engineering Division.

Table B4 Design Storm Events - Runoff Volumes (m^3)

Subcatchment	1:5 (24hr)	1:10 (24hr)	1:100 (24hr)
Existing Conditions			
101	334	382	527
102	509	582	804
103	289	327	451
104	406	464	641
105	1005	1150	1584
106	133	148	191
107	259	323	535
Total	**2935**	**3376**	**4733**
Post-Development Conditions			
201	310	354	491
202	307	382	634
203	172	214	354
204	633	789	1308
Total	**1422**	**1739**	**2787**

Table B5 Design Storm Events - Peak Discharge (m^3/s)

Subcatchment	1:5 (24hr)	1:10 (24hr)	1:100 (24hr)
Existing Conditions			
101	0.0224	0.0261	0.0365
102	0.0349	0.0398	0.0563
103	0.0196	0.0220	0.0315
104	0.0280	0.0320	0.0446
105	0.0677	0.0788	0.1079
106	0.0090	0.0100	0.0129
107	0.0073	0.0107	0.0264
Post-Development Conditions			
201	0.0187	0.0220	0.0323
202	0.0082	0.0121	0.0265
203	0.0048	0.0069	0.0162
204	0.0170	0.0245	0.0546

Appendix B1
Table B1 Gibsons IDF

Environment Canada/Environnement Canada

Short Duration Rainfall Intensity-Duration-Frequency Data
Données sur l'intensité, la durée et la fréquence des chutes de pluie de courte durée

Gumbel - Method of moments/Méthode des moments

2012/02/09

GIBSONS BC 1043150

Latitude: 49 24'N Longitude: 123 31'W Elevation/Altitude: 62 m

Years/Années : 1983 - 2004 # Years/Années : 20

Table 1 : Annual Maximum (mm)/Maximum annuel (mm)

Year / Année	5 min	10 min	15 min	30 min	1 h	2 h	6 h	12 h	24 h
1983	-99.9	-99.9	-99.9	-99.9	9.9	13.0	28.3	42.3	67.5
1984	-99.9	-99.9	-99.9	-99.9	8.0	11.8	25.0	34.6	49.3
1985	-99.9	-99.9	-99.9	-99.9	6.5	11.5	20.2	32.6	49.0
1986	-99.9	-99.9	-99.9	-99.9	8.6	12.4	25.4	33.8	58.7
1987	-99.9	-99.9	-99.9	-99.9	8.2	9.6	21.4	25.5	44.6
1988	-99.9	-99.9	-99.9	-99.9	-99.9	-99.9	-99.9	-99.9	49.2
1989	-99.9	-99.9	-99.9	-99.9	13.6	18.2	23.3	35.4	65.2
1990	-99.9	-99.9	-99.9	-99.9	9.7	15.6	23.7	37.0	64.9
1991	-99.9	-99.9	-99.9	-99.9	11.6	21.8	41.4	55.1	79.5
1992	-99.9	-99.9	-99.9	-99.9	13.1	18.8	31.4	39.7	63.6
1993	-99.9	-99.9	-99.9	-99.9	19.0	27.4	28.8	34.5	44.7
1994	-99.9	-99.9	-99.9	-99.9	11.3	16.3	28.4	37.6	54.2
1995	-99.9	-99.9	-99.9	-99.9	8.6	14.8	29.6	39.0	50.0
1996	-99.9	-99.9	-99.9	-99.9	13.1	15.1	30.9	49.6	59.1
1997	-99.9	-99.9	-99.9	-99.9	9.7	14.4	28.0	40.9	61.1
1998	-99.9	-99.9	-99.9	-99.9	10.7	11.3	25.5	33.9	42.5
2000	-99.9	-99.9	-99.9	-99.9	10.4	13.2	26.3	42.6	48.1
2001	-99.9	-99.9	-99.9	-99.9	17.0	25.2	27.6	41.8	47.0
2002	-99.9	-99.9	-99.9	-99.9	8.3	12.5	18.4	31.0	54.3
2003	-99.9	-99.9	-99.9	-99.9	7.5	12.9	30.9	49.3	78.6
2004	-99.9	-99.9	-99.9	-99.9	12.8	19.6	25.1	34.1	58.3
# Yrs. / Années	0	0	0	0	20	20	20	20	21
Mean / Moyenne	-99.9	-99.9	-99.9	-99.9	10.9	15.8	27.0	38.5	56.6
Std. Dev. / Écart-type	-99.9	-99.9	-99.9	-99.9	3.2	4.8	4.9	7.0	10.5
Skew. / Dissymétrie	-99.90	-99.90	-99.90	-99.90	1.10	1.15	0.98	0.69	0.76
Kurtosis	-99.90	-99.90	-99.90	-99.90	4.43	4.12	6.19	4.01	3.34

Appendix B1
*-99.9 Indicates Missing Data/Données manquantes

****

Table 2a : Return Period Rainfall Amounts (mm)
Quantité de pluie (mm) par période de retour

****

Duration/Durée	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans	#Years Années
5 min	-99.9	-99.9	-99.9	-99.9	-99.9	-99.9	0
10 min	-99.9	-99.9	-99.9	-99.9	-99.9	-99.9	0
15 min	-99.9	-99.9	-99.9	-99.9	-99.9	-99.9	0
30 min	-99.9	-99.9	-99.9	-99.9	-99.9	-99.9	0
1 h	10.4	13.2	15.0	17.4	19.1	20.9	20
2 h	15.0	19.2	22.0	25.5	28.1	30.7	20
6 h	26.2	30.5	33.4	37.0	39.8	42.4	20
12 h	37.4	43.6	47.6	52.8	56.7	60.5	20
24 h	54.9	64.2	70.4	78.2	84.0	89.7	21

****

Table 2b :

Return Period Rainfall Rates (mm/h) - 95% Confidence limits
Intensité de la pluie (mm/h) par période de retour - Limites de confiance de 95%

****

Duration/Durée	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans	#Years Années
5 min	-99.9	-99.9	-99.9	-99.9	-99.9	-99.9	0
	+/--99.9	+/--99.9	+/--99.9	+/--99.9	+/--99.9	+/--99.9	0
10 min	-99.9	-99.9	-99.9	-99.9	-99.9	-99.9	0
	+/--99.9	+/--99.9	+/--99.9	+/--99.9	+/--99.9	+/--99.9	0
15 min	-99.9	-99.9	-99.9	-99.9	-99.9	-99.9	0
	+/--99.9	+/--99.9	+/--99.9	+/--99.9	+/--99.9	+/--99.9	0
30 min	-99.9	-99.9	-99.9	-99.9	-99.9	-99.9	0
	+/--99.9	+/--99.9	+/--99.9	+/--99.9	+/--99.9	+/--99.9	0
1 h	10.4	13.2	15.0	17.4	19.1	20.9	20
	+/- 1.3	+/- 2.2	+/- 2.9	+/- 3.9	+/- 4.7	+/- 5.5	20
2 h	7.5	9.6	11.0	12.7	14.1	15.4	20
	+/- 1.0	+/- 1.6	+/- 2.2	+/- 2.9	+/- 3.5	+/- 4.1	20
6 h	4.4	5.1	5.6	6.2	6.6	7.1	20
	+/- 0.3	+/- 0.6	+/- 0.8	+/- 1.0	+/- 1.2	+/- 1.4	20
12 h	3.1	3.6	4.0	4.4	4.7	5.0	20
	+/- 0.2	+/- 0.4	+/- 0.5	+/- 0.7	+/- 0.9	+/- 1.0	20
24 h	2.3	2.7	2.9	3.3	3.5	3.7	21
	+/- 0.2	+/- 0.3	+/- 0.4	+/- 0.5	+/- 0.6	+/- 0.7	21

****

Table 3 : Interpolation Equation / Équation d'interpolation: R = A*T^B

R = Interpolated Rainfall rate (mm/h)/Intensité interpolée de la pluie (mm/h)
RR = Rainfall rate (mm/h) / Intensité de la pluie (mm/h)
T = Rainfall duration (h) / Durée de la pluie (h)

****

Statistics/Statistiques	2	5	10	25	50	100

Appendix B1

	yr/ans	yr/ans	yr/ans	yr/ans	yr/ans	yr/ans
Mean of RR/Moyenne de RR	5.5	6.8	7.7	8.8	9.6	10.4
Std. Dev. /Écart-type (RR)	3.3	4.4	5.1	6.0	6.7	7.4
Std. Error/Erreur-type	0.0	0.2	0.4	0.5	0.6	0.7
Coefficient (A)	10.4	13.2	15.1	17.5	19.3	21.1
Exponent/Exposant (B)	-0.479	-0.513	-0.529	-0.545	-0.555	-0.563
Mean % Error/% erreur moyenne	0.8	2.5	3.4	4.3	4.8	5.2

APPENDIX C
HELP MODEL DATA

Table C1 Infiltration Rate Summary

Cover Type	Model	Slope (%)	Infiltration Rate (mm/yr)
Existing Daily Cover	HELP	3%	478
Existing Daily Cover	HELP	12%	474
Existing Intermediate Cover	HELP	3%	467
Existing Intermediate Cover (Road)	HELP	8%	465
Existing Intermediate Cover	HELP	12%	444
Existing Intermediate Cover	HELP	33%	448
Proposed Final Cover (Evapotranspiration)	HELP	10%	1
Proposed Final Cover (Evapotranspiration)	HELP	33%	1

Note:
1. Hydrological Evaluation of Landfill Performance (HELP) Model (USACE, 1997)

Table C2 Leachate Generation Rate Summary

Cover Type	Area (m^2)	Infiltration Rate (mm/yr)	Leachate Generation Rate (m^3/yr)
Existing Conditions			
Existing Daily Cover (3%)	2,132	478	1,019
Existing Daily Cover (12%)	2,750	474	1,304
Existing Intermediate Cover (3%)	26,609	467	12,426
Intermediate Cover (Road) (8%)	1,533	465	713
Existing Intermediate Cover (12%)	2,276	444	1,011
Existing Intermediate Cover (33%)	18,660	448	8,360
Existing Final Cover (33%)	18,929	1	19
	72,889		**24,851**
Stage H			
Existing Intermediate Cover (3%)	30,319	467	14,159
Intermediate Cover (Road) (8%)	1,533	465	713
Existing Intermediate Cover (33%)	4,365	448	1,956
Existing Final Cover (33%)	36,672	1	37
	72,889		**16,864**
Proposed Final Cover			
Intermediate Cover (3%)	2,734	467	1,277
Intermediate Cover (Road) (8%)	1,533	465	713
Proposed Final Cover (10%)	11,746	1	12
Proposed Final Cover (33%)	56,876	1	57
	72,889		**2,058**

APPENDIX D
LANDFILL GAS MODEL DATA

Table D1 LFG Assessment Summary

Year	LFG Emission Rate (m^3/hr)	Methane Emission Rate (tonne/yr)	CO_2e Emission Rate (tonne/yr)	NMOC Emission Rate (tonne/yr)
2017	276	793	16645	5.2
2018	279	803	16853	5.2
2019	283	813	17064	5.3
2020	286	823	17276	5.4
2021	290	833	17490	5.4
2022	293	843	17705	5.5
2023	297	853	17920	5.6
2024	301	864	18136	5.6
2025	304	874	18352	5.7
2026	289	830	17426	5.4
2027	263	756	15866	4.9
2028	240	688	14455	4.5
2029	218	628	13178	4.1
2030	199	572	12022	3.7
2031	182	523	10974	3.4
2032	166	477	10025	3.1
2033	152	436	9165	2.8
2034	139	399	8384	2.6
2035	127	366	7676	2.4
2036	117	335	7033	2.2
2037	107	307	6448	2
2038	98	282	5917	1.8
2039	90	259	5434	1.7
2040	83	238	4995	1.6
2041	76	219	4594	1.4
2042	70	201	4230	1.3
2043	65	186	3897	1.2
2044	60	171	3594	1.1
2045	55	158	3317	1
2046	51	146	3064	1
2047	47	135	2833	0.9
2048	43	125	2622	0.8
2049	40	116	2428	0.8
2050	37	107	2251	0.7

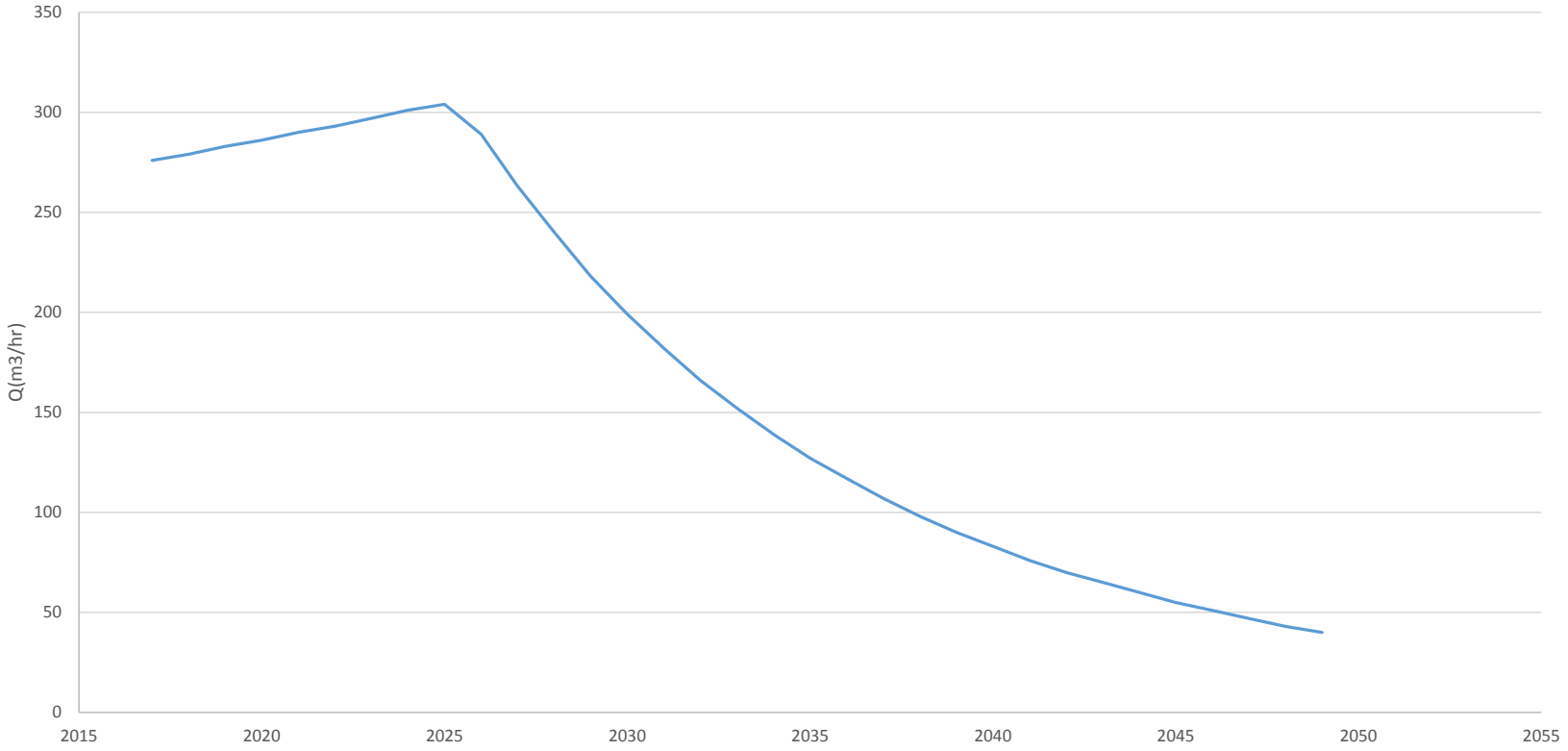


Figure D1
LFG PRODUCTION ESTIMATE
Sechelt Landfill

Notes:
Relatively Inert: k= 0.02 yr-1, Lo= 20 m3/tonne
Moderately Decomposable: k= 0.06 yr-1, Lo= 120 m3/tonne
Decomposable: k= 0.11 yr-1, Lo= 160 m3/tonne

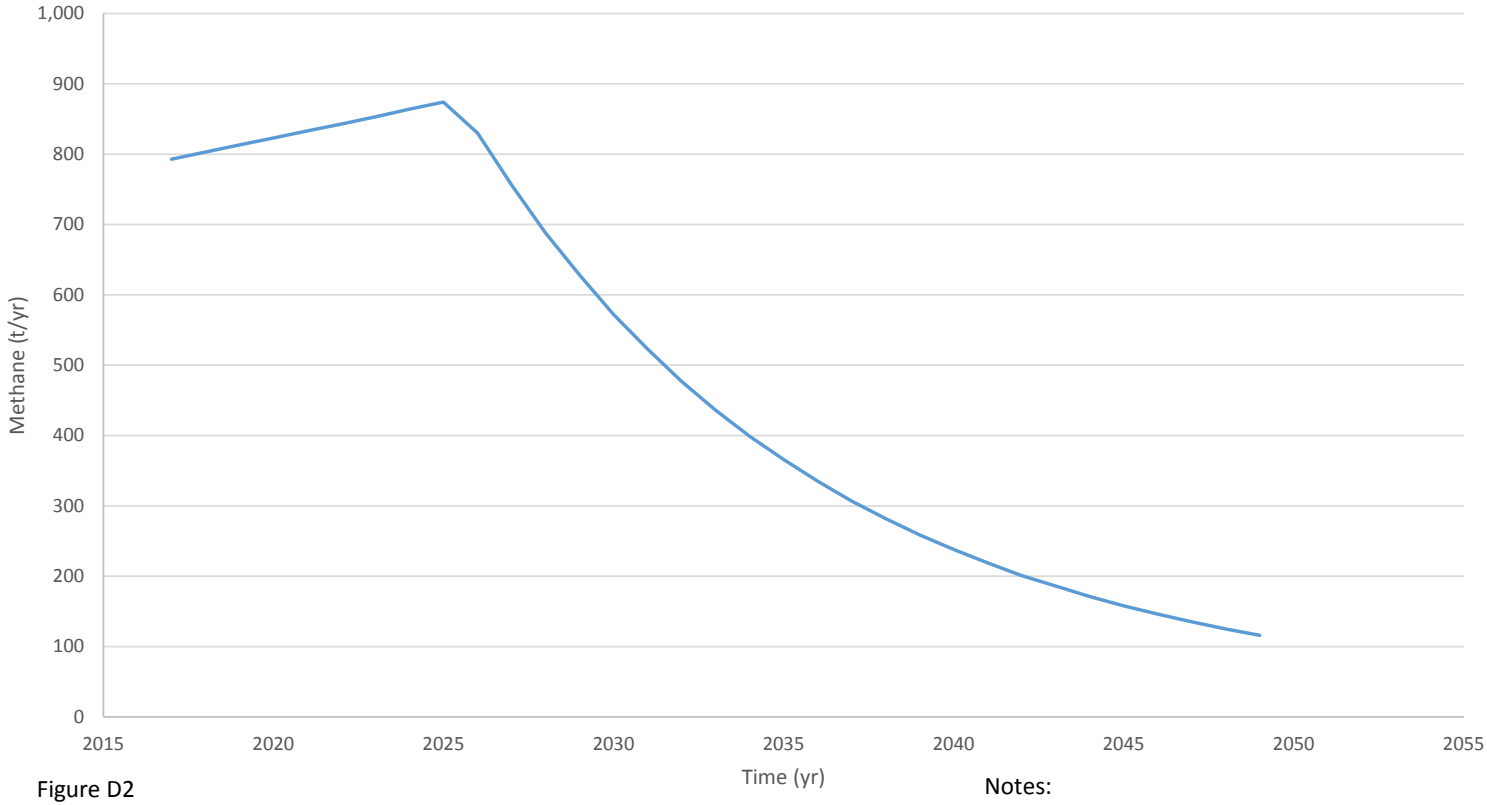


Figure D2
METHANE GAS EMISSION ESTIMATE
Sechelt Landfill

Notes:
Relatively Inert: k= 0.02 yr-1, Lo= 20 m3/tonne
Moderately Decomposable: k= 0.06 yr-1, Lo= 120 m3/tonne
Decomposable: k= 0.11 yr-1, Lo= 160 m3/tonne

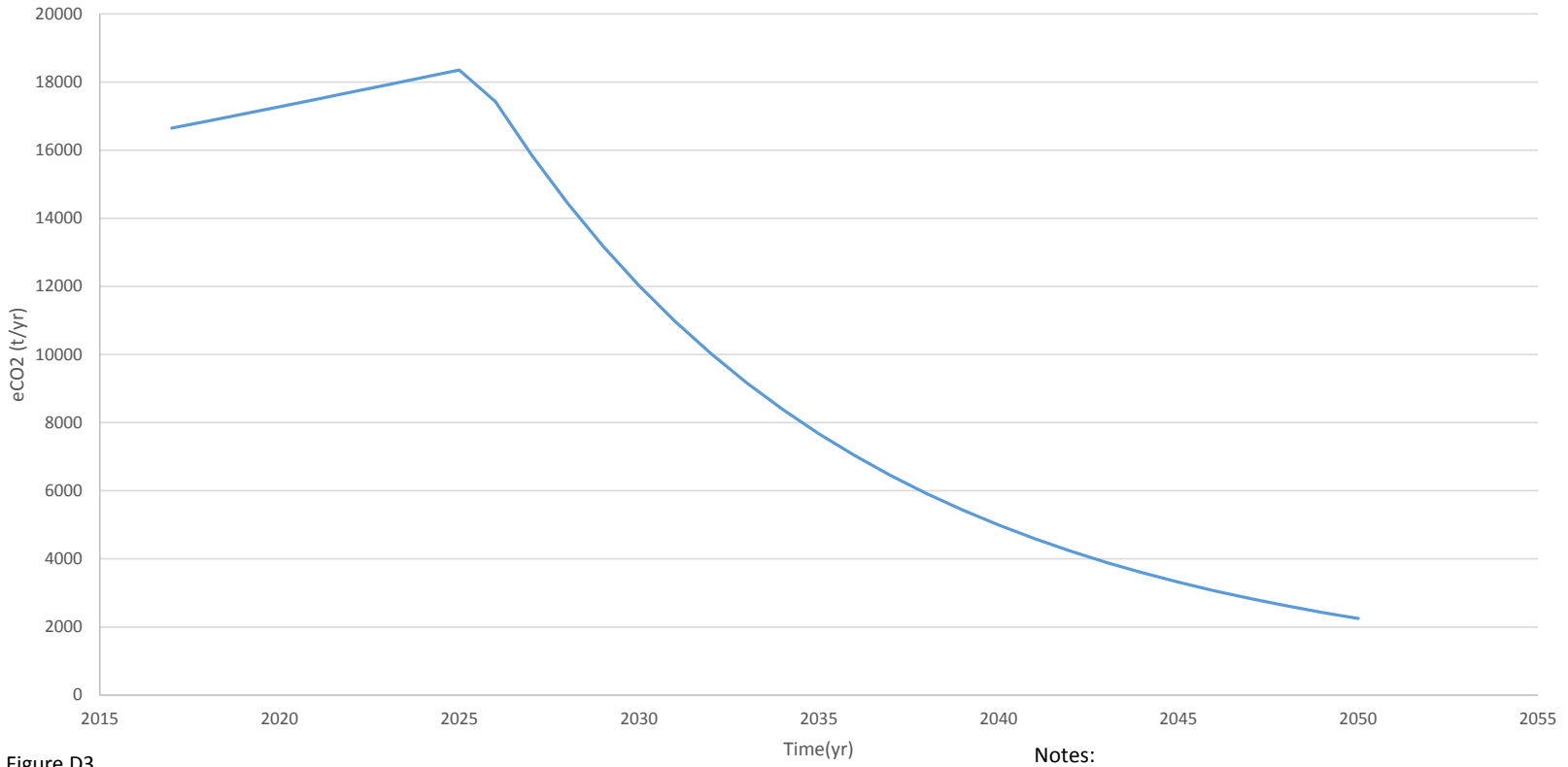


Figure D3
GREENHOUSE GAS EMISSION ESTIMATE
Sechelt Landfill

Notes:
Relatively Inert: k= 0.02 yr-1, Lo= 20 m3/tonne
Moderately Decomposable: k= 0.06 yr-1, Lo= 120 m3/tonne
Decomposable: k= 0.11 yr-1, Lo= 160 m3/tonne

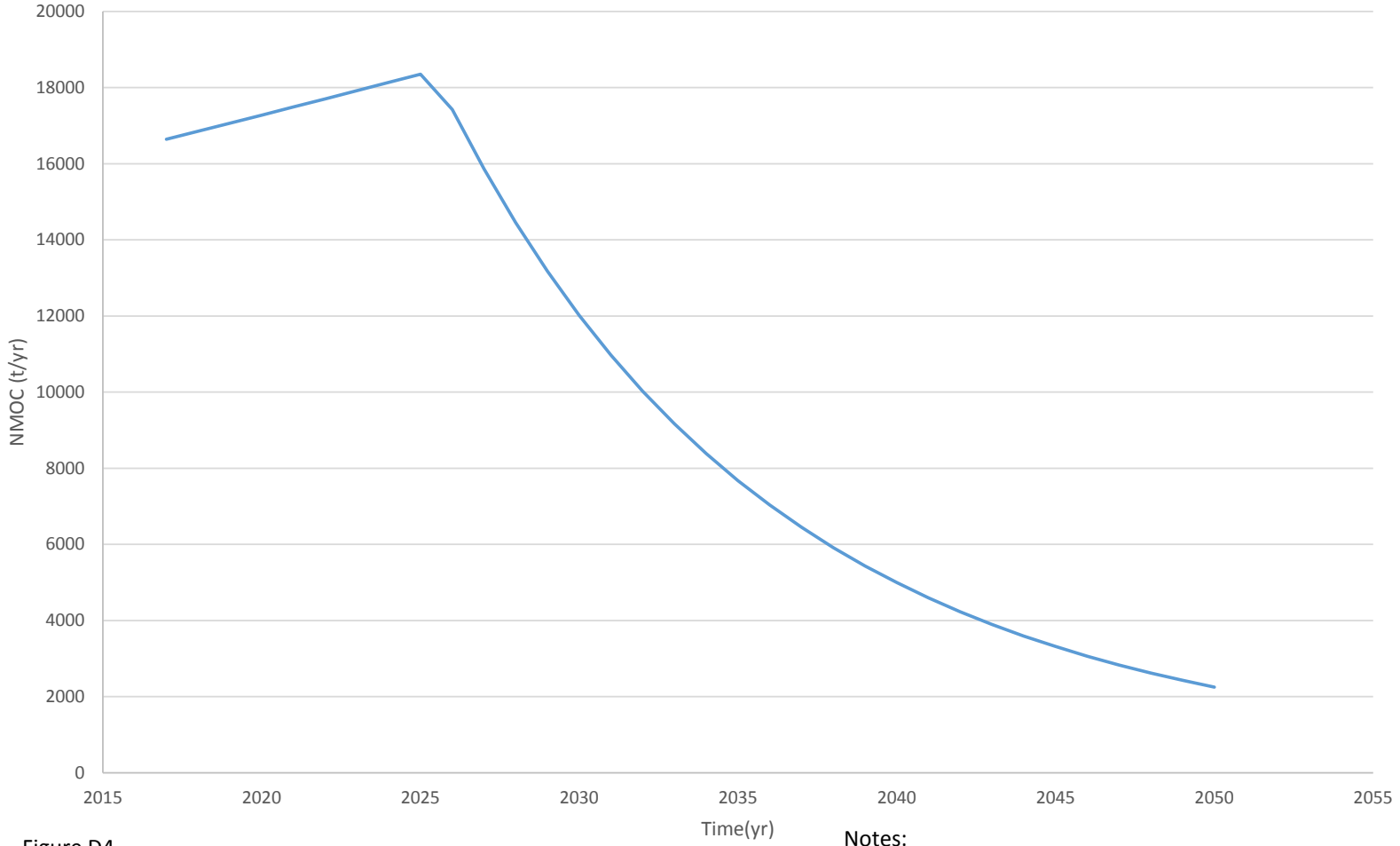


Figure D4
NMOC EMISSION RATE ESTIMATE
Sechelt Landfill

Notes:
Relatively Inert: k= 0.02 yr-1, Lo= 20 m3/tonne
Moderately Decomposable: k= 0.06 yr-1, Lo= 120 m3/tonne
Decomposable: k= 0.11 yr-1, Lo= 160 m3/tonne

APPENDIX E

BRAUN GEOTECHNICAL ENGINEERING MEMORANDUM

BRAUN GEOTECHNICAL LTD.

ENGINEERING MEMO

TO:	XCG Consultants Ltd.	FILE NO.:	**13-5854**
ATTENTION:	Michel Lefebvre, M.Sc., P.Eng	DATE:	March 25, 2013
FROM:	Harman Dhillon, EIT	CLIENT:	XCG Consultants Ltd.
CC:	Phillip Auclair, B.Comm, P.Eng.		
SUBJECT:	Sechelt Landfill Cover System Veneer Stability Assessment		
LOCATION:	Sechelt Landfill – 4905 Dusty Road, Sechelt, BC., V0N 3A0		

MESSAGE/INSTRUCTIONS:

As requested, Braun Geotechnical Ltd. has completed a veneer stability assessment of the proposed cover system for the Sechelt Landfill.

It is understood that a cover system comprised of 300mm of topsoil, over a minimum 500mm of till-fill, over 50LL Supergripnet geomembrane over 300mm of sand is proposed over a minimum 100mm thick existing cover underlain by Municipal Solid Waste (MSW). It is understood that drain tubes are present above the geomembrane. It is understood that the cover system is proposed for a maximum slope height of approximately 18m, at a maximum slope gradient of 2.6H:1V (Horizontal to Vertical).

Veneer Stability Analysis

The cover system veneer stability assessment was carried out using parameters, geometry and cross section information provided by XCG Consultants. The purpose of the veneer stability assessment was to evaluate the stability of the proposed cover system under static and design seismic conditions.

The soil parameters used in the assessment are provided in the table below:

Material	Soil Type	Soil Strength Parameters		
		Unit Weight (kN/m3)	*Internal Friction Angle*	*Cohesion (kPa)*
1.	Topsoil*	16	28°	3
2.	Till-Fill	20	34°	1.5**
3.	Sand*	18	34°	0
4.	Existing Cover (Assumed Till-Fill)	20	34°	1.5**
5.	MSW*	12	30°	0

*Soil strength parameters provided by XCG Consultants.

**Apparent cohesion intercept.

As indicated above, an apparent cohesion intercept of 1.5 kPa was used for the till-fill fill zone in the analysis due to negative pore water pressure in unsaturated soils (Rinaldi and Gasagli 1999).

Soil/geosynthetic interaction parameters provided by XCG Consultants are provided in the table below:

Material	Interface	Interface Resistance Values	
		Peak	*Residual*
1.	Till-Fill/Drain Tube	38°	38°
2.	Drain Tube/Geomembrane	37°	23°
3.	Geomembrane/Sand	40°	39°

A soil/geosynthetic interface resistance friction angle of 37°, corresponding to the peak interface

resistance value between the drain tube and geomembrane, was selected for the analyses, as it is the lowest slope parallel peak interface resistance value. Note that residual friction interface values are generally only considered once significant shear displacement has occurred.

The presence of groundwater was not considered in the cover system stability analyses, as drain tubes are present within cover system to drain the cover system.

In order to assess the veneer stability of the cover system, a failure plane at the MSW and existing cover interface was considered. Note that failure surfaces confined to the topsoil layer was considered to be nuisance surficial sloughing, and a maintenance issue. Potential for shallow sloughing in the topsoil layer is expected to be reduced over time as surface vegetation becomes established.

Static analyses to assess the stability of the slope were run using the limit equilibrium software, SLIDE 6.0 (RocScience, 2007). Pseudo-dynamic analysis to assess stability under seismic loading conditions was also carried out. A design horizontal acceleration of 0.222g associated with an earthquake event with a return period of 1 in 475 years (10% probability in 50 years) was used for the pseudo-dynamic analysis.

The analyses indicated that the computed static and seismic factors of safety are greater than 1.7 and 1.0 respectively, and are considered to be within an acceptable range for shallow sloughing type failures.

A simplified infinite slope analysis was also carried out to confirm the findings of the SLIDE static analysis, using the following equation:

$$\text{Factor of Safety} = \tan\varphi/\tan\beta,$$

where φ is the internal angle of friction of the MSW (30°), and β is the slope angle of the cover system (21°). The static factor of safety was determined to be 1.5.

Note that the veneer stability assessment of the cover system was based on a uniform thickness of materials above the geomembrane, as per the cross-section provided by XCG Consultants.

Based on available site information and the slope stability assessment, stability concerns for the cover system are not anticipated for static and design seismic conditions. However, it is considered that some localized shallow sloughing requiring maintenance may occur on surficial soils, especially under periods of extended rainfall until vegetation becomes established on the topsoil surface. In order to reduce potential for shallow sloughing within the topsoil layer, consideration may be given to installation of temporary erosion control matting.

Note that the current veneer stability assessment was limited to the cover system only. Global stability of the existing and proposed MSW stockpile sections will be carried out as a part of Phase II of the proposed scope of work.

We hope the above meets with your requirements. Should any questions arise, please do not hesitate to contact the undersigned

Attachments: SLIDE 6.0 Outputs

Braun Geotechnical Ltd.

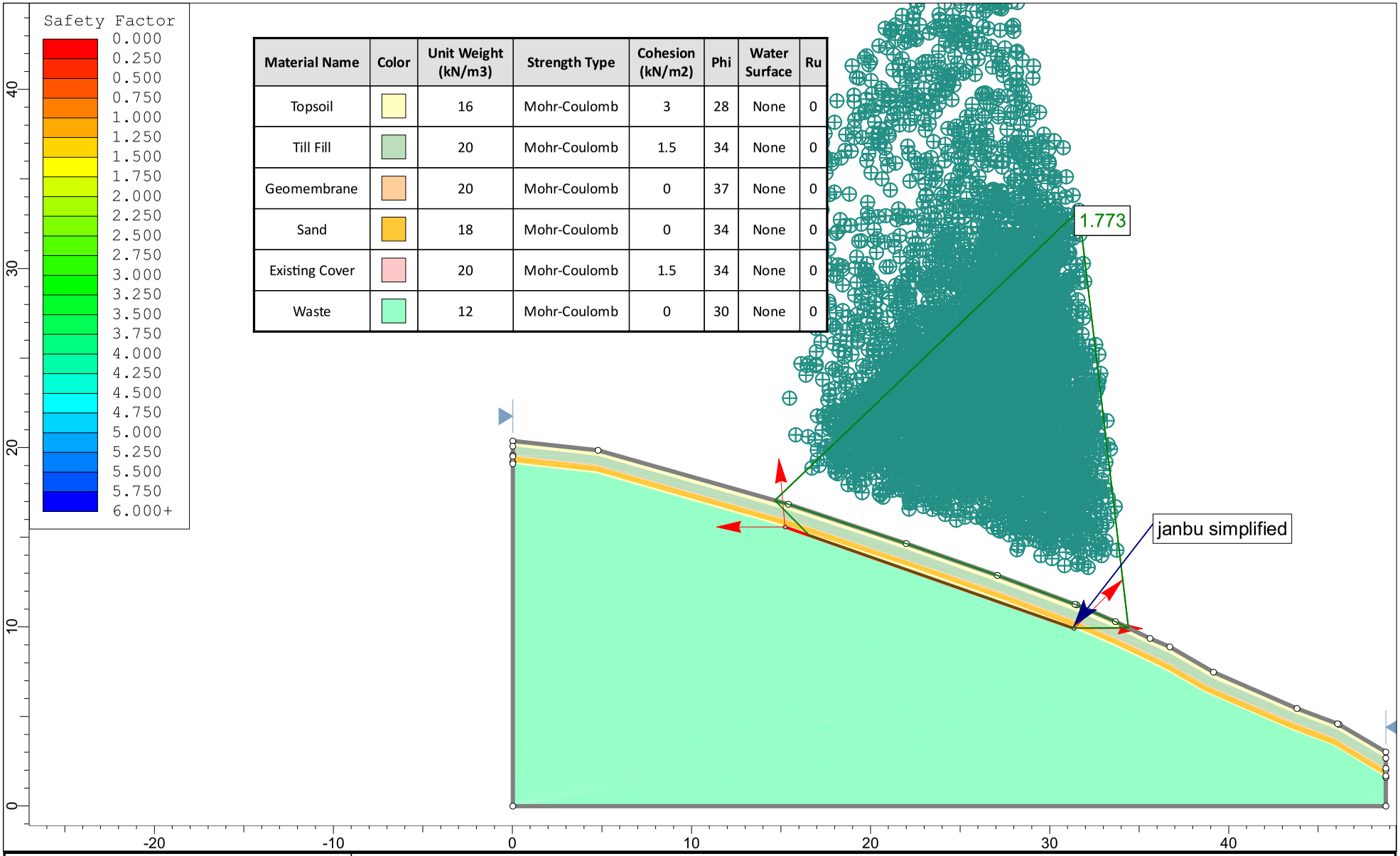
Reviewed By J.F. WETHERILL

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA 19963

MAR 25/13

Harman Dhillon, EIT

James Wetherill, P.Eng.

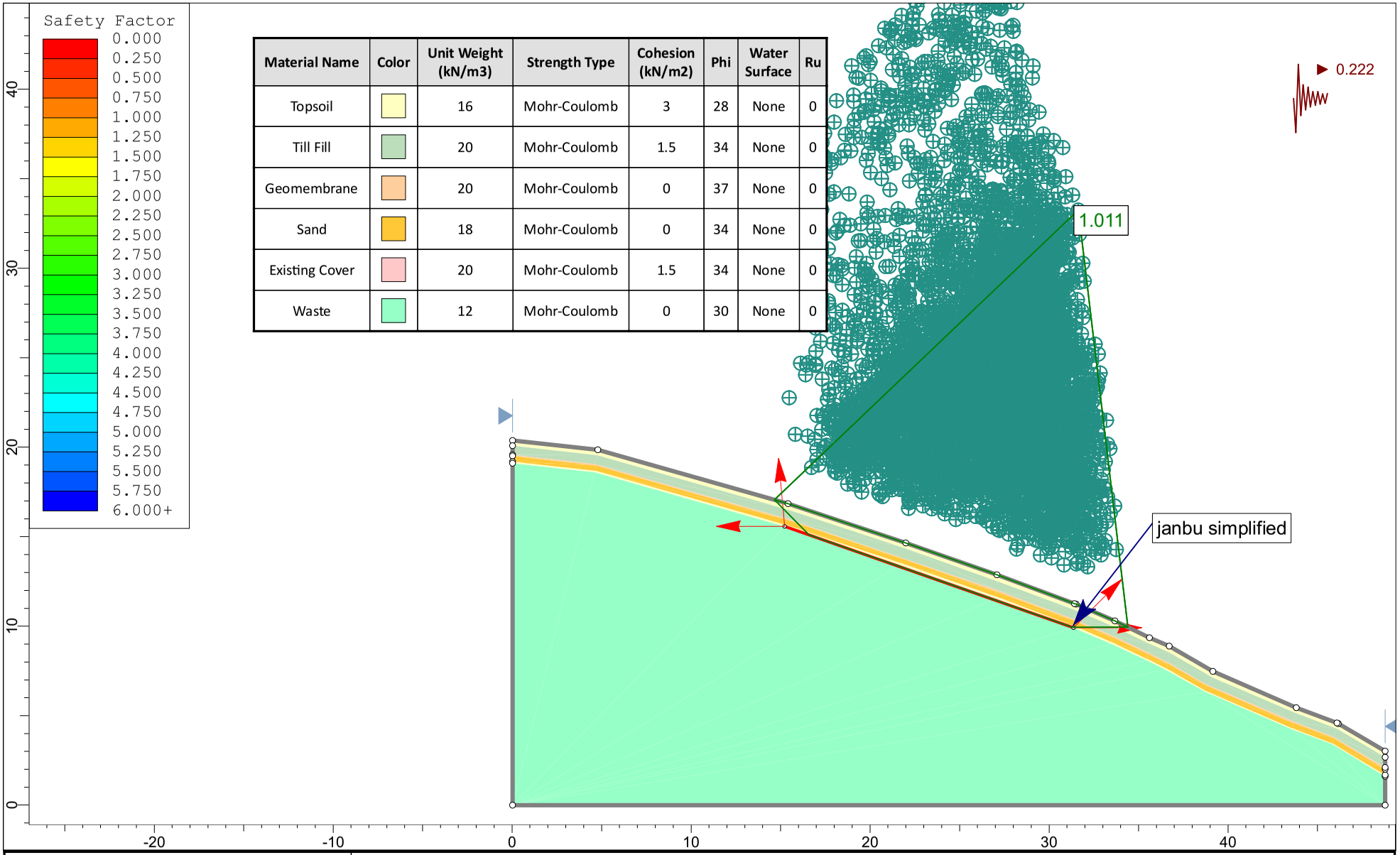


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kN/m2)	Phi	Water Surface	Ru
Topsoil		16	Mohr-Coulomb	3	28	None	0
Till Fill		20	Mohr-Coulomb	1.5	34	None	0
Geomembrane		20	Mohr-Coulomb	0	37	None	0
Sand		18	Mohr-Coulomb	0	34	None	0
Existing Cover		20	Mohr-Coulomb	1.5	34	None	0
Waste		12	Mohr-Coulomb	0	30	None	0

BRAUN GEOTECHNICAL LTD.

SLIDEINTERPRET 6.013

Project	Sechelt Landfill		
Analysis Description	Cover System - Static		
Drawn By	HD	*Scale* 1:300	*Client* XCG Consultants
Date	3/20/13, 2:43:06 PM		*File Name* Slide1 - Cover.slim



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kN/m2)	Phi	Water Surface	Ru
Topsoil		16	Mohr-Coulomb	3	28	None	0
Till Fill		20	Mohr-Coulomb	1.5	34	None	0
Geomembrane		20	Mohr-Coulomb	0	37	None	0
Sand		18	Mohr-Coulomb	0	34	None	0
Existing Cover		20	Mohr-Coulomb	1.5	34	None	0
Waste		12	Mohr-Coulomb	0	30	None	0

BRAUN GEOTECHNICAL LTD.

SLIDEINTERPRET 6.013

Project	Sechelt Landfill				
Analysis Description	Cover System - Seismic				
Drawn By	HD	*Scale*	1:300	*Client*	XCG Consultants
Date	3/20/13, 2:43:06 PM			*File Name*	Slide1 - Cover.slim

APPENDIX F
BRAUN GEOTECHNICAL REPORT

Foundations, Excavation & Shoring Specialists

April 18, 2013

Our File: 13-5854

Via email: Michel@xcg.com

XCG Consultants Ltd.
10455 84th Avenue
Edmonton, Alberta
T6E 2H3

Attention: Michel Lefebvre, M.Sc., P.Eng

Re: Preliminary Geotechnical Report
Sechelt Landfill Slope Stability Assessment
Sechelt Landfill – 4905 Dusty Road, Sechelt, BC., V0N 3A0

Braun Geotechnical
110 – 19188 94th Ave
Surrey, BC
V4N 4X8
Tel: 604-513-4190
Fax: 604-513-4195
info@braungeo.com

www.braungeo.com

Foundations

Excavation & Shoring

Slope Stability

Natural Hazards

Pavement Design and Management

Reinforced Soil Walls and Slopes

Professional Engineers and Geoscientists of BC MEMBER

1.0 INTRODUCTION

As requested, Braun Geotechnical Ltd. has carried out a geotechnical exploration and slope stability assessment for the above referenced project. It is understood that the geotechnical assessment was required for development of a closure plan for the Sechelt sanitary landfill. The geotechnical work has been performed in general accordance with the Braun Geotechnical Proposal and Fee Estimate dated January 29, 2013 (reference no. P13-3847).

The geotechnical work scope included a test pit exploration and provision of this geotechnical report with comments and recommendations pertaining to slope stability assessment of the existing and proposed Municipal Solid Waste (MSW) mass. The slope assessment work has been carried out in general accordance with the Landfill Criteria for Municipal Solid Waste (June 1993), and sufficient in scope and scale to sign and seal a copy of Appendix D of the APEGBC Task Force Report, "Landslide Assessment Assurance Statement", and Appendix J of the APEGBC document "Legislated Flood Assessments in a Changing Climate in BC, June 2012."

Note that the slope stability assessment is based on an assumption that the MSW mass is not bottom lined (i.e. no clay/geocomposite liner).

The scope of services was limited to the evaluation of geotechnical characteristics of the site with respect to slope stability, and no consideration has been given to any environmental issues.

2.0 SITE AND PROJECT DESCRIPTION

The subject site is the existing Sechelt Landfill, located south of Dusty Road, and is approximately trapezoidal in shape, with maximum overall dimensions of approximately 450 by 270m. The subject site is located within a relatively flat area, that slopes down gently to the east/southeast at gradients of approximately 10H:1V (horizontal to vertical) to 35H:1V. Steep south facing slopes, sloping down to the site and away from the site are located approximately 120m north of and 400m south

of the site, respectively. Steep west facing slopes are located approximately 1km west of the subject site.

Irgens Creek, an existing creek orientated approximately east-west, is located approximately 120m north of the subject site, with the headwater of the creek located approximately 100m east of the west property line. Chapman Creek, an existing creek orientated approximately northeast-southwest is located approximately 520m south of the subject site.

At the time of the field exploration, the existing limit of waste occupied approximately 80% of the subject site. Onsite roadways, including a perimeter road around the MSW, as well as a vehicle weigh scale, and multiple temporary/permanent accessory/storage buildings were present on the site.

It is understood that the eastern approximately half of the landfill is near capacity, and final proposed grades are to be developed as per the approved Design and Operations Plan. It is understood that a final cover system is proposed over the existing MSW as a part of the progressive closure. It is understood that a slope stability assessment was required for proposed final grades of the area to be closed. Final contours and proposed final cover system areas were provided in the XCG Consultants Ltd. drawing "Final Contours," dated August 2012, attached for reference.

It is understood that proposed final grades of the landfill's north, east, and south sidewall slopes are in the order of 3H:1V, with localized areas with slopes as steep as 2.6H:1V. A critical section for slope stability assessment was provided by XCG Consultants, and is attached for reference.

3.0 DESK STUDY INFORMATION

The Desk Study phase of geotechnical services was non-intrusive in nature, and involved update and review of available geological and geotechnical information and update and review of available historical aerial photographs.

The following geotechnical comments based on the desk study information are provided:

- A review of historical government air photos available for most decades dating back to 1947 were reviewed. Obvious visible features and/or tones to indicate past or incipient onsite slope movements were not observed on the photographs.
- Obvious visible features and/or tones to indicate past or incipient offsite slope movements in the immediate vicinity of the study site and considered to have potential for having an impact on or be impacted by the study site were not observed on the photographs.
- Light tones on the 1998 and prior air-photos indicate that surficial slumping may have occurred along the banks of Chapman Creek. Surficial slumping adjacent to banks has been known to retrogress upslope, impacting property beyond existing slope crests. However, as the relatively steep sloping banks of Chapman Creek are located a minimum of 400m south of the subject site, surficial slumping and/or shallow slides along the banks of Chapman Creek having potential to impact the subject site is not considered a credible hazard.
- The subject site was observed to be undeveloped in the 1962 and prior air photos. An existing road/trail was observed intersecting Dusty Road at the subject site.
- Clearing and development of the subject site was observed in the 1967 and newer air photos, with the footprint of the landfill increasing to the current cleared dimensions in the 1998 air photo.

- Light tones were observed adjacent to Dusty Road east of the subject site, and adjacent to the Dusty Road switchback, inferred to be logging and/or stripping of surficial soils for pull outs and/or sand and gravel sourcing and/or stockpiling.

4.0 SUBSURFACE EXPLORATION

Eight test pits (TP13-01 to TH13-08) were excavated on March 6th, 2013, using a tracked excavator and operator supplied by the client. The test pits were excavated to depths of approximately 2.0 to 3.5m, along the existing perimeter road adjacent to the limit of waste, at the locations shown on the attached plan (Dwg. 13-5854-01). The soil conditions were logged in the field and representative samples were returned for further classification.

5.0 SOIL AND GROUNDWATER CONDITIONS

The results of the test pit exploration are summarized on the attached test pit logs. Please refer to the test pit logs for detailed subsurface conditions encountered.

A generalized subsoil profile based on the test pits is provided below.

Granular FILL
Grey to brown, damp, loose to compact, SAND and GRAVEL with trace silt, occasional to trace municipal solid waste and occasional cobbles was encountered immediately below existing grades to depths of 0.3 to 1.2m.

MUNICIPAL SOLID WASTE (MSW)
Variable MSW, including, moist to wet, loose MUNICIPAL SOLID WASTE with trace to some variable mixed fill, and grey to brown, damp to moist, loose SAND with some gravel, and occasional silty zones mixed with municipal solid waste were encountered below the granular fill to depths of approximately 0.8 to 3.0m.

Composition of the MSW was noted to be generally consistent with household waste.

Note that a 0.3m thick zone of dark-brown, damp, compact sandy ORGANICS with some gravel (inferred to be organic fill and/or surficial organics prior to municipal solid waste placement), and a 0.8m thick zone of rust brown, compact SAND and GRAVEL with trace silt, occasional organics, and occasional municipal solid waste (FILL) was encountered below that municipal solid waste below TP13-02 and TP13-03 respectively.

SAND AND GRAVEL
Grey-brown, damp to moist, compact to dense cobbley SAND and GRAVEL to SAND and GRAVEL with occasional cobbles, with trace silt and occasional boulders was encountered below the fill and/or MSW to depth of test pit exploration.

GROUNDWATER
Static groundwater was not encountered within the test pits. Sidewall seepage was encountered within TP13-01 at a depth of approximately 3.0m, and within the MSW layer within TP13-04 and TP13-05. Depending on the season and/or weather, near-surface seepage flows are anticipated within loose fill/MSW layers overlying the compact to dense soils. In general, groundwater levels and near-surface run-off flows are expected to fluctuate seasonally, and with drainage conditions.

Further, based on existing profiles provided by XCG Consultants, the static groundwater level was assumed to be approximately 8 to 10m below existing grades within the MSW mass.

The subsurface conditions described above were encountered at the test pit locations only. Subsurface conditions at other locations could vary.

6.0 SLOPE STABILITY ASSESSMENT

6.1 General

The purpose of the slope stability assessment was to evaluate the stability of the proposed final grades of the MSW for static and seismic loading conditions. The slope assessment was based on the available site information, the site walkover review, and findings from the test pit exploration, as well as on parameters, geometry, and cross section information provided by XCG Consultants.

Note that the slope stability assessment is limited to the global stability of proposed landfill final grades. A veneer stability assessment for the proposed MSW cover system was carried out as an earlier phase of work by Braun Geotechnical, and the findings presented in an Engineering Memorandum dated March 25th, 2013, attached for reference.

The findings from the subsurface exploration indicate that the subsurface soils at the toe of the existing MSW mass generally consist of varying depths of fill overlying MSW, over natural compact to dense SAND and GRAVEL soils. Obvious visible evidence to suggest immediate stability concerns with the existing slope was not revealed during the assessment.

However, it is considered that some localized shallow sloughing requiring maintenance may occur within the surface layer of organic soil (topsoil) provided as a growing medium for the landfill cover system, especially under periods of extended rainfall.

6.2 Factor of Safety Discussion

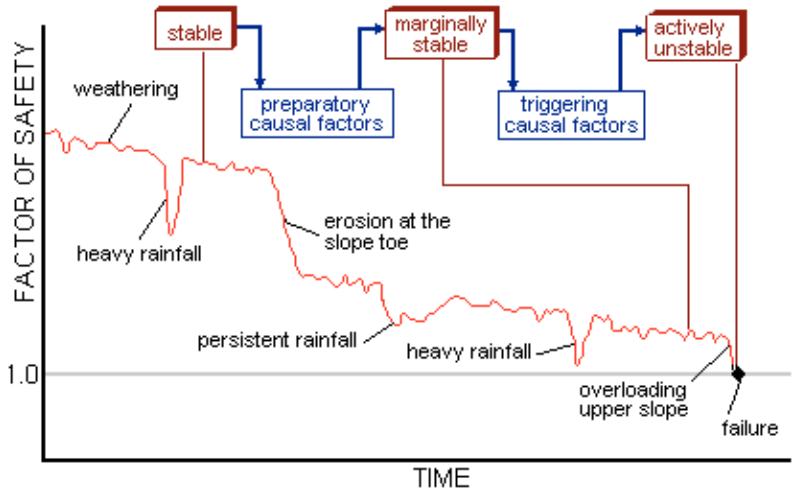
Current BC Building Code (2012) requires a clear and simple distinction between stable and unstable slope conditions for structures, expressed as a computed value of the factor of safety. Further, the current BC Building Code requires that slope performance under both static and seismic conditions be addressed as part of foundation designs, and that the seismic hazard probability with a 2% probability of exceedance in 50 years (~1:2475 return period) should be considered in seismic slope stability assessment.

Minimum acceptable factors of safety are presented in the building code reference document 1991 BC Mine Dump Guidelines and 2006 Canadian Foundation Engineering Manual, and indicate that for slopes in static condition the factor of safety should be at least 1.3.

The minimum factor of safety indicated above has been adopted for this assessment. Further, based on information provided by XCG Consultants, the seismic hazard probability with a 10% probability of exceedance in 50 years (~1:475 return period) has been adopted for consideration in the seismic slope stability assessment.

However, calculated factors of safety only present a baseline (or 'snapshot') assessment of slope conditions at the time of analysis, and may not present an accurate representation of slope conditions over the long term. The following diagram is provided for illustration:

Influence Factors on Slope Stability (after Popescu, 1994)



Preparatory Causal Factor – factor that makes the slope susceptible to movement (ie. tend to place the slope in a marginally stable state).

Triggering Causal Factor – factor that initiates slope movement (ie. tend to place the slope from a marginally stable state to an actively unstable state).

Site slopes are considered stable in the condition where the margin of stability is sufficiently large to withstand all reasonably foreseeable destabilizing forces. Slopes are considered marginally stable if they will fail at some time in the future in response to foreseeable destabilizing forces that reach a certain level of activity. Slopes are considered actively unstable if they are undergoing intermittent movement or on-going creep caused by destabilizing forces.

Man-made processes with potential to negatively impact the stability of slopes and/or promote erosion include, but may not be limited to the following:

- Excavations into the slope or slope toe areas
- Water leakage from waterlines
- Excessive vibration from heavy machinery, such as compaction equipment or pile drivers
- Defective maintenance of slope drainage systems
- Loading of slopes and/or slope crests (fill, structures, etc.)
- Construction of ponds, pools, or other water retention structures with potential for uncontrolled leakage
- Unexpected changes to groundwater flow regimes due to development in the area.

Natural processes with potential to negatively impact the stability of the steep site slopes include, but may not be limited to the following:

- Extended periods of seasonally wet weather
- Storm events with exceptionally high rainfall intensity and duration
- Erosion of slope toe areas
- Earthquake events
- Removal of slope vegetation cover by disease or fire.

6.3 Slope Stability Analysis

Static analyses to assess stability of the slope were run using the limit equilibrium software, SLIDE (RocScience, 2007) based on information provided by XCG Consultants and on the subsurface conditions encountered during the test pit exploration.

The soil parameters used in the assessment are provided in the table below:

Material	Soil Type	Soil Strength Parameters		
		Unit Weight (kN/m3)	*Internal Friction Angle*	*Cohesion (kPa)*
1.	Topsoil*	16	28°	3
2.	Till-Fill	20	34°	1.5**
3.	Sand*	18	34°	0
4.	Existing Cover (Assumed Till-Fill)	20	34°	1.5**
5.	MSW*	12	30°	0
6.	Granular Fill	20	0	35
7.	Native Sand and Gravel	20	1	38

*Soil strength parameters provided by XCG Consultants.
**Apparent cohesion intercept.

As indicated above, an apparent cohesion intercept of 1.5 kPa was used for the till-fill fill zone in the analysis due to negative pore water pressure in unsaturated soils (Rinaldi and Gasagli 1999).

Soil/geosynthetic interaction parameters provided by XCG Consultants are provided in the table below:

Material	Interface	Interface Resistance Values	
		Peak	*Residual*
1.	Till-Fill/Drain Tube	38°	38°
2.	Drain Tube/Geomembrane	37°	23°
3.	Geomembrane/Sand	40°	39°

A soil/geosynthetic interface resistance friction angle of 37°, corresponding to the peak interface resistance value between the drain tube and geomembrane, was selected for the analyses, as it is the lowest slope parallel peak interface resistance value. Note that residual friction interface values are generally only considered once significant shear displacement has occurred.

The analyses indicated the computed static factor of safety is greater than 1.3 and is considered to be within an acceptable range for shallow sloughing type failure.

Pseudo-dynamic analysis to assess stability under seismic loading conditions was also carried out. A design horizontal acceleration of 0.222g associated with an earthquake event with a return period of 1 in 475 years (10% probability in 50 years) was used for the pseudo-dynamic analysis. Seismic slope deformation was estimated using updated procedures for estimating earthquake-induced deviatoric slope displacements at MSW landfill facilities (Bray and Travasarou, 2007).

The findings of the analysis indicate the seismic slope displacements would be expressed within approximately the lower half of the proposed MSW mass slope. The estimated median permanent slope displacements along the slip surface resulting from design seismic loading were approximately 15cm. This is less than the typical acceptable limit of 30cm adopted by other approving authorities concerning seismically induced permanent displacements. The civil consultant should evaluate this median displacement with respect to maximum tolerable displacements permissible for landfill infrastructure and the proposed cover system.

Note that as maximum slope heights will be achieved at the time of the landfill closure, the slope stability assessment was based on full height (post-closure) condition. As such, the findings of the slope stability assessment may be considered applicable to construction and operation conditions.

7.0 GEOTECHNICAL CONSIDERATIONS

7.1 Maximum Contact Pressure

Note that the global slope stability assessment discussed in Section 6.0 above takes into consideration the soil strength parameters of the underlying natural dense sand and gravel soils. Further, the underlying natural dense sand and gravel soils are not considered susceptible to stain softening.

The underlying native dense sand and gravel soils encountered are considered capable of supporting a contact pressure of 300 kPa (6265 psf) under confined conditions. The confined condition contact pressure is less than the maximum anticipated surcharge of approximately 250 kPa, based on a maximum MSW mass and cover system height of approximately 20m.

7.2 Differential Settlements

Differential settlement of the underlying natural subgrade soils over time is anticipated to be negligible relative to differential settlements typically experienced in MSW. Based on reference information provided by XCG Consultants, typical average settlement of the waste mass of 11 percent of the overall depth can be expected (McBean et al, 1995). As such, the impact of any potential minor differential settlement of the surficial soils is deemed to be negligible and not anticipated to adversely impact landfill infrastructure. Further, it is reported by XCG that the design minimum final slope grade is 10 percent, which should typically accommodate differential settlement within the waste mass.

8.0 CLOSURE

This report is prepared for the exclusive use of XCG Consultants Ltd. and their designated representatives and may not be used by other parties without the written permission of Braun Geotechnical Ltd. The Sunshine Coast Regional District and/or the District Municipality of Sechelt may also rely on the findings of this report.

The use of this assessment report is subject to the conditions on the attached Report Interpretation and Limitations sheet. The reader's attention is drawn specifically to those conditions, as it is considered essential that they be followed for proper use and interpretation of this report.

We hope the above meets with your requirements. Should any questions arise, please do not hesitate to contact the undersigned.

Yours truly,

Braun Geotechnical Ltd.

Harman Dhillon, EIT.
Geotechnical Engineer

Braun Geotechnical Ltd.

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
APR 18/13
J.F. WETHERILL
19963

James Wetherill, P.Eng.
Geotechnical Engineer

Encl: Report Interpretation and Limitation
Location Plan
Test Pit Logs (8)
Select SLIDE (RocScience 2007) output (1)
Cover System Engineering Memorandum dated March 25, 2013
APEGBC Appendix D: Landslide Assessment Assurance Statement
APEGBC Appendix J: Flood Hazard and Risk Assurance Statement
XCG Consultants Ltd. drawing "Final Contours," dated August 2012
XCG Consultants Ltd. "Critical Section," "North-South (Final) PROFILE," and "West-East (Final) PROFILE" Received March 15, 2013

X:\2013 Projects\13-5854 Sechelt Landfill\Report 13-5854 2013-04-18.docx

BRAUN GEOTECHNICAL LTD.

REPORT INTERPRETATION AND LIMITATIONS

1. STANDARD OF CARE

Braun Geotechnical Ltd. (Braun) has prepared this report in a manner consistent with generally accepted engineering consulting practices in this area, subject to the time and physical constraints applicable. No other warranty, expressed or implied, is made.

2. COMPLETENESS OF THIS REPORT

This Report represents a summary of paper, electronic and other documents, records, data and files and is not intended to stand alone without reference to the instructions given to Braun by the Client, communications between Braun and the Client, and/or to any other reports, writings, proposals or documents prepared by Braun for the Client relating to the specific site described herein.

This report is intended to be used and quoted in its entirety. Any references to this report must include the whole of the report and any appendices or supporting material. Braun cannot be responsible for use by any party of portions of this report without reference to the entire report.

3. BASIS OF THIS REPORT

This report has been prepared for the specific site, development, design objective, and purpose described to Braun by the Client or the Client's Representatives or Consultants. The applicability and reliability of any of the factual data, findings, recommendations or opinions expressed in this document pertain to a specific project at described in this report and are not applicable to any other project or site, and are valid only to the extent that there has been no material alteration to or variation from any of the descriptions provided to Braun. Braun cannot be responsible for use of this report, or portions thereof, unless we were specifically requested by the Client to review and revise the Report in light of any alterations or variations to the project description provided by the Client.

If the project does not commence within 18 months of the report date, the report may become invalid and further review may be required.

The recommendations of this report should only be used for design. The extent of exploration including number of test pits or test holes necessary to thoroughly investigate the site for conditions that may affect construction costs will generally be greater than that required for design purposes. Contractors should rely upon their own explorations and interpretation of the factual data provided for costing purposes, equipment requirements, construction techniques, or to establish project schedule.

The information provided in this report is based on limited exploration, for a specific project scope. Braun cannot accept responsibility for independent conclusions, interpretations, interpolations or decisions by the Client or others based on information contained in this Report. This restriction of liability includes decisions made to purchase or sell land.

4. USE OF THIS REPORT

The contents of this report, including plans, data, drawings and all other documents including electronic and hard copies remain the copyright property of Braun Geotechnical Ltd. However, we will consider any reasonable request by the Client to approve the use of this report by other parties as "Approved Users." With regard to the duplication and distribution of this Report or its contents, we authorize only the Client and Approved Users to make copies of the Report only in such quantities as are reasonably necessary for the use of this Report by those parties. The Client and "Approved Users" may not give, lend, sell or otherwise make this Report or any portion thereof available to any other party without express written permission from Braun. Any use which a third party makes of this Report – in its entirety or portions thereof – is the sole responsibility of such third parties. BRAUN GEOTECHNICAL LTD. ACCEPTS NO RESPONSIBILITY FOR DAMAGES SUFFERED BY ANY PARTY RESULTING FROM THE UNAUTHORIZED USE OF THIS REPORT.

Electronic media is susceptible to unauthorized modification or unintended alteration, and the Client should not rely on electronic versions of reports or other documents. All documents should be obtained directly from Braun.

5. INTERPRETATION OF THIS REPORT

Classification and identification of soils and rock and other geological units, including groundwater conditions have been based on exploration(s) performed in accordance with the standards set out in Paragraph 1. These tasks are judgemental in nature; despite comprehensive sampling and testing programs properly performed by experienced personnel with the appropriate equipment, some conditions may elude detection. As such, all explorations involve an inherent risk that some conditions will not be detected.

Further, all documents or records summarizing such exploration will be based on assumptions of what exists between the actual points sampled at the time of the site exploration. Actual conditions may vary

significantly between the points investigated and all persons making use of such documents or records should be aware of and accept this risk.
The Client and "Approved Users" accept that subsurface conditions may change with time and this report only represents the soil conditions encountered at the time of exploration and/or review. Soil and ground water conditions may change due to construction activity on the site or on adjacent sites, and also from other causes, including climactic conditions.
The exploration and review provided in this report were for geotechnical purposes only. Environmental aspects of soil and groundwater have not been included in the exploration or review, or addressed in any other way.
The exploration and Report is based on information provided by the Client or the Client's Consultants, and conditions observed at the time of our site reconnaissance or exploration. Braun has relied in good faith upon all information provided. Accordingly, Braun cannot accept responsibility for inaccuracies, misstatements, omissions, or deficiencies in this Report resulting from misstatements, omissions, misrepresentations or fraudulent acts of persons or sources providing this information.

6. DESIGN AND CONSTRUCTION REVIEW

This report assumes that Braun will be retained to work and coordinate design and construction with other Design Professionals and the Contractor. Further, it is assumed that Braun will be retained to provide field reviews during construction to confirm adherence to building code guidelines and generally accepted engineering practices, and the recommendations provided in this report. Field services recommended for the project represent the minimum necessary to confirm that the work is being carried out in general conformance with Braun's recommendations and generally accepted engineering standards. It is the Client's or the Client's Contractor's responsibility to provide timely notice to Braun to carry out site reviews. The Client acknowledges that unsatisfactory or unsafe conditions may be missed by intermittent site reviews by Braun. Accordingly, it is the Client's or Client's Contractor's responsibility to inform Braun of any such conditions.
Work that is covered prior to review by Braun may have to be re-exposed at considerable cost to the Client. Review of all Geotechnical aspects of the project are required for submittal of unconditional Letters of Assurance to regulatory authorities. The site reviews are not carried out for the benefit of the Contractor(s) and therefore do not in any way effect the Contractor(s) obligations to perform under the terms of his/her Contract.

7. SAMPLE DISPOSAL

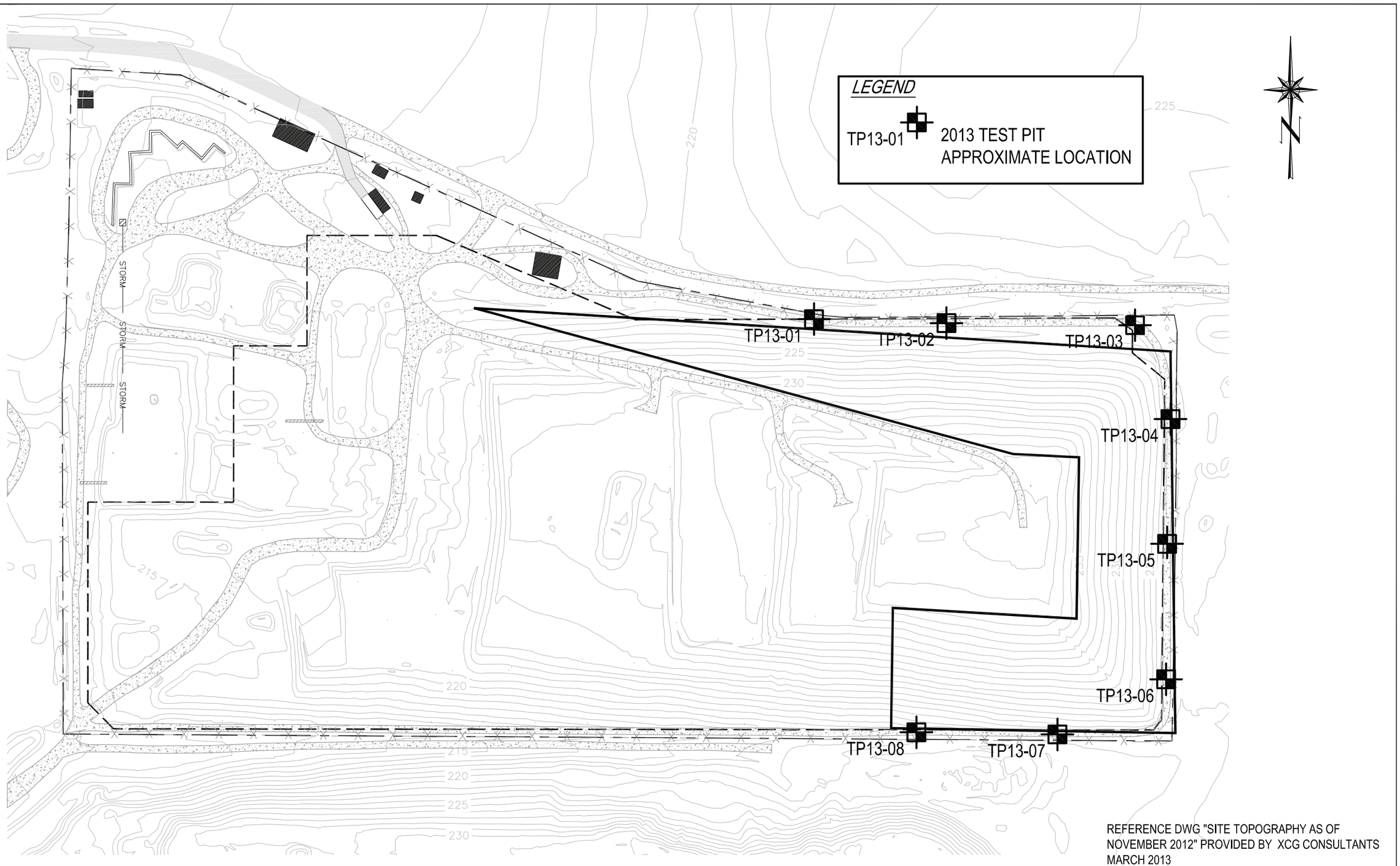
Braun will dispose of all samples 3 months after issuance of this report, or after a longer period of time at the Client's expense if requested by the Client. All contaminated samples remain the property of the Client and it will be the Client's responsibility to dispose of them properly.

8. SUBCONSULTANTS AND CONTRACTORS

Engineering studies frequently requires hiring the services of individuals and companies with special expertise and/or services which Braun Geotechnical Ltd. does not provide. These services are arranged as a convenience to our Clients, for the Client's benefit. Accordingly, the Client agrees to hold the Company harmless and to indemnify and defend Braun Geotechnical Ltd. from and against all claims arising through such Subconsultants or Contractors as though the Client had retained those services directly. This includes responsibility for payment of services rendered and the pursuit of damages for errors, omissions or negligence by those parties in carrying out their work. These conditions apply to specialized subconsultants and the use of drilling, excavation and laboratory testing services, and any other Subconsultant or Contractor.

9. SITE SAFETY

Braun Geotechnical Ltd. assumes responsibility for site safety solely for the activities of our employees on the jobsite. The Client or any Contractors on the site will be responsible for their own personnel. The Client or his representatives, Contractors or others retain control of the site. It is the Client's or the Client's Contractors responsibility to inform Braun of conditions pertaining to the safety and security of the site – hazardous or otherwise – of which the Client or Contractor is aware.
Exploration or construction activities could uncover previously unknown hazardous conditions, materials, or substances that may result in the necessity to undertake emergency procedures to protect workers, the public or the environment. Additional work may be required that is outside of any previously established budget(s). The Client agrees to reimburse Braun for fees and expenses resulting from such discoveries. The Client acknowledges that some discoveries require that certain regulatory bodies be informed. The Client agrees that notification to such bodies by Braun Geotechnical Ltd. will not be a cause for either action or dispute.



REFERENCE DWG "SITE TOPOGRAPHY AS OF NOVEMBER 2012" PROVIDED BY XCG CONSULTANTS MARCH 2013

BRAUN GEOTECHNICAL LTD.

Rev.	Description	Date
0	Issued for Discussion	April 15 / 13

Client: XCG Consultants Ltd.

Project: Sechelt Landfill, Sunshine Coast Regional District, BC

Title: LOCATION PLAN

Project no.	Drawn	Design	Checked	Date	Scale	Drawing no.
13-5854	HD	HD	JW	March 5, 2013	1:1500	13-5854-01

Test Hole Log: TP13-01

File: 13–5854
Project: Sechelt Landfill
Client: XCG Consultants Ltd.
Location: Sunshine Coast Regional District

BRAUN GEOTECHNICAL LTD.

Depth		Sample	Soil Description	Sample #	Water Cont.	Remarks
0 ft / 0 m			grey-brown, damp, compact SAND & GRAVEL, trace silt (roadway FILL)			
			grey to brown, damp to moist, loose SAND with some gravel, trace silt, occasional silty zones mixed with municipal solid waste (variable FILL)			
5 / 1						
2						
10 / 3			grey-brown, moist, dense, cobbly SAND & GRAVEL, trace silt, occasional boulders			- seepage @ 3.0m
			End of Test Pit @ 3.5m			
4						
15 / 5						
20 / 6						

Equipment: Tracked Excavator
Sampling Method: N/A

Datum: Ground Surface
Water Depth: Seepage @ 3.0m

Logged By: HD
Exploration Date: March 6, 2013
Dwg No.: 13-5854-TP01
Page: 1 of 1

Test Hole Log: TP13-02

File: 13–5854
Project: Sechelt Landfill
Client: XCG Consultants Ltd.
Location: Sunshine Coast Regional District

BRAUN GEOTECHNICAL LTD.

Depth		Sample	Soil Description	Sample #	Water Cont.	Remarks
0 ft / 0 m		○	grey-brown, damp, compact SAND & GRAVEL, trace silt (roadway FILL)	S1		
1			grey to brown, damp to moist, loose SAND with some gravel, trace silt, occasional silty zones mixed with municipal solid waste (variable FILL)			
5			dark-brown, damp, compact, sandy ORGANICS with some gravel (TOPSOIL/FILL?)			
2		○	grey-brown, damp, dense, cobbly SAND & GRAVEL, trace silt, occasional boulders	S2		
			End of Test Pit @ 2.4m			
10	3					
4						
15	5					
20	6					

Equipment: Tracked Excavator
Sampling Method: Lump Sample

Datum: Ground Surface
Water Depth: Not Encountered

Logged By: HD
Exploration Date: March 6, 2013
Dwg No.: 13-5854-TP02
Page: 1 of 1

Test Hole Log: TP13-03

File: 13–5854
Project: Sechelt Landfill
Client: XCG Consultants Ltd.
Location: Sunshine Coast Regional District

BRAUN GEOTECHNICAL LTD.

Depth		Sample	Soil Description	Sample #	Water Cont.	Remarks
0 ft / 0 m			grey-brown, damp, compact SAND & GRAVEL, trace silt (roadway FILL)			
1			grey to brown, damp to moist, loose SAND with some gravel, trace silt, occasional silty zones mixed with municipal solid waste (variable FILL)			
5 / 2			rust-brown, damp, compact SAND & GRAVEL, trace silt, occasional organics, occasional municipal solid waste (FILL)			
			grey-brown, damp, compact to dense, cobbly SAND & GRAVEL, trace silt, occasional boulders - sidewalls caving in above 2.1m - dense below 2.1m			
10 / 3			End of Test Pit @ 3.0m			
4						
15 / 5						
20 / 6						

Equipment: Tracked Excavator
Sampling Method: N/A

Datum: Ground Surface
Water Depth: Not Encountered

Logged By: HD
Exploration Date: March 6, 2013
Dwg No.: 13-5854-TP03
Page: 1 of 1

Test Hole Log: TP13-04

File: 13–5854
Project: Sechelt Landfill
Client: XCG Consultants Ltd.
Location: Sunshine Coast Regional District

BRAUN GEOTECHNICAL LTD.

Depth		Sample	Soil Description	Sample #	Water Cont.	Remarks
0 ft / 0 m			grey-brown, damp, compact SAND & GRAVEL, trace silt, occasional municipal solid waste and cobbles (roadway FILL)			
1 m / 5 ft			moist to wet, loose MUNICIPAL SOLID WASTE, trace to some variable mixed FILL - seepage within municipal solid waste layer			
2 m / 10 ft		○	grey, damp, compact to dense SAND & GRAVEL, trace silt, occasional cobbles and boulders	S1		
3 m			End of Test Pit @ 3.0m			
4 m / 15 ft						
5 m						
6 m / 20 ft						

Equipment: Tracked Excavator
Sampling Method: Lump Sample

Datum: Ground Surface
Water Depth: Seepage from 0.5-1.8m

Logged By: HD
Exploration Date: March 6, 2013
Dwg No.: 13-5854-TP04
Page: 1 of 1

Test Hole Log: TP13-05

File: 13–5854
Project: Sechelt Landfill
Client: XCG Consultants Ltd.
Location: Sunshine Coast Regional District

BRAUN GEOTECHNICAL LTD.

Depth		Sample	Soil Description	Sample #	Water Cont.	Remarks
0 ft / 0 m			grey-brown, damp, compact SAND & GRAVEL, trace silt, occasional cobbles (roadway FILL)			
			moist to wet, loose MUNICIPAL SOLID WASTE, trace to some variable mixed FILL - seepage within municipal solid waste layer			
5 / 1						
			grey, damp, compact to dense SAND & GRAVEL, trace silt, occasional cobbles and boulders			
2						
			End of Test Pit @ 2.7m			
10 / 3						
4						
15 / 5						
20 / 6						

Equipment: Tracked Excavator
Sampling Method: N/A

Datum: Ground Surface
Water Depth: Seepage from 0.6-1.8m

Logged By: HD
Exploration Date: March 6, 2013
Dwg No.: 13-5854-TP05
Page: 1 of 1

Test Hole Log: TP13-06

File: 13–5854
Project: Sechelt Landfill
Client: XCG Consultants Ltd.
Location: Sunshine Coast Regional District

BRAUN GEOTECHNICAL LTD.

Depth		Sample	Soil Description	Sample #	Water Cont.	Remarks
0 ft / 0 m			grey-brown, damp, compact SAND & GRAVEL, trace silt, occasional cobbles (roadway FILL)			
			brown to grey, damp, loose to compact SAND & GRAVEL, trace silt (FILL)			
1 m			moist, loose MUNICIPAL SOLID WASTE, trace to some variable mixed FILL			
5 ft						
2 m						
			grey-brown, damp, dense SAND & GRAVEL, trace silt, occasional cobbles and boulders			
10 ft / 3 m			End of Test Pit @ 2.9m			
4 m						
15 ft						
5 m						
20 ft / 6 m						

Equipment: Tracked Excavator
Sampling Method: N/A

Datum: Ground Surface
Water Depth: Not Encountered

Logged By: HD
Exploration Date: March 6, 2013
Dwg No.: 13-5854-TP06
Page: 1 of 1

Test Hole Log: TP13-07

File: 13–5854
Project: Sechelt Landfill
Client: XCG Consultants Ltd.
Location: Sunshine Coast Regional District

BRAUN GEOTECHNICAL LTD.

Depth		Sample	Soil Description	Sample #	Water Cont.	Remarks
0 ft / 0 m			grey-brown, damp, compact SAND & GRAVEL, trace silt, occasional cobbles (roadway FILL)			
			brown, damp, loose to compact SAND & GRAVEL, trace silt, trace municipal solid waste (FILL)			
			grey-brown, damp, compact SAND & GRAVEL, trace silt (FILL)			
1			moist, loose MUNICIPAL SOLID WASTE, trace to some variable mixed FILL			
5			grey-brown, damp, dense, cobbly SAND & GRAVEL, trace silt, occasional boulders			
2			End of Test Pit @ 2.0m			
10						
3						
4						
15						
5						
20						
6						

Equipment: Tracked Excavator
Sampling Method: N/A

Datum: Ground Surface
Water Depth: Not Encountered

Logged By: HD
Exploration Date: March 6, 2013
Dwg No.: 13-5854-TP07
Page: 1 of 1

Test Hole Log: TP13-08

File: 13–5854
Project: Sechelt Landfill
Client: XCG Consultants Ltd.
Location: Sunshine Coast Regional District

BRAUN GEOTECHNICAL LTD.

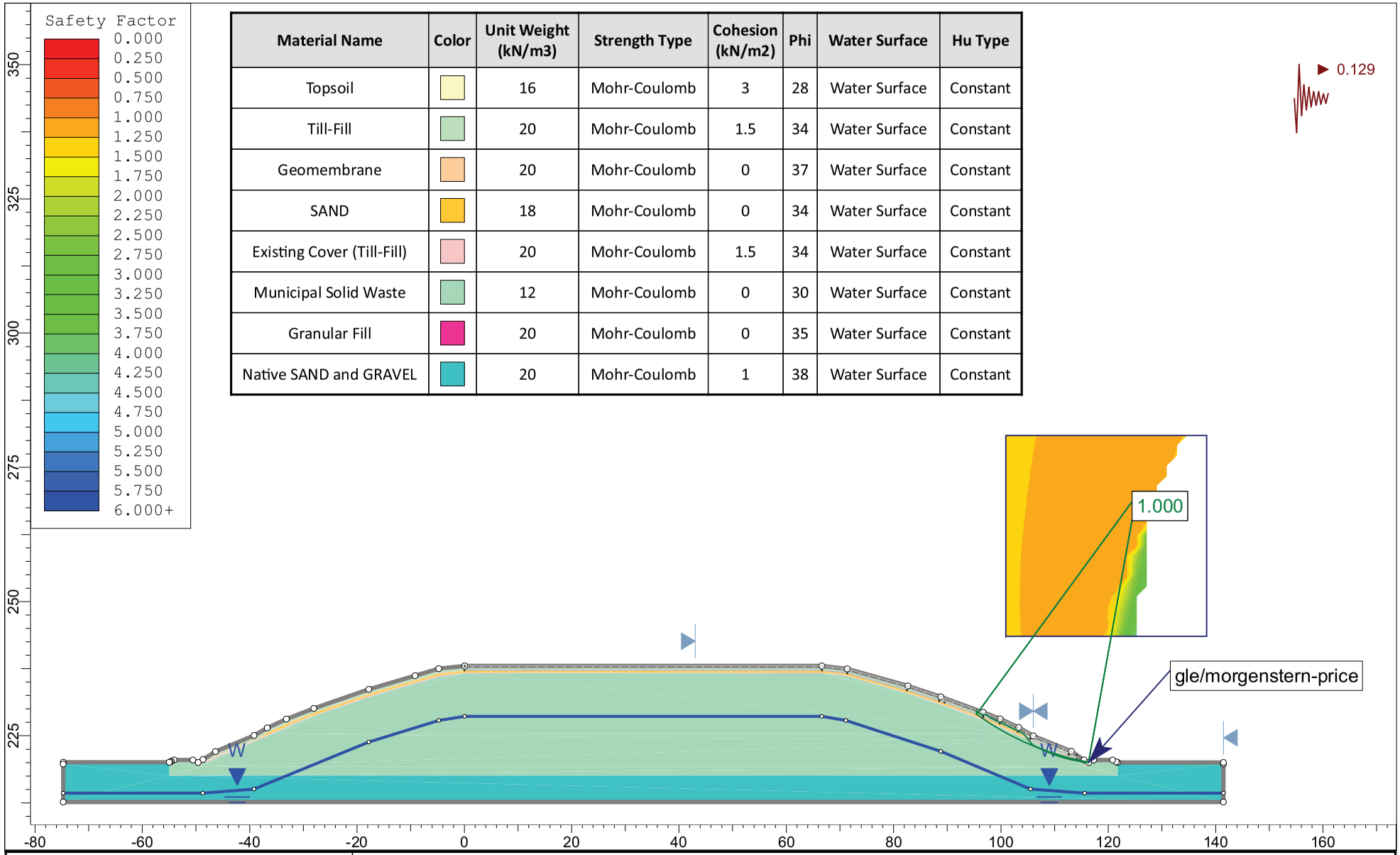
Depth		Sample	Soil Description	Sample #	Water Cont.	Remarks
0 ft / 0 m		○	grey-brown, damp, compact SAND & GRAVEL, trace silt	S1		
			brown to grey, damp, loose to compact SAND & GRAVEL, trace silt, occasional cobbles, occasional boulders, occasional municipal solid waste			
1 m			moist, loose MUNICIPAL SOLID WASTE, trace to some SAND & GRAVEL (FILL)			
5 ft						
		○	grey-brown, damp, dense, cobbly SAND & GRAVEL, trace silt, occasional boulders	S2		
2 m						
			End of Test Pit @ 2.1m			
10 ft / 3 m						
4 m						
15 ft						
5 m						
20 ft / 6 m						

Equipment: Tracked Excavator
Sampling Method: Lump Sample

Datum: Ground Surface
Water Depth: Not Encountered

Logged By: HD
Exploration Date: March 6, 2013
Dwg No.: 13-5854-TP08
Page: 1 of 1

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kN/m2)	Phi	Water Surface	Hu Type
Topsoil		16	Mohr-Coulomb	3	28	Water Surface	Constant
Till-Fill		20	Mohr-Coulomb	1.5	34	Water Surface	Constant
Geomembrane		20	Mohr-Coulomb	0	37	Water Surface	Constant
SAND		18	Mohr-Coulomb	0	34	Water Surface	Constant
Existing Cover (Till-Fill)		20	Mohr-Coulomb	1.5	34	Water Surface	Constant
Municipal Solid Waste		12	Mohr-Coulomb	0	30	Water Surface	Constant
Granular Fill		20	Mohr-Coulomb	0	35	Water Surface	Constant
Native SAND and GRAVEL		20	Mohr-Coulomb	1	38	Water Surface	Constant



BRAUN GEOTECHNICAL LTD.

SLIDEINTERPRET 6.013

Project	Sechelt Landfill Slope Stability Assessment		
Analysis Description	Critical Section - Ky		
Drawn By	HD	Scale 1:1000	Company
Date	4/04/13, 3:15:34 PM		File Name Critical Section TP13-01.slim

BRAUN GEOTECHNICAL LTD.

ENGINEERING MEMO

TO:	XCG Consultants Ltd.	FILE NO.:	**13-5854**
ATTENTION:	Michel Lefebvre, M.Sc., P.Eng	DATE:	March 25, 2013
FROM:	Harman Dhillon, EIT	CLIENT:	XCG Consultants Ltd.
CC:	Phillip Auclair, B.Comm, P.Eng.		
SUBJECT:	Sechelt Landfill Cover System Veneer Stability Assessment		
LOCATION:	Sechelt Landfill – 4905 Dusty Road, Sechelt, BC., V0N 3A0		

MESSAGE/INSTRUCTIONS:

As requested, Braun Geotechnical Ltd. has completed a veneer stability assessment of the proposed cover system for the Sechelt Landfill.

It is understood that a cover system comprised of 300mm of topsoil, over a minimum 500mm of till-fill, over 50LL Supergripnet geomembrane over 300mm of sand is proposed over a minimum 100mm thick existing cover underlain by Municipal Solid Waste (MSW). It is understood that drain tubes are present above the geomembrane. It is understood that the cover system is proposed for a maximum slope height of approximately 18m, at a maximum slope gradient of 2.6H:1V (Horizontal to Vertical).

Veneer Stability Analysis

The cover system veneer stability assessment was carried out using parameters, geometry and cross section information provided by XCG Consultants. The purpose of the veneer stability assessment was to evaluate the stability of the proposed cover system under static and design seismic conditions.

The soil parameters used in the assessment are provided in the table below:

Material	Soil Type	Soil Strength Parameters		
		Unit Weight (kN/m3)	*Internal Friction Angle*	*Cohesion (kPa)*
1.	Topsoil*	16	28°	3
2.	Till-Fill	20	34°	1.5**
3.	Sand*	18	34°	0
4.	Existing Cover (Assumed Till-Fill)	20	34°	1.5**
5.	MSW*	12	30°	0

*Soil strength parameters provided by XCG Consultants.

**Apparent cohesion intercept.

As indicated above, an apparent cohesion intercept of 1.5 kPa was used for the till-fill fill zone in the analysis due to negative pore water pressure in unsaturated soils (Rinaldi and Gasagli 1999).

Soil/geosynthetic interaction parameters provided by XCG Consultants are provided in the table below:

Material	Interface	Interface Resistance Values	
		Peak	*Residual*
1.	Till-Fill/Drain Tube	38°	38°
2.	Drain Tube/Geomembrane	37°	23°
3.	Geomembrane/Sand	40°	39°

A soil/geosynthetic interface resistance friction angle of 37°, corresponding to the peak interface

resistance value between the drain tube and geomembrane, was selected for the analyses, as it is the lowest slope parallel peak interface resistance value. Note that residual friction interface values are generally only considered once significant shear displacement has occurred.

The presence of groundwater was not considered in the cover system stability analyses, as drain tubes are present within cover system to drain the cover system.

In order to assess the veneer stability of the cover system, a failure plane at the MSW and existing cover interface was considered. Note that failure surfaces confined to the topsoil layer was considered to be nuisance surficial sloughing, and a maintenance issue. Potential for shallow sloughing in the topsoil layer is expected to be reduced over time as surface vegetation becomes established.

Static analyses to assess the stability of the slope were run using the limit equilibrium software, SLIDE 6.0 (RocScience, 2007). Pseudo-dynamic analysis to assess stability under seismic loading conditions was also carried out. A design horizontal acceleration of 0.222g associated with an earthquake event with a return period of 1 in 475 years (10% probability in 50 years) was used for the pseudo-dynamic analysis.

The analyses indicated that the computed static and seismic factors of safety are greater than 1.7 and 1.0 respectively, and are considered to be within an acceptable range for shallow sloughing type failures.

A simplified infinite slope analysis was also carried out to confirm the findings of the SLIDE static analysis, using the following equation:

$$\text{Factor of Safety} = \tan\varphi/\tan\beta,$$

where φ is the internal angle of friction of the MSW (30°), and β is the slope angle of the cover system (21°). The static factor of safety was determined to be 1.5.

Note that the veneer stability assessment of the cover system was based on a uniform thickness of materials above the geomembrane, as per the cross-section provided by XCG Consultants.

Based on available site information and the slope stability assessment, stability concerns for the cover system are not anticipated for static and design seismic conditions. However, it is considered that some localized shallow sloughing requiring maintenance may occur on surficial soils, especially under periods of extended rainfall until vegetation becomes established on the topsoil surface. In order to reduce potential for shallow sloughing within the topsoil layer, consideration may be given to installation of temporary erosion control matting.

Note that the current veneer stability assessment was limited to the cover system only. Global stability of the existing and proposed MSW stockpile sections will be carried out as a part of Phase II of the proposed scope of work.

We hope the above meets with your requirements. Should any questions arise, please do not hesitate to contact the undersigned

Attachments: SLIDE 6.0 Outputs

Braun Geotechnical Ltd.

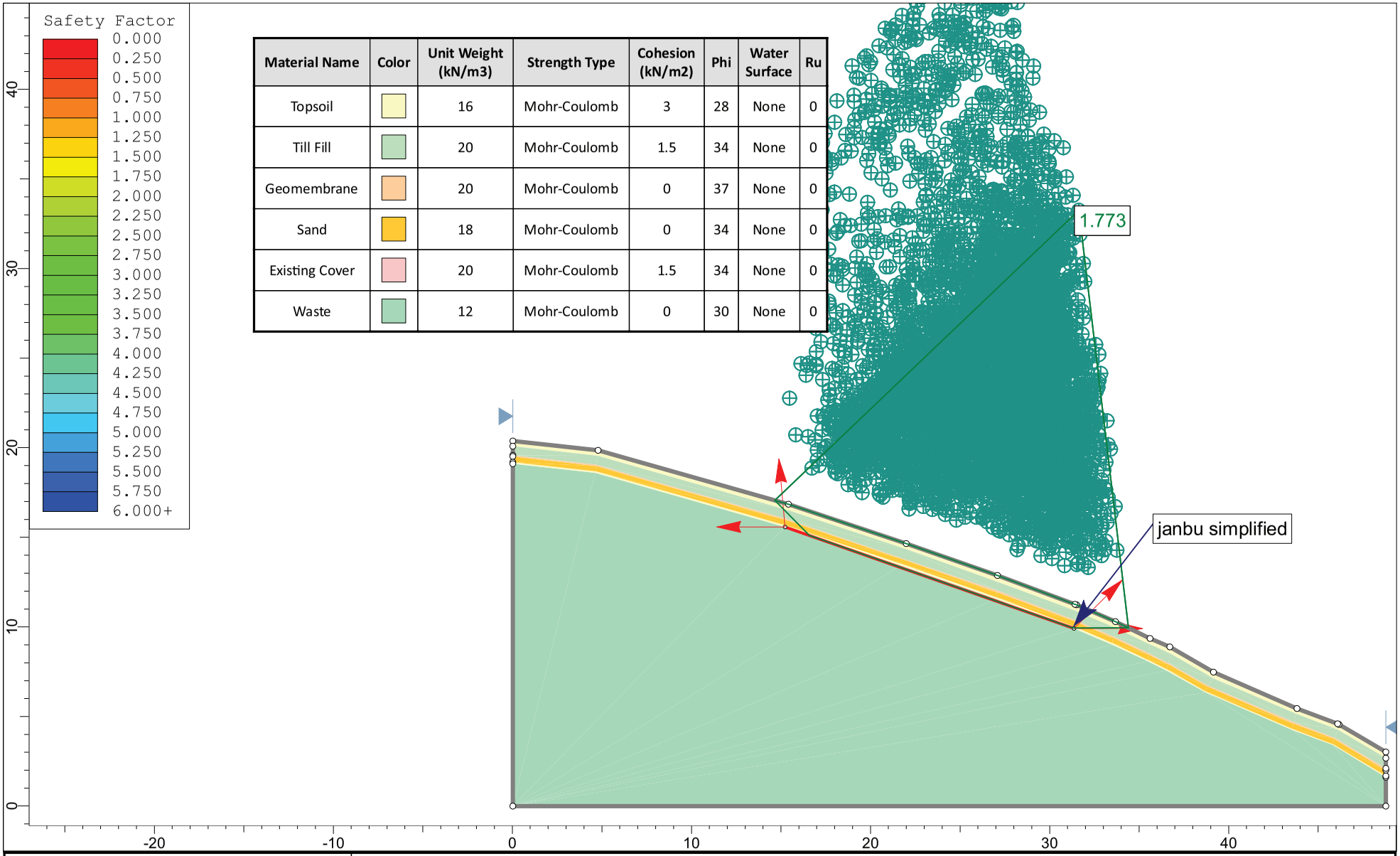
Reviewed By J.F. WETHERILL

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA 19963

MAR 25/13

Harman Dhillon, EIT

James Wetherill, P.Eng.

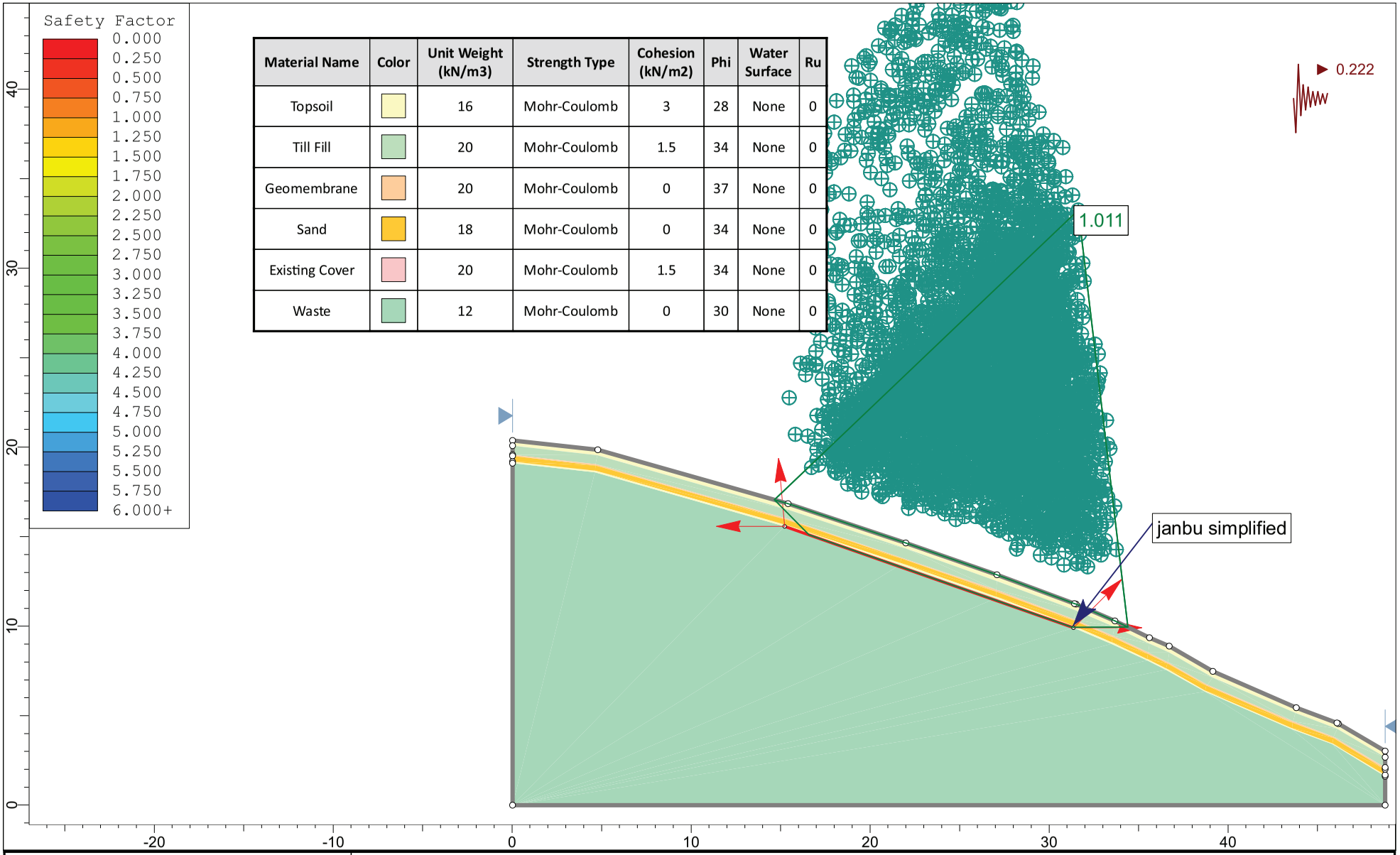


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kN/m2)	Phi	Water Surface	Ru
Topsoil		16	Mohr-Coulomb	3	28	None	0
Till Fill		20	Mohr-Coulomb	1.5	34	None	0
Geomembrane		20	Mohr-Coulomb	0	37	None	0
Sand		18	Mohr-Coulomb	0	34	None	0
Existing Cover		20	Mohr-Coulomb	1.5	34	None	0
Waste		12	Mohr-Coulomb	0	30	None	0

BRAUN GEOTECHNICAL LTD.

SLIDEINTERPRET 6.013

Project	Sechelt Landfill		
Analysis Description	Cover System - Static		
Drawn By	HD	*Scale* 1:300	*Client* XCG Consultants
Date	3/20/13, 2:43:06 PM		*File Name* Slide1 - Cover.slim



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kN/m2)	Phi	Water Surface	Ru
Topsoil		16	Mohr-Coulomb	3	28	None	0
Till Fill		20	Mohr-Coulomb	1.5	34	None	0
Geomembrane		20	Mohr-Coulomb	0	37	None	0
Sand		18	Mohr-Coulomb	0	34	None	0
Existing Cover		20	Mohr-Coulomb	1.5	34	None	0
Waste		12	Mohr-Coulomb	0	30	None	0

BRAUN GEOTECHNICAL LTD.

SLIDEINTERPRET 6.013

Project	Sechelt Landfill		
Analysis Description	Cover System - Seismic		
Drawn By	HD	*Scale* 1:300	*Client* XCG Consultants
Date	3/20/13, 2:43:06 PM		*File Name* Slide1 - Cover.slim

Bldg Dept Fax: Our File: 13-5854

APPENDIX D: LANDSLIDE ASSESSMENT ASSURANCE STATEMENT

Note: This Statement is to be read and completed in conjunction with the "APEGBC Guidelines for Legislated Landslide Assessments for Proposed Residential Development in British Columbia", March 2006 / Revised September 2008 ("APEGBC Guidelines") and the "2006 BC Building Code (BCBC 2006)" and is to be provided for *landslide assessments* (not floods or flood controls) for the purposes of the Land Title Act, Community Charter or the Local Government Act. Italicized words are defined in the APEGBC Guidelines.

To: The *Approving Authority* Date: April 15, 2013

SUNSHINE COAST REGIONAL DISTRICT
1975 Field Road
Sechelt, BC, V0N 3A1
Jurisdiction and address

With reference to (check one):

- ☐ Land title (Section 86) Subdivision Approval
- ☐ Local Government Act (Sections 919.1 and 920) - Development Permit
- ☑ Community Charter (Section 56) - Building Permit
- ☐ Local Government Act (Section 910) - Flood Plain Bylaw Variance
- ☐ Local Government Act (Section 910) - Flood Plain Bylaw Exemption
- ☐ British Columbia Building Code 2006 sentences 4.1.8.16 (8) and 9.4.4.4.(2). (Refer to BC Building and Safety Policy Branch Information Bulletin B10-01 issued January 18, 2010)

For the Property:

4095 Dusty Road, Sechelt, BC
Legal description and civic address of the Property

The undersigned hereby gives assurance that he/she is a Qualified Professional and is a *Professional Engineer* or *Professional Geoscientist*.

I have signed, sealed,and dated, and thereby certified, the attached *landslide assessment* report on the Property in accordance with the APEGBC Guidelines. That report must be read in conjunction with this Statement. In preparing that report I have:

Check to the left of applicable items

- ☑ 1. Collected and reviewed appropriate background information
- ☑ 2. Reviewed the proposed ~~*residential*~~ *development* on the Property
- ☑ 3. Conducted field work on and, if required, beyond the Property
- ☑ 4. Reported on the results of the field work on, and if required, beyond the Property
- ☑ 5. Considered any changed conditions on and, if required, beyond the Property
- 6. For a landslide hazard analysis or *landslide risk analysis* I have:
  - ☑ 6.1 reviewed and characterized, if appropriate, any *landslide* that may affect the Property
  - ☑ 6.2 estimated the *landslide hazard*
  - ☑ 6.3 identified existing and anticipated future *elements at risk* on and, if required, beyond the Property
  - ☑ 6.4 estimated the potential *consequences* to those *elements at risk*
- 7. Where the *Approving Authority* has adopted a level of landslide safety I have:
  - ☐ 7.1 compared the *level of landslide safety* adopted by the Approving Authority with the findings of my investigation
  - ☐ 7.2 made a finding on the *level of landslide safety* on the Property based on the comparison
  - ☐ 7.3 made recommendations to reduce *landslide hazards* and/or *landslide risks*
- 8. Where the Approving Authority has **not** adopted a level of landslide safety I have:
  - ☑ 8.1 described the method of *landslide hazard analysis* or *landslide risk analysis* used
  - ☑ 8.2 referred to an appropriate and identified provincial, national or international guideline for *level of landslide safety*
  - ☑ 8.3 compared this guideline with the findings of my investigation

☑ 8.4 made a finding on the *level of landslide safety* on the Property based on my comparison
☑ 8.5 made recommendations to reduce *landslide hazards* and/or *landslide risks*

☑ 9. Reported on the requirements for future inspections of the Property and recommended who should conduct those inspections

Based on my comparision between

Check one

☐ the findings from the investigation and the adopted *level of landslide safety* (item 7.2 above)

☑ the appropriate and identified provincial, national or international guideline for *level of landslide safety* (item 8.4 above)

I hereby give my assurance based on conditions[1] contained in the attached *landslide assessment* report

Check one or more where appropriate

☐ for subdivision approval, as required by the Land Title Act (Section 86), "that the land may be used safely for the use intended

Check one

☐ with one or more recommended registered *covenants*.

☐ without any registered *covenant*.

☐ for a development permit, as required by the Local Government Act (Sections 919.1 and 920), my report will "assist the *local government* in determining what conditions or requirements under (Section 920) subsection (7.1) it will impose in the permit."

☑ for a ~~building permit~~, as required by the Community Charter (Section 56), "the land may be used safely for the use intended"

Check one

☐ with one or more recommended registered *covenants*.

☑ without any registered *covenant*.

☐ for flood plain bylaw variance, as required by the "Flood Hazard Area Land Use Management Guidelines" associated with the Local Government Act (Section 910), "the development may occur safely."

☐ for flood plain bylaw exemption , as required by the Local Government Act (Section 910), "the land may be used safely for the use intended."

James Wetherill, P.Eng.
Name (print)

Signature

110-19188 94th Avenue
Address (Print)

Surrey, BC V4N 4X8

604-513-4190
Phone

April 15, 2013
Date

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
J.F. WETHERILL
19983
(Affix Professional seal here)

If the Qualified Professional is a member of a firm, complete the following.

I am a member of the firm and I sign this letter on behalf of the firm. Braun Geotechnical Ltd. (Print name of firm)

[1] When seismic slope stability assessments are involved, level of landslide safety is considered to be a "life safety" criteria as described in the National Building Code of Canada (NBCC 2005), Commentary on Design for Seismic effects in the User's Guide, Structural Commentaries, Part 4 of division B. This states:

"The primary objective of seismic design is to provide an acceptable level of safety for building occupants and the general public as the building responds to strong ground motion; in other words, to minimize loss of life. This implies that, although there will likely be extensive structural and non-structural damage, during the DGM (design ground motion), there is a reasonable degree of confidence that the building will not collapse nor will its attachments break off and fallon people near the building. This performance level is termed 'extensive damage' because, although the structure may be heavily damaged and may have lost a substantial amount of its initial strength and stiffness, it retains some margin of resistance against collapse".

Bldg Dept Fax: Our File: 13-5854

APPENDIX J: *FLOOD HAZARD* AND *RISK* ASSURANCE STATEMENT

Note: This Statement is to be read and completed in conjunction with the "*APEGBC Professional Practice Guidelines - Legislated Flood Assessments in a Changing Climate*, March 2012 ("*APEGBC* Guidelines") and is to be provided for *flood assessments* for the purposes of the *Land Title Act*, Community Charter or the *Local Government Act*. Italicized words are defined in the *APEGBC* Guidelines.

To: The *Approving Authority* Date: April 15, 2013

SUNSHINE COAST REGIONAL DISTRICT
1975 Field Road
Sechelt, BC, V0N 3A1
Jurisdiction and address

With reference to (check one):

- ☐ Land title (Section 86) Subdivision Approval
- ☐ Local Government Act (Sections 919.1 and 920) - Development Permit
- ☑ Community Charter (Section 56) ~~- Building Permit~~
- ☐ Local Government Act (Section 910) - Flood Plain Bylaw Variance
- ☐ Local Government Act (Section 910) - Flood Plain Bylaw Exemption

For the Property:

4095 Dusty Road, Sechelt, BC
Legal description and civic address of the Property

The undersigned hereby gives assurance that he/she is a *Qualified Professional* and is a *Professional Engineer* or *Professional Geoscientist*.

I have signed, sealed,and dated, and thereby certified, the attached flood assessment report on the Property in accordance with the APEGBC Guidelines. That report must be read in conjunction with this Statement. In preparing that report I have:

Check to the left of applicable items

- ☑ 1. Collected and reviewed appropriate background information
- ☑ 2. Reviewed the proposed ~~*residential*~~ *development* on the Property
- ☑ 3. Conducted field work on and, if required, beyond the Property
- ☑ 4. Reported on the results of the field work on, and if required, beyond the Property
- ☑ 5. Considered any changed conditions on and, if required, beyond the Property
- ☑ 6. For a *flood hazard* analysis or *flood risk* analysis I have:
  - ☑ 6.1 reviewed and characterized, if appropriate, floods that may affect the Property
  - ☑ 6.2 estimated the *flood hazard* or *flood risk* on the property
  - ☑ 6.3 included (if appropriate) the effects of climate change and land use change
  - ☑ 6.4 identified existing and anticipated future *elements at risk* on and, if required, beyond the Property
  - ☑ 6.5 estimated the potential *consequences* to those *elements at risk*
- 7. Where the *Approving Authority* has adopted a specific level of *flood hazard* or *flood risk* tolerance or return period that is different from the standard 200-year return period design criteria[1], I have
  - ☐ 7.1 compared the level of *flood hazard* or *flood risk* tolerance adopted by the *Approving Authority* with the findings of my investigation
  - ☐ 7.2 made a finding on the level of *flood hazard* or *flood risk* tolerance on the Property based on the comparison
  - ☐ 7.3 made recommendations to reduce *flood hazard* or *flood risk* on the Property

[1] *Flood Hazard Area Land Use Management Guidelines* published by the BC Ministry of Forests, Lands, and Natural Resource Operations and the 2009 publication *Subdivision Preliminary Layout Review - Natural Hazard Risk* published by the Ministry of Transportation and Public Infrastructure. It should be noted that the 200-year return period is a standard used typically for rivers and purely fluvial processes. For small creeks subject to debris floods and debris flows return periods are commonly applied that exceed 200 years. For life-threatening events including debris flows, the Ministry of Transportation and Public Infrastructure stipulates in their 2009 publication *Subdivision Preliminary Layout Review - Natural*

Hazard Risk that a 10,000-year return period needs to be considered.

8. Where the *Approving Authority* has **not** adopted a level of *flood risk* or *flood hazard* tolerance I have:

- [x] 8.1 described the method of *flood hazard* analysis or *flood risk* analysis used
- [x] 8.2 referred to an appropriate and identified provincial or national guideline for level of *flood hazard* or *flood risk*
- [x] 8.3 compared this guideline with the findings of my investigation
- [x] 8.4 made a finding on the level of *flood hazard* or *flood risk* tolerance on the Property based on the comparison
- [ ] 8.5 made recommendations to reduce *flood risks*

[x] 9. Reported on the requirements for future inspections of the Property and recommended who should conduct those inspections.

Based on my comparision between

Check one

- [ ] the findings from the investigation and the adopted level of *flood hazard* or *flood risk* tolerance (item 7.2 above)
- [x] the appropriate and identified provincial or national guideline for level of *flood hazard* or *flood risk* tolerance (item 8.4 above)

I hereby give my assurance based on conditions contained in the attached flood assessment report,

Check one

- [ ] for subdivision approval, as required by the *Land Title Act* (Section 86), "that the land may be used safely for the use intended".

  Check one
  - [ ] with one or more recommended registered *covenants*.
  - [ ] without any registered *covenant*.

- [ ] for a development permit, as required by the *Local Government Act* (Sections 919.1 and 920), my report will "assist the local government in determining what conditions or requirements under (Section 920) subsection (7.1) it will impose in the permit."

- [x] for a building permit, as required by the Community Charter (Section 56), "the land may be used safely for the use intended"

  Check one
  - [ ] with one or more recommended registered *covenants*.
  - [x] without any registered *covenant*.

- [ ] for flood plain bylaw variance, as required by the *Flood Hazard Area Land Use Management Guidelines* associated with the *Local Government Act* (Section 910), "the development may occur safely."

- [ ] for flood plain bylaw exemption , as required by the *Local Government Act* (Section 910), "the land may be used safely for the use intended."

James Wetherill, P.Eng.
Name (print)

Signature

110-19188 94th Avenue
Address (Print)

Surrey, BC V4N 4X8

604-513-4190
Phone

April 15, 2013
Date

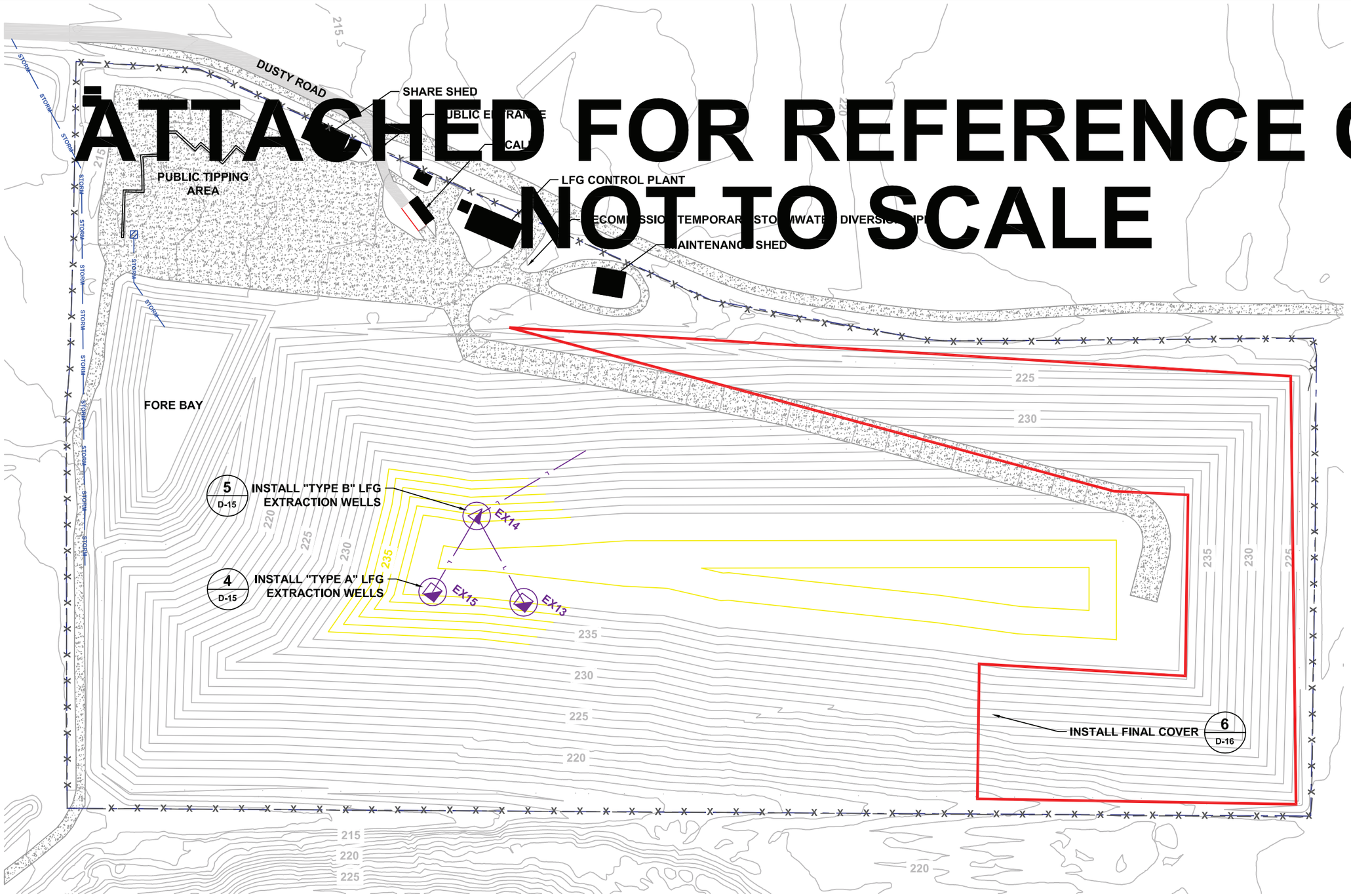
PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
J.F. WETHERILL
19963
(Affix Professional seal here)

If the Qualified Professional is a member of a firm, complete the following.

I am a member of the firm and I sign this letter on behalf of the firm.

Braun Geotechnical Ltd.
(Print name of firm)

ATTACHED FOR REFERENCE ONLY.
NOT TO SCALE



0 20 40 m

1 : 1500

LEGEND

- PROPERTY BOUNDARY
- APPROXIMATE FENCE LINE
- EXISTING CONTOURS
- PROPOSED CONTOURS
- EXISTING ASPHALT ROAD
- EXISTING GRAVEL ROAD
- EXISTING BUILDING
- EXISTING FINAL COVER
- PROPOSED FINAL COVER
- EXISTING STORMWATER GRAVITY MAIN
- EXISTING CATCHBASIN
- EXISTING LFG HEADER
- EXISTING LFG LATERAL
- PROPOSED LFG LATERAL
- EX4 EXISTING "TYPE A" LFG EXTRACTION WELL
- EX3 EXISTING "TYPE B" LFG EXTRACTION WELL
- EX8 PROPOSED "TYPE A" LFG EXTRACTION WELL
- EX6 PROPOSED "TYPE B" LFG EXTRACTION WELL
- CT1 EXISTING LFG CONDENSATE TRAP
- EXISTING CULVERT
- EXISTING SURFACE WATERCOURSE

NOTES: EXISTING CONDITIONS AS OF JUNE 30, 2009.

(file: R421110116001DWG13.dwg)

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
0	ISSUED FOR REVIEW	AUG. 2012	M. LEFEBVRE

INTERIM DESIGN AND OPERATION PLAN

SECHELT LANDFILL

SUNSHINE COAST REGIONAL DISTRICT

VERIFY SCALE

BAR IS 10 mm ON ORIGINAL DRAWING.
0 ■ 10 mm
IF NOT 10 mm ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

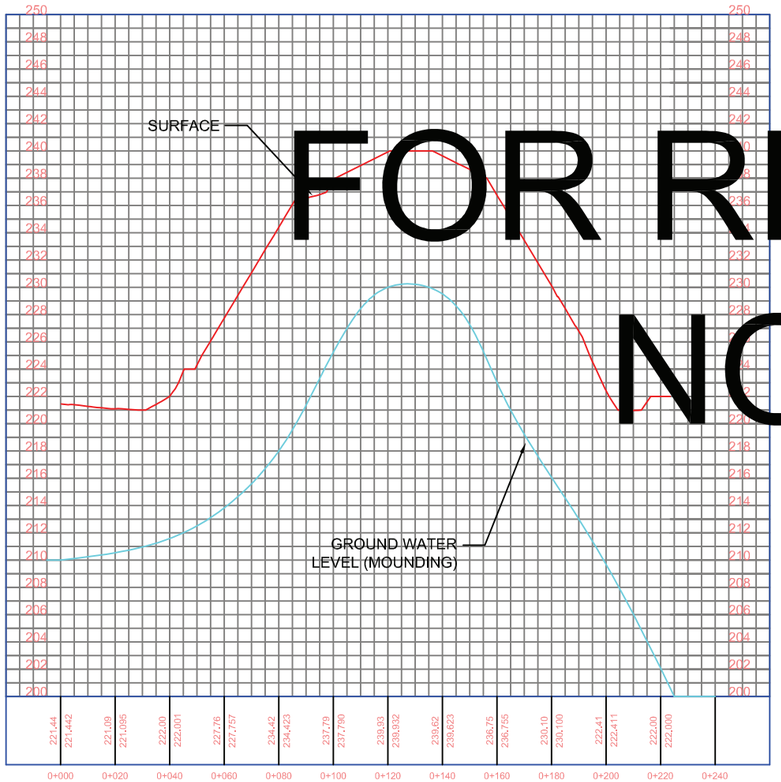
FINAL CONTOURS

XCG CONSULTANTS LTD.

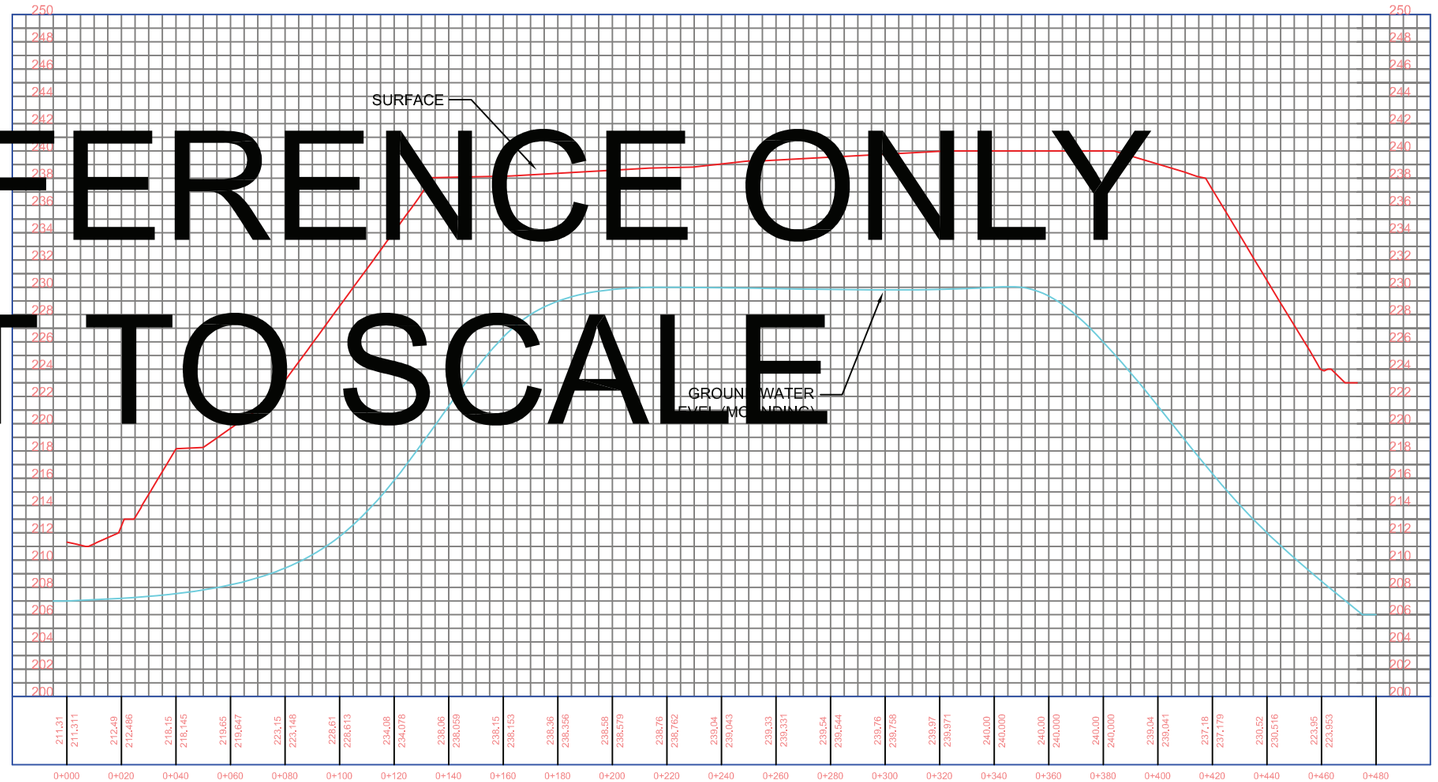
Date:	Location:	Rev.
AUGUST 2012	SECHELT, B.C.	0

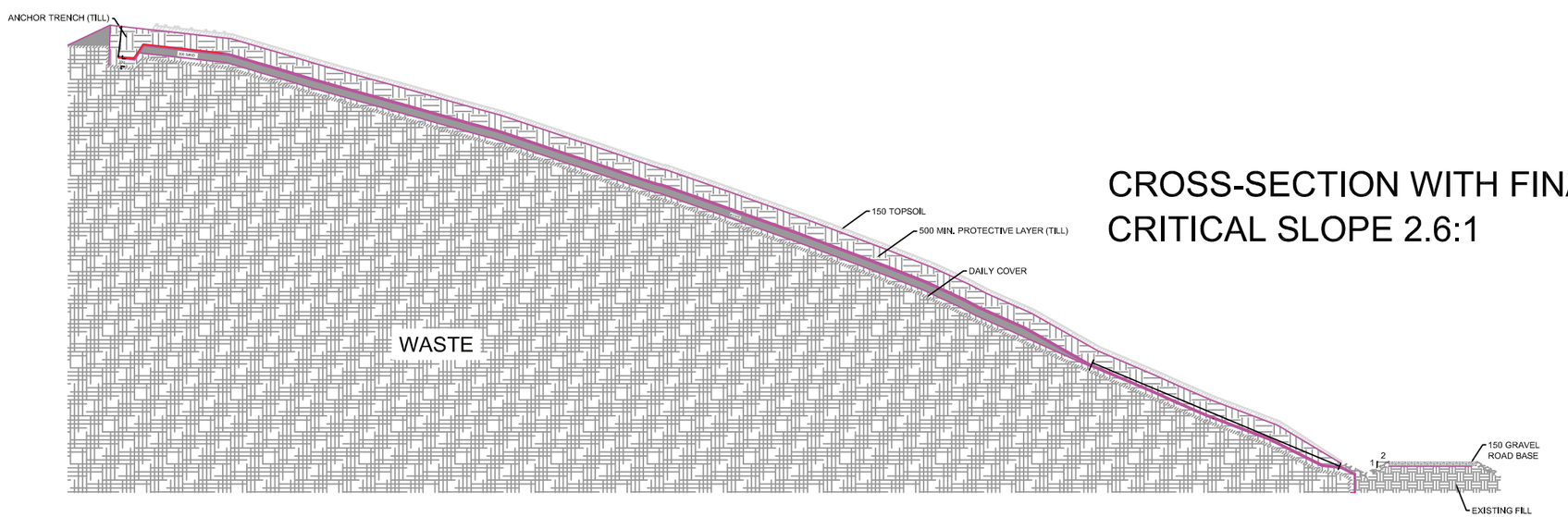
Scale:		Sheet:
1 : 1500	4-2111-01-16	D-13

North-South (Final) PROFILE



West-East (Final) PROFILE





CROSS-SECTION WITH FINAL COVER
CRITICAL SLOPE 2.6:1

RECEIVED BY BRAUN GEOTECHNICAL ON MARCH 15, 2013

APPENDIX G
EMERGENCY RESPONSE AND CONTINGENCY PLAN

XCG CONSULTING LIMITED
T 780 432 5770 | edmonton@xcg.com
10455 - 84th Avenue, Edmonton, Alberta, Canada T6E 2H3

XCG File No.: 4-2111-01-48
December 20, 2017

EMERGENCY RESPONSE AND CONTINGENCY PLAN
SECHELT LANDFILL
SECHELT, BRITISH COLUMBIA

Prepared for:

SUNSHINE COAST REGIONAL DISTRICT (SCRD)
1975 Field Road
Sechelt, British Columbia
V0N 3A1

Attention: Ms. Cathy Kenny
Solid Waste Operations Coordinator

Breanna Martin, B. Sc., E.I.T.
Project Specialist

Chloe Stone, B. Sc., P.Eng.
Project Engineer

TABLE OF CONTENTS

TABLES

FIGURE

APPENDIX

1. INTRODUCTION

XCG Consulting Limited (XCG) was retained by Sunshine Coast Regional District (SCRD) to prepare this Emergency Response and Contingency Plan (Plan) for the Sechelt Landfill (Site). This Emergency Response and Contingency Plan has been prepared as a component of the Design, Operations and Closure Plan (DOCP).

The Sechelt Landfill Emergency Response and Contingency Plan (Plan) is based upon the Solid Waste Association of North America (SWANA) Emergency Response Plan (SWANA, 2013) and sets out appropriate procedures to address foreseeable emergencies. The key elements of the Plan identify:

1. The nature and severity of the emergency;
2. Actions to be undertaken; and
3. By whom.

Emergency and contingency responses include the following:

- Medical emergencies;
- Fires;
- Spills;
- Extreme climate events; and
- Environmental and operational contingencies.

1.1 Emergency Response Plan Updates

The SCRD will review the Plan annually and following an emergency incident to ensure that:

- Emergency response procedures for the Site are effective and updated as necessary;
- Appropriate individuals are appointed to manage emergency situations;
- Regular fire prevention meetings are conducted with all landfill employees and site contractor in consultation with the Fire Department as required;
- The Sechelt Landfill is outside of the Fire Protection District, therefore the SCRD has an agreement with the Sechelt Fire Department (SFD) to provide emergency firefighting services at the landfill (this is on a fee for service basis, the SFD brings their own water tanker truck when responding); and
- Regular safety and emergency meetings are held with landfill employees and site contractor.

1.2 Emergency Organization

The key to the success of the Plan is to assign a responsible person to take charge of an emergency situation. The Solid Waste Operations Coordinator (Operations Coordinator) is designated to have the primary responsibility to manage emergency

situations at the landfill. The Site Supervisor is designated as the alternate person responsible.

The Operations Coordinator will have complete commission for the duration of the emergency. This together with proper training of operating personnel, practice drills to test emergency response activities, and continual review and updating of the Plan will be undertaken to ensure an efficient and effective response to any emergency that may occur.

1.3 Operations Coordinator Responsibility

The Operations Coordinator has the responsibility to:

- Declare an emergency;
- Review and update the emergency response procedures;
- Ensure that all emergency response procedures are appropriate;
- Respond to all emergencies and to contact appropriate emergency response agencies;
- Establish control of the emergency prior to the arrival of appropriate emergency response agencies;
- Direct personnel and site visitors to a safe muster point;
- Liaise with the emergency response representatives upon their arrival;
- Correct any potential emergency or unsafe situations; and
- Complete necessary documentation with respect to emergencies.

The Operations Coordinator will report any emergency or contingency situations to the Manager, Solid Waste Services. The Manager will contact appropriate agencies to report incidents related to environmental or health and safety issues related to the emergency or contingency activities.

1.4 Evacuation Procedures

In the event that an area or structure at the landfill must be evacuated due to a fire, gaseous release, or other situations, landfill employees, customers, and site visitors will be evacuated. Employees and site visitors will exit buildings via the closest exit and will proceed to a designated muster point.

In the event of a fire or gaseous release from active areas of the landfill, the Site Contractor will focus on notifying contractors, crew, and customers at the active face, while the Operations Coordinator, Site Supervisor, and Scale Attendant will direct all staff and site visitors to immediately leave the public areas and proceed to the designated muster point. Visitors will be requested to remain at the muster point until otherwise notified.

The designated muster point is to be designated for each emergency situation according to the nature and the location of the emergency and a safe exit route. A

muster point must not be used when it is unsafe or that is downwind of a fire or gaseous release.

1.5 Muster Points

Muster points are:

1. Primary Offsite: Dusty Road to the west of the Site Entrance (See Figure G1);or
2. Primary Onsite: Public drop-off area, immediately south of the scale; or
3. An alternate area designated by the Operations Coordinator.

The following rules apply to all employees during an evacuation emergency:

- Do NOT exit buildings through a smoke-filled area. Exit via an alternate exit, if needed, and notify the Emergency Fire Response at 911;
- Do NOT return to work area when an alarm sounds (alarm will be in the form of one long blast from an air horn);
- Do NOT attempt to re-enter a smoke-filled area or building, or an area that is being evacuated due to a chemical release; and
- Do NOT attempt to remove any vehicle from a parking area or area that is endangered by a fire or chemical release.

When the evacuation is complete, the Operations Coordinator will then proceed to the muster point.

The prime consideration for the Operations Coordinator is to ensure that all employees and site visitors are safely evacuated. The Operations Coordinator will:

- Only if safe to do so, check areas and buildings, including portable toilets, ShareShed, and unlocked storage buildings to ensure that all individuals have left;
- Close doors as they move throughout the facility;
- Meet at the muster point to ensure all Site employees have been evacuated;
- Await for appropriate emergency response personnel; and
- As required, establish perimeter security, conduct searches, or other actions that may be warranted by specific circumstances.

The Site Supervisor and / or Scale Attendant at the time of an alarm will, if possible, count the number of vehicles in the computer queue, remove the Daily Sign-In Sheet and take it to the muster point. The Operations Coordinator will verify any names appearing on the Daily Sheet as being present or employees who are signed out or away from the facility at the time of the alarm.

Employees and visitors must treat fire alarms as an actual fire and undertake a total and immediate evacuation of the facility. If for some reason, the alarm stops, employees and visitors will always complete the evacuation. In the event of a fire or chemical release, the Operations Coordinator or other site personnel are NOT to conduct searches in the involved areas for their own personal safety. If personnel are unaccounted for, emergency response search and rescue personnel will be informed.

It is imperative that all employees and visitors remain at the muster point until the Operations Coordinator gives permission to return to the respective areas or to leave the Site. Upon termination of the emergency, an "All Clear" (in the form of 2 long blasts of the air horn) will be indicated to allow employees and visitors to return to their work areas. Under NO circumstances will an employee or visitor return to the work area prior to receiving permission from the Operations Coordinator.

2. MEDICAL EMERGENCIES

All injuries should be considered important and should be reported as a safety incident to the Operations Coordinator.

First Aid should be applied that is appropriate to the nature of the injury, and in the event the injury requires medical assistance, an ambulance service contacted.

A medical doctor should be consulted for all injuries that may result in infections as a result of working with waste materials. This includes injuries such as cuts and scrapes, skin punctures with sharp items, and fire or chemical burns.

If the person injured is a site customer or visitor, Site employees are to provide any assistance necessary including applying appropriate First Aid and summoning medical assistance.

All injuries should be attended to immediately using by an employee trained in First Aid and documented and investigated immediately after. All related Site Health and Safety forms should be filled out and filed in the Health and Safety Binder.

2.1 Minor Medical Injuries

Minor medical injuries include injuries that can be treated using Level 1 First Aid Training and onsite First Aid Kit or Automated External Defibrillator (AED) (i.e. minor cuts, scratches, etc.)

2.1.1 Prevention

The following programs are in place in order to prevent and/or treat minor medical injuries:

- Emergency Response Plan contained herein;
- Employee safety training and awareness; and
- First Aid training.

2.1.2 Response Plan

The response plan to follow in the case of a minor medical emergency is presented in Table G1.

2.2 Serious Medical Injury

Serious medical injuries are injuries that require critical intervention (i.e. major or continuous bleeding, falls, head injury, fractures, etc.)

2.2.1 Prevention

The following programs are in place in order to prevent and/or treat serious medical injuries:

- Emergency Response Plan contained herein; and
- Employee safety training and awareness.

2.2.2 Response Plan

The response plan to follow in the case of a serious medical emergency is presented in Table G2.

2.3 Vehicle or Equipment Accidents

All vehicle accidents should be reported using the SCRD Incident Report Form or the MIA Form (separate from this document) to the Operations Coordinator and an investigation as to the cause should be carried out. Following the investigation, appropriate mitigative measures should be determined and implemented to avoid future accidents.

2.3.1 Prevention

The following programs are in place in order to prevent vehicle or equipment accidents:

- Emergency Response Plan contained herein;
- Employee safety training and awareness; and
- Traffic control signs.

2.3.2 Response Plan

The response plan to follow in the case of a vehicle or equipment accident is presented in Table G3.

3. FIRES

3.1 Fire Prevention

The Sechelt Landfill will be operated in a manner that will minimize the potential for landfill fires. Fire prevention techniques will include:

- Strictly enforcing "NO SMOKING" and informing customers of the fire hazard;
- Thoroughly compacting all waste;
- Applying daily cover to completely cover daily waste of each cell;
- Maintaining a comprehensive load checking program to prevent the dumping of hot/burning materials;
- Day end visual inspections for hot spots, smoke or other signs of possible fire by the Site Contractor;
- Fire break within buffer zones to be maintained and free of combustibles;
- Ongoing employee training on early fire hazard recognition, including smoke and flames;
- Notify municipalities and commercial waste haulers and request that they let their garbage collection customers know that flammable materials including household aerosols and flares are prohibited from disposal and why; and
- Minimizing the size of the wood and green waste stockpiles and regular removal of these materials in order to reduce the risk of spontaneous combustion especially during the dry season.

3.2 General Fire Response Procedures

Fires may occur at the following locations:

- Fires in the office buildings (Scale and Operations Coordinator's);
- Fires in onsite sheds (Power, Contractor's, Storage, and ShareShed);
- Fires in Public Drop Off area including storage compounds and recycling containers (Paint and Special Waste, Public Drop Off Containers, and Stockpile Areas);
- Fires at the active landfill working face;
- Fires in treed or grassed areas, and on slopes; or
- Fires in equipment and vehicles.

All fires will be treated as serious.

All fires will be reported as an emergency situation. Should an emergency occur, employees shall report to the primary onsite muster point. Should the primary muster point be inaccessible, employees shall report to the offsite muster point, or alternative muster point determined by the Operations Coordinator.

3.3 General Instructions

- STAY CALM, DO NOT PANIC, the greatest danger lies not in fighting the fire, but in the panic that arises from a fire. Spend a few minutes assessing the situation. Go through the steps of notifying the appropriate authorities and follow the basic steps in the fire control plan;
- Contact other nearby employees;
- Summon the appropriate landfill equipment;
- Notify the Operations Coordinator immediately. Follow their instructions;
- Notify the Fire Department. Tell them the location and type of fire and whether it looks like it will spread out of the immediate area;
- Notify the Ministry by submitting a written report to the Ministry within 30 days following the incident. The report shall include, at a minimum, site location, description of the incident, emergency response measures, assessment and corrective actions, and actions taken to prevent similar incidents in the future;
- Notify surrounding property owners, particularly if it appears that the fire could spread beyond the landfill;
- When the Fire Department arrives, follow their instructions;
- Do not fight a fire alone; and
- Do not place yourself or others in danger while fighting the fire.

3.4 General Fire-Fighting Guidelines

- For a landfill fire, the fire is better controlled with the use of onsite equipment and soil. If it is safe to do so, dig out and isolate the burning waste. Then either let it burn out or cover with soil to smother the fire. Lots of water will not necessarily extinguish the fire and can cause more problems than it solves;
- Do not over use water. Remember that most landfill fires can be controlled with a relatively small amount of water. In most cases, soil is more effective than water;
- If two or more water trucks are being used, try to use shifts so that at least one water truck is at the fire at all times;
- Do not waste time trying to fight a LARGE fire with a fire extinguisher;
- Do not approach any fire with onsite equipment unless a water truck is close by for backup;
- Never risk personal injury or death attempting to save a machine or building; and
- Remember, SAFETY FIRST.

3.5 Small Contained Fires

- Do not attempt to fight a fire alone;
- Secure the area and re-direct customers to a safe area;

- ONLY if safe to do so, work with Site Contractor and other staff to extinguish the fire using the onsite water truck, equipment and 20 pound carbon dioxide extinguisher; and
- If the fire becomes uncontained, or if it gives off toxic fumes, do not attempt to extinguish the fire. Wait for the Fire Department to arrive.

3.6 Uncontained Fires

- Do not attempt to fight the fire;
- Follow evacuation procedures; and
- Call 911.

3.7 Building Fires

3.7.1 Prevention

The following systems are in place in order to prevent building fires:

- Staff training and awareness; and
- Coordination with Fire Department.

3.7.2 Response

The response plan to follow in the case of a low risk building fire (low risk buildings do NOT contain materials that could explode or release hazardous emissions in the event of a fire, including; Scale Office, Operations Coordinator's Office, Storage Sheds) is presented in Table G4. The response plan in the case of a high risk building fire (high risk buildings contain materials that could explode or release hazardous emissions in the event of a fire, including; Power Shed, Contractor's Shed, Propane Tank Area, and Paint and Special Waste Storage Area) in Table G5.

3.8 Fires at the Working Face

3.8.1 Prevention

The following systems are in place in order to prevent fires at the working face:

- Staff training and awareness;
- Waste acceptance procedures and policies;
- Diversion of hot loads from working face;
- Thoroughly compacting all waste;
- Application of appropriate cover to minimize size of the active working face; and
- Day end visual inspections for hot spots, smoke or other signs of possible fire.

3.8.2 Response

The response plan to follow in the case of a fire at the working face is presented in Table G6.

3.9 Stored Material Fires

3.9.1 Prevention

The following systems are in place in order to prevent fires of stored materials:

- Site security (drive by visual inspections after hours); and
- Separation of stored materials according to best practices.

3.9.2 Response

The response plan to follow in the case of a fire involving stored materials is presented in Table G7.

4. SPILLS

4.1 On-Site Spills:

4.1.1 Prevention

The following systems are in place in order to prevent on-site spills:

- Minimize on-site storage of liquids;
- Utilize appropriate containment on-site for liquids; and
- Prohibition of liquid waste disposal.

4.1.2 Response Plan

Actions should be taken in accordance with the Environmental Management Act Spill Ministerial Order No. M329 (effective October 30, 2017, replacing BC Regulations 263/90) and reported immediately. A copy of the order is included in Appendix G1. The response plan to follow in the case of on-site spills is presented in Table G8. Granular absorbents are stored in a bin at the northwest corner of the special waste depot, and spill pads are stored in the paint storage trailer.

In the event of an off-site release, the Operations Coordinator is to immediately contact the Manager and provide information on:

- The nature and status of the release; and
- Activities and corrective actions being undertaken.

In the event if over 10 kilograms of flammable gas or 100 litres of flammable liquids are spilled (Regulation of the Ministry of the Environment and Climate Change Strategy, 2017), the Emergency Coordination Centre [part of Emergency Management BC (EMBC)] must also be notified immediately by calling the spill report line at 1-800-663-3456; the dispatcher will notify the appropriate Environmental Emergency Response Officer.

5. EXTREME CLIMATE EVENTS

5.1 Extreme Weather

5.1.1 Prevention

The following systems are in place in order to prevent problems arising from extreme weather:

- Monitor weather forecasts;
- Employee safety and response training and awareness; and
- Maintain on and off-site communications systems.

5.1.2 Response Plan

The response plan to follow in the case of extreme weather is presented in Table G9.

The Operations Coordinator has the right to close the facility due to any severe weather conditions that may affect the health and safety of the staff and customers of the facility, without notice. Should this occur, notice will be posted on a barricade at the bottom of Dusty Road and on the entrance gate, if accessible. As well, notice will be disseminated through the SCRD website and social media.

5.2 Natural Disasters

5.2.1 Prevention

The following systems are in place in order to prevent safety incidents due to natural disasters such as forest fire, wind storm, flooding, earthquakes and rock slides:

- Emergency Response Plan contained herein;
- Employee safety training and awareness,
- Contact Operations Coordinator;
- Work with local Sunshine Coast Emergency Program; and
- First Aid training.

5.3 Response Plan

In the event of a natural disaster that impacts the Sechelt Landfill, the Operations Coordinator will notify the Manager. The Manager will work with the SCRD CAO and the Sunshine Coast Emergency Program to coordinate the response.

6. CONTINGENCY PLAN

Environmental and operational contingencies may vary in degree of their nature and seriousness, and therefore actual situations will dictate the appropriate actions and responses that should be undertaken. Generally, the response plan includes the following steps:

- Secure and contain the problem;
- Verify and validate the problem;
- Investigate the cause and potential risk;
- Assess appropriate corrective actions;
- Implement the corrective action; and
- Review operational procedures and preventative measures.

All incidents and corrective measures undertaken will be documented and maintained in the operating record.

6.1 Prohibited Wastes Delivered to or Discovered at the Landfill

6.1.1 Prevention

The following systems are in place in order to prevent prohibited wastes being delivered to the landfill:

- Waste acceptance policies and procedures [SCRD Bylaw No. 405 (SCRD, 1994)];
- Asbestos Exposure Control Plan for materials that may contain friable asbestos;
- Employee training and awareness; and
- Load screening.

6.1.2 Response Plan

The response plan to follow in the case of prohibited wastes being delivered to the Site is presented in Table G10.

The response plan to follow in the case of prohibited wastes are discovered at the Site is presented in Table G11.

6.2 Hot Loads Delivered to the Landfill

6.2.1 Prevention

The following systems are in place in order to prevent hot loads being delivered to the landfill:

- Waste acceptance policies and procedures (SCRD Bylaw No. 405 (SCRD, 1994));
- Employee training and awareness; and
- Load screening.

6.2.2 Response Plan

The response plan to follow in the case of a hot load delivered to the Site is presented in Table G12.

6.3 Elevated Parameters Detected in Groundwater Monitoring System

6.3.1 Prevention

The following systems are in place in order to prevent contamination of groundwater and the surrounding subsurface:

- Quarterly groundwater monitoring program; and
- Employee training and awareness.

6.3.2 Response Plan

The response plan to follow in the case of elevated parameters are detected consistently in the groundwater monitoring system is presented in Table G13.

6.4 Contamination of Surface Water

6.4.1 Prevention

The following systems are in place in order to prevent the contamination of surface water:

- Surface water management plan;
- Quarterly surface water sampling and analysis;
- Operational controls in active working areas; and
- Employee training and awareness.

6.4.2 Response Plan

The response plan to follow in the case of contamination of surface water including any off-Site discharge to surface water from the Contact Water Pond is presented in Table G14.

6.5 Landfill Gas Exceedance

6.5.1 Prevention

The following systems are in place in order to prevent the landfill gas migration:

- Onsite landfill gas monitoring program;
- Cover placement;
- Natural soil barrier; and
- Buffer zones.

6.5.2 Response Plan

The response plan to follow in the case of soil gas concentration exceedance or an exceedance in combustible gas concentrations in a building is presented in Table G15.

6.6 Leachate Seepage through Final Cover System

6.6.1 Prevention

The following systems are in place in order to prevent leachate seepage through the final cover system:

- Minimize leachate generation by application of daily, intermediate and final cover; and
- Prohibition of liquid waste disposal and materials that create barriers i.e. tarps, nets, large plastic sheets, etc.

6.6.2 Response Plan

The response plan to follow in the case of leachate seepage through the final cover system is presented in Table G16.

6.7 Excess Stormwater Flow into the Active Operating Area

6.7.1 Prevention

The following systems are in place in order to prevent excess stormwater flow into the active operating area:

- Continued inspection and maintenance of surface water management system;
- Surface water diversion ditches and berms around working face;
- Application of appropriate cover;
- Maintain minimal working face; and
- Employee training and awareness.

6.7.2 Response Plan

The response plan to follow in the case of excess stormwater flow into the active operating area is presented in Table G17.

6.8 Breach of the Cover System

6.8.1 Prevention

The following system is in place in order to prevent breach of the final cover system:

- Routine inspection of cover (intermediate and final cover, if applicable), for vegetative growth, animal burrows, erosion, settlement, or cracking.

6.8.2 Response Plan

The response plan to follow in the case of a breach of the cover system is presented in Table G18.

6.9 Extreme Dust Emissions

6.9.1 Prevention

The following systems are in place in order to prevent extreme dust emissions:

- Use of calcium chloride to supress dust during the dry season;
- Control speed limits on all on-site roads;
- Road maintenance, limit the amount of road maintenance done during dry conditions;
- Seed or tarp soil stockpiles;
- Cover inbound loads;
- Special handling procedures for waste loads prone to emission of dust;
- Personal protective equipment; and
- Employee training and awareness.

6.9.2 Response Plan

The response plan to follow in the case of extreme dust emissions is presented in Table G19.

6.10 Detection of Strong Odors

6.10.1 Prevention

The following systems are in place in order to prevent strong odours:

- Waste acceptance and handling procedures;
- Waste cover operations; and
- Employee training and awareness.

6.10.2 Response Plan

The response plan to follow in the case of the detection of strong odours is presented in Table G20.

7. CHECKLISTS

Checklists for various situations as described above are provided as part of Tables G1 through G20.

8. REFERENCES

1. Solid Waste Association of North America, February 2013, "Emergency Response Plan – Generic."
2. Sunshine Coast Regional District Sanitary Landfill Site, Bylaw No. 405, 1994.
3. Regulation of the Minister of Environmental and Climate Change Strategy, Province of British Columbia, October 2017.

TABLES

XCG

Table G1 Response Plan - Minor Medical Injury

For Minor Injuries that can be treated using Level 1 First Aid Training and onsite First Aid Kit (i.e. minor cuts, scratches, etc.).

Action	Time Frame	Who?	Resources	Done?	Location	Date	Initial of Person who Completed Task
Apply appropriate First Aid	Immediately	Employee trained in First Aid	First Aid Kit located in Scale Office, AED and emergency supplies such as blankets located in Scale House				
If appropriate, recommend injured person consult a physician	Immediately	Employee trained in First Aid					
Review cause of the injury and prepare appropriate mitigative measures	Within 1 month	Operations Coordinator	Site Staff and Occupational Health and Safety				

XCG

Table G2 Response Plan - Serious Medical Injury

For major injuries that require critical intervention (i.e. major or continuous bleeding, falls, head injury, fractures, near drowning etc.).

Action	Time Frame	Who?	Resources	Done?	Location	Date	Initial of Person who Completed Task
Assess Site conditions for personal safety and safety of others, and take appropriate actions to secure unsafe areas	Immediately	Operations Coordinator and employee trained in First Aid	Site employees				
Attend to the injured person and apply First Aid	Immediately when safe to do so	Employee trained in First Aid	First Aid Kit located in Scale Office, AED and emergency supplies such as blankets, located in Scale House				
Contact 911	Immediately	Employee trained in First Aid or Site employee.					
Stay with the injured person until medical assistance arrives.	Duration of medical emergency	Employee trained in First Aid					
Conduct an investigation to determine the cause of the injury and prepare appropriate mitigative measures	Investigate immediately following the incident. Complete mitigative measures within 1 month of the incident	Operations Coordinator	Site Personnel and Occupational Health and Safety				

Table G3 Response Plan - Vehicle or Equipment Accident

Action	Time Frame	Who?	Resources	Done?	Location	Date	Initial of Person who Completed Task
Report the accident to the Operations Coordinator	Immediately	All employees	Incident Report Form, MIA Form				
If an injury is involved, call 911 and implement medical response actions	Immediately	Operations Coordinator, Site Supervisor					
If damage is minor, have the vehicle driver report the accident to the RCMP. Take pictures prior to vehicle leaving.	Immediately	Operations Coordinator, Site Supervisor	Incident Report Form, MIA Form				
If the damage is significant, call the RCMP and take pictures.	Immediately	Operations Coordinator, Site Supervisor	Incident Report Form, MIA Form				
Secure the area for a follow-up investigation.	Immediately	Operations Coordinator, Site Supervisor	Barricades, flagging tape, etc.				
Conduct an investigation to the cause of the accident and prepare appropriate mitigative measures.	Within 1 month of the accident.	Operations Coordinator, Joint Health and Safety Committee, Human Resources					

Table G4 Response Plan - Low Risk Building Fire

Low risk buildings do NOT contain materials that could explode or release hazardous emissions in the event of a fire. Includes Scale Office, Operations Coordinator's Office and Storage Sheds

Action	Time Frame	Who?	Resources	Done?	Location	Date	Initial of Person who Completed Task
Evacuate the Building	Immediately	All Staff					
Call 911	Immediately	Scale Attendant, Site Supervisor, Operations Coordinator					
Secure the Area	Immediately	Operations Coordinator, Site Supervisor, Scale Attendant, Designated Alternate					
Contact British Columbia Ministry of Environment	Immediately	Operations Coordinator, Manager, Designated Alternate					
Contact the Manager, Solid Waste Services	Within the hour	Operations Coordinator, Site Supervisor, Scale Attendant, Designated Alternate					

Table G5 Response Plan - High Risk Building Fire

High risk buildings contain materials that could explode or release hazardous emissions in the event of a fire. Includes Power Shed, Contractor's Shed, Propane Tank Area and Paint and Special Waste Storage Area

Action	Time Frame	Who?	Resources	Done?	Location	Date	Initial of Person who Completed Task
Evacuate the Building	Immediately	All Staff					
Call 911, relay the fact that hazardous materials may be involved in the fire.	Immediately	Scale Attendant, Site Supervisor, Operations Coordinator					
Secure the area, and maintain an adequate buffer of the fire site	Immediately	Operations Coordinator, Site Supervisor, Scale Attendant, Designated Alternate					
Contact British Columbia Ministry of Environment	Immediately	Operations Coordinator, Manager, Designated Alternate					
Contact the Manager, Solid Waste Services	Within the hour	Operations Coordinator, Site Supervisor, Scale Attendant, Designated Alternate					
Review the cause of the fire and prepare appropriate mitigative measures	Within 1 month	Operations Coordinator, Site Supervisor, Site Contractor	Site employees, Fire Department				

Table G6 Response Plan - Fire at the Working Face

Action	Time Frame	Who?	Resources	Done?	Location	Date	Initial of Person who Completed Task
Evacuate and secure the area	Immediately	All Staff	Site employees				
If contained and secure, inform Fire Department and British Columbia Ministry of Environment	Immediately	Operations Coordinator, Site Supervisor, Scale Attendant	Fire Department, British Columbia Ministry of Environment				
If uncontained call 911 and British Columbia Ministry of the Environment	Immediately	Scale Attendant, Site Supervisor, Operations Coordinator	Fire Department, British Columbia Ministry of Environment				
Determine the nature and extent of the fire	Immediately	Operations Coordinator, Site Supervisor, Site Contractor, Equipment Operator, Scale Attendant	Site employees				
Isolate burning wastes	Immediately, when safe to do so	Equipment Operator, Site Employees	Landfill equipment				
Excavate and remove burning waste and soak or smother	As soon as it is determined safe to do so	Site Contractor, Site Supervisor	Site employees, Fire Department, water truck, water pumps				
Confirm the fire is extinguished	Immediately and monitor over next 24 hours	Operations Coordinator, Site Supervisor, Site Contractor	Fire Department, Equipment Operator				
Review the cause of the fire and prepare appropriate mitigative measures	Within 1 month	Operations Coordinator, Site Supervisor, Site Contractor	Site employees, Fire Department				

Table G7 Response Plan - Fire of Stored Materials

Action	Time Frame	Who?	Resources	Done?	Location	Date	Initial of Person who Completed Task
Evacuate and secure the area	Immediately	All Staff	Site employees				
If contained and secure, inform Fire Department and British Columbia Ministry of Environment	Immediately	Operations Coordinator, Site Supervisor, Scale Attendant	Fire Department, British Columbia Ministry of Environment				
If uncontained call 911 and British Columbia Ministry of the Environment	Immediately	Scale Attendant, Site Supervisor, Operations Coordinator	Fire Department, British Columbia Ministry of Environment				
Determine the nature of the burning material and potential for emission of toxic fumes	Immediately	Operations Coordinator, Site Supervisor	Fire Department, British Columbia Ministry of Environment				
Isolate burning material	Immediately when safe to do so	Equipment Operator, Site Employees	Landfill equipment				
Determine the nature and extent of the fire	Immediately	Operations Coordinator, Site Supervisor, Site Contractor, Equipment Operator, Scale Attendant	Site employees				
Extinguish the fire as appropriate to the nature of the material	As soon as it is determined safe to do so	Operations Coordinator, Site Supervisor, Site Contractor, Fire Department	Fire Department, Site Equipment				
Confirm the fire is extinguished	Immediately	Operations Coordinator, Site Supervisor, Site Contractor	Fire Department, Equipment Operator				
Review the cause of the fire and prepare appropriate mitigative measures	Within 1 month	Operations Coordinator, Site Supervisor, Site Contractor	Site employees, Fire Department				

Table G8 Response Plan - On-Site Spills

Action	Time Frame	Who?	Resources	Done?	Location	Date	Initial of Person who Completed Task
Contact British Columbia Ministry of Environment	Immediately	Operations Coordinator, Site Supervisor	Call the Spill Report line at 1-800-663-3456				
Isolate the area and implement containment to prevent spills from entering off-Site and on-Site drainage systems	Immediately	Operations Coordinator, Site Supervisor, Site Contractor, Scale Attendant, Site Attendant	For small spills use absorbent pads, for larger spills (over 100L) use excavator to contain the spill (i.e. berm area)				
Investigate the cause of the leak/spill	Immediately	Operations Coordinator, Site Supervisor, Site Contractor	Environmental consultant				
Investigate corrective measures	Within 24 hours	Operations Coordinator, Site Supervisor, Site Contractor	Environmental consultant				
Implement corrective measures	Within 24 hours	Operations Coordinator, Site Supervisor, Site Contractor	Environmental consultant				
Review operating procedures and revise, if appropriate	Within 2 weeks	Operations Coordinator	Environmental consultant				

Table G9 Response Plan - Extreme Weather

Action	Time Frame	Who?	Resources	Done?	Location	Date	Initial of Person who Completed Task
Tornado/Hurricane/Wind warning - cease all operations and take immediate precautionary measures	Immediately	All employees and visitors	Radio and cell phones				
Severe electrical storm-stop scale operation and take precautionary measures	Immediately	Scale attendant, all employees and visitors	Radio and cell phones				
Extreme snow storm or rain with no visibility - stop scale operation and take precautionary measures	Immediately	Scale attendant, all employees and visitors	Radio and cell phones				

Table G10 Response Plan - Prohibited Waste Delivered to the Landfill

Action	Time Frame	Who?	Resources	Done?	Location	Date	Initial of Person who Completed Task
Reject Load	Immediately	Site Supervisor, Scale Attendant, Site Attendants	Waste Acceptance Procedures (SCRD Bylaw No. 405) and Operational Certificate				
Determine if the load is safe for transport on local roads	Within 1 hour	Site Supervisor, Scale Attendant, Operations Coordinator	Transport Canada, Transport of Dangerous Goods Regulation				
Inform the waste generator of the infraction	Within 1 hour	Site Supervisor, Scale Attendant, Operations Coordinator					
Document the nature of the incident and actions taken	Within 1 hour	Operations Coordinator, Site Supervisor, Scale Attendant	Daily Activity Log Book				
Review waste acceptance procedures and implement necessary mitigative measures	Within 1 month	Operations Coordinator, Site Supervisor, Scale Attendant					

Table G11 Response Plan - Prohibited Waste Discovered at the Landfill

Action	Time Frame	Who?	Resources	Done?	Location	Date	Initial of Person who Completed Task
Isolate the waste and cease operations in the area of the waste	Immediately	Site Supervisor, Scale Attendant, Site Contractor, Site Attendant	Landfill Equipment				
Construct containment around the perimeter of the waste, if necessary	Immediately	Site Supervisor, Site Contractor, Site Attendant	Landfill Equipment				
Determine the source of the waste, and if possible, the waste hauler and generator	Within 1 week	Site Supervisor, Scale Attendant, Operations Coordinator	Scale records and staff observations				
If identified, contact the hauler and waste generator to review the options	Within 1 to 2 weeks	Site Supervisor, Operations Coordinator					

Table G12 Response Plan - Hot Load Delivered to the Landfill

Action	Time Frame	Who?	Resources	Done?	Location	Date	Initial of Person who Completed Task
Inform equipment operator of incoming hot load	Immediately	Scale Attendant	Radio, Cell Phone				
Direct load to designated area away from the working face	Immediately	Scale Attendant, Site Contractor, Site Attendant					
Contain the burning material within soil berms	Immediately	Site Contractor, Site Attendant					
Apply appropriate measures to extinguish the fire: wet, smother with soil, or allow to burn out	Within 1 hour	Site Contractor, Site Supervisor, Site Attendant	Water truck, water trailer, and landfill equipment				
Monitor fire	Duration of fire	Site Supervisor, Operations Coordinator, Site Contractor					
Remove extinguished material and dispose of at the working face	2 to 3 days after being extinguished	Site Contractor, Site Attendants	Landfill equipment				

Table G13 Response Plan - Groundwater Contamination

Action	Time Frame	Who?	Resources	Done?	Location	Date	Initial of Person who Completed Task
Contact British Columbia Ministry of Environment	Immediately	Operations Coordinator, Site Supervisor	British Columbia Ministry of Environment				
Re-sample to verify or validate exceedances.	Within 1 month	Environmental Technician, Operations Coordinator	Environmental consultant and laboratory				
Assessment of the nature and risk of the problem	Within 2 months	Operations Coordinator, Environmental Technician, Site Supervisor	Environmental consultant				
Identify the appropriate corrective actions and implement	Within 1 month	Operations Coordinator, Environmental Technician, Site Supervisor	Environmental consultant				
Implement corrective measures	Within 2 months	Operations Coordinator, Site Supervisor	Environmental consultant				

Table G14 Response Plan - Surface Water Contamination

Including any off-Site discharge from the Contact Water Pond

Action	Time Frame	Who?	Resources	Done?	Location	Date	Initial of Person who Completed Task
Contact British Columbia of Environment	Immediately	Operations Coordinator, Site Supervisor	British Columbia Ministry of Environment				
Investigate the cause of the surface water contamination	Immediately	Certified operator	Environmental consultant				
Re-sample to verify and validate	Within 2 days, laboratory results within 9 days	Environmental Technician, Operations Coordinator	Environmental consultant, laboratory				
Assessment of the nature and risk of the problem	Within 2 months	Operations Coordinator, Environmental Technician, Site Supervisor	Environmental consultant				
Identify the appropriate corrective actions and implement	Within 1 month	Operations Coordinator, Environmental Technician, Site Supervisor	Environmental consultant				
Review the surface water management plan and update and revise if necessary	Within 2 months	Operations Coordinator, Site Supervisor	Environmental consultant				

Table G15 Response Plan - Landfill Gas Exceedance

Action	Time Frame	Who?	Resources	Done?	Location	Date	Initial of Person who Completed Task
Contact British Columbia Ministry of Environment	Immediately	Operations Coordinator, Site Supervisor	British Columbia Ministry of Environment				
Re-sample to verify or validate exceedances.	Within 2 days	Environmental Technician, Operations Coordinator	Environmental consultant				
Assessment of the nature and risk of the problem	Within 2 months	Operations Coordinator, Environmental Technician, Site Supervisor	Environmental consultant				
Identify the appropriate corrective actions and implement	Within 1 month	Operations Coordinator, Environmental Technician, Site Supervisor	Environmental consultant				
Implement corrective measures	Determined following the assessment of the problem	Operations Coordinator, Site Supervisor, Site Contractor	Environmental consultant				

Table G16 Response Plan - Leachate Seepage through Final Cover System

Action	Time Frame	Who?	Resources	Done?	Location	Date	Initial of Person who Completed Task
Contact British Columbia Ministry of Environment	Immediately	Operations Coordinator, Site Supervisor	British Columbia Ministry of Environment				
Isolate the area and implement containment to prevent leachate from entering off-site and on-site drainage systems	Immediately	Operations Coordinator, Site Supervisor, Site Contractor					
Investigate the cause of the seep	Within 2 days	Operations Coordinator, Site Supervisor, Site Contractor	Environmental consultant				
Investigate corrective measures	Within 1 week	Operations Coordinator, Site Supervisor	Environmental consultant				
Implement corrective measures	Within 2 weeks	Operations Coordinator, Site Supervisor, Site Contractor	Environmental consultant				
Review operating procedures and revise if appropriate	Within 2 months	Operations Coordinator, Site Supervisor	Environmental consultant				

Table G17 Response Plan - Excess Storm Water Flow into the Active Area

Action	Time Frame	Who?	Resources	Done?	Location	Date	Initial of Person who Completed Task
Cease operations in the active area and develop an alternate working face	Immediately	Site Supervisor, Site Contractor, Operations Coordinator	Environmental consultant				
Construct perimeter berms to prevent run-on	Immediately	Site Supervisor, Site Contractor	Environmental consultant				
Removal of excess surface water for treatment, disposal, or redirect to contact water pond	Within 1 week	Site Supervisor, Site Contractor	Environmental consultant				
Review the cause and identify corrective measures	Within 2 weeks	Operations Coordinator, Site Supervisor, Site	Environmental consultant				
Implement corrective measures	Within 2 weeks	Operations Coordinator, Site Supervisor, Site Contractor	Environmental consultant				

Table G18 Response Plan - Breach of the Cover System

Action	Time Frame	Who?	Resources	Done?	Location	Date	Initial of Person who Completed Task
Identify nature and significance of the problem	Within 1 week	Site Supervisor, Site Contractor					
Develop a corrective plan for the breach	Within 2 weeks to 1 month	Operations Coordinator, Site Supervisor, Site Contractor	Environmental consultant				
Reconstruct the breached area	Within 1 to 2 months	Operations Coordinator, Site Supervisor, Site Contractor	Environmental consultant				

Table G19 Response Plan - Extreme Dust Emissions

Action	Time Frame	Who?	Resources	Done?	Location	Date	Initial of Person who Completed Task
Schedule application of Calcium Chloride to road surfaces during dry season as necessary	Beginning of dry season	Site Supervisor					
Deposit dust loads in a sheltered area	Upon unloading	Vehicle operator					
Require Waste Generator to pre-wet waste load	Prior to delivery when pre-arranged with waste generator	Waste generator					
Cover dusty wastes with other waste or soil	Immediately upon unloading	Site Supervisor, Site Contractor					
Review waste handling procedures with waste generator for a specific problem material		Operations Coordinator, Site Supervisor					

Table G20 Response Plan - Detection of Strong Odours

Action	Time Frame	Who?	Resources	Done?	Location	Date	Initial of Person who Completed Task
Cover up waste with a strong odour	Immediately	Site Supervisor, Site Contractor					
Investigate source of strong odour	Immediately	Site Supervisor, Site Contractor					
Review operating procedures and identify appropriate mitigative measures	Within 1 week	Operations Coordinator, Site Supervisor	Environmental consultant				

FIGURE

DUSTY ROAD

PRIMARY OFF-SITE MUSTER POINT

SHARE SHED

GATE/PUBLIC ENTRANCE

SCALE HOUSE

PRIMARY ON-SITE MUSTER POINT

MAINTENANCE SHED

PUBLIC TIPPING AREA

GATE

CONTACT WATER POND

EX2

EX1

GATE

0 20 40 m

1 : 1500

LEGEND

- PROPERTY BOUNDARY
- APPROXIMATE LIMIT OF WASTE
- APPROXIMATE FENCE LINE
- EXISTING CONTOURS
- EXISTING ASPHALT ROAD
- EXISTING GRAVEL ROAD
- EXISTING BUILDING
- EXISTING TARPED AREA
- EXISTING FINAL COVER
- EXISTING CULVERT
- EXISTING SURFACE WATERCOURSE
- EXISTING STORMWATER GRAVITY MAIN
- EXISTING CATCHBASIN
- EX1 EXISTING LANDFILL GAS EXTRACTION WELL

NOTES: EXISTING CONDITIONS AS OF DECEMBER 4, 2016 (file: R421110148001G1ERP.dwg)

EXISTING SITE CONDITIONS

EMERGENCY RESPONCE AND CONTINGENCY PLAN

SECHELT LANDFILL

SUNSHINE COAST REGIONAL DISTRICT

XCG CONSULTING LTD.

DATE	JOB NO.	FIGURE NO.
DECEMBER 2017	4-2111-01-48	G1

APPENDIX G1
MINISTERIAL ORDER NO M. 329

PROVINCE OF BRITISH COLUMBIA

REGULATION OF THE MINISTER OF ENVIRONMENT AND CLIMATE CHANGE STRATEGY

Environmental Management Act

Ministerial Order No. M 329

I, George Heyman, Minister of Environment and Climate Change Strategy, order that, effective October 30, 2017, the Spill Reporting Regulation, B.C. Reg. 263/90, is repealed and the attached Spill Reporting Regulation is made.

September 14, 2017
Date

Minister of Environment and Climate Change Strategy

(This part is for administrative purposes only and is not part of the Order.)

Authority under which Order is made:

Act and section: *Environmental Management Act*, S.B.C. 2003, c. 53, ss. 92.1 and 139

Other: OIC 1223/90

R10163014

SPILL REPORTING REGULATION

Contents

Definitions

1 In this regulation:

"Act" means the *Environmental Management Act*;

"body of water" includes

(a) a stream, as defined in the *Water Sustainability Act*,

(b) an aquifer, as defined in the *Water Sustainability Act*,

(c) fish habitat, as defined in the Water Sustainability Regulation, B.C. Reg. 36/2016, and

(d) any of the following that could drain or empty directly into a body of water:

(i) a naturally formed pool of water other than one referred to in paragraph (a), (b) or (c);

(ii) a ditch;

"contact information", in relation to a person, means the address, telephone number and, if any, email address of the person;

"emergency response completion date", in relation to a spill, has the meaning given in section 8 *[emergency response completion date]*;

"listed quantity", in relation to a listed substance, means the quantity listed in Column 2 of the Schedule opposite the listed substance or, if more than one quantity is listed, the highest of those quantities;

"listed substance" means a substance listed in Column 1 of the Schedule;

"Provincial Emergency Program" has the same meaning as in the *Emergency Program Act*.

Reportable spills

2 This regulation applies for the purposes of section 91.2 (1) (a) *[responsible persons – spill response]* of the Act in relation to a spill of a listed substance, other than natural gas, if

(a) the spill enters, or is likely to enter, a body of water, or

(b) the quantity of the substance spilled is, or is likely to be, equal to or greater than the listed quantity for the listed substance.

Reportable spills of natural gas

3 This regulation applies for the purposes of section 91.2 (1) (a) *[responsible persons – spill response]* of the Act in relation to a spill of natural gas if

(a) the spill is caused by a break in a pipeline or fitting operated above 100 psi that results in a sudden and uncontrolled release of natural gas, and

(b) the quantity of natural gas spilled is, or is likely to be, equal to or greater than the listed quantity for natural gas.

Initial report

4 (1) If a spill occurs or is at imminent risk of occurring, a responsible person must ensure that the actual or potential spill is immediately reported to the Provincial Emergency Program by calling 1-800-663-3456.

(2) A report under this section must include, to the extent practicable, the following information:

(a) the contact information for

(i) the individual making the report,

(ii) the responsible person in relation to the spill, and

(iii) the owner of the substance spilled;

(b) the date and time of the spill;

(c) the location of the spill site;

(d) a description of the spill site and the surrounding area;

(e) a description of the source of the spill;

(f) the type and quantity of the substance spilled;

(g) a description of the circumstances, cause and adverse effects of the spill;

(h) details of action taken or proposed to comply with section 91.2 (2) *[responsible persons – spill response]* of the Act;

(i) the names of the government, federal government, local government and first nation government agencies at the spill site;

(j) the names of other persons or government, federal government, local government or first nation government agencies advised about the spill.

Updates to minister

5 (1) A responsible person for a spill that occurs on or after October 30, 2018 must, until the emergency response completion date, submit written reports on the spill to the minister in accordance with subsection (2).

(2) A report under subsection (1) must be made

(a) as soon as practicable on request of the minister,

(b) at least once every 30 days after the date the spill began, and

(c) at any time the responsible person has reason to believe that information previously reported by the responsible person under section 4 or this section was or has become inaccurate or incomplete.

(3) A report under this section must be made in the manner and form specified by the minister and must include, to the extent practicable, the information set out in section 6 (2).

End-of-spill report

6 (1) The responsible person for a spill that occurs on or after October 30, 2018 must submit a written report on the spill to the minister within 30 days after the emergency response completion date for that spill.

(2) A report under this section must be made in the manner and form specified by the minister and must include the following information:

(a) the contact information of

(i) the responsible person, and

(ii) the owner of the substance spilled;

(b) the date, time and duration of the spill;

(c) the location of the spill site, which must be specified by

(i) its address, if any, and

(ii) its latitude and longitude;

(d) a description of the spill site and sites affected by the spill;

(e) a description of the source of the spill;

(f) the type and quantity of the substance spilled;

(g) a description of the circumstances, cause and adverse effects of the spill, including, without limitation, a description of the following:

(i) the activity during which the spill occurred (e.g., transportation, transfer of cargo, fuelling, cleaning, maintenance);

(ii) the incident leading to the spill (e.g., tank rupture, overfill, collision, rollover, derailment, fire, explosion);

(iii) the underlying cause of the spill (e.g., human error, external conditions, organizational or management failure);

(iv) the adverse effects of the spill to human health, which must specify

(A) the number of injuries,

(B) the number of fatalities, and

(C) the number of evacuees;

(v) the adverse effects of the spill to the environment and infrastructure at the spill site and the area surrounding the spill, which description must specify

(A) the size of the area adversely affected by the spill,

(B) the biological and other resources adversely affected by the spill, including, without limitation,

(I) bodies of water,

(II) flora and fauna, and

(III) animal, fish and plant habitat;

(h) details of action taken to comply with section 91.2 *[responsible persons – spill response]* of the Act;

(i) how and where waste from the spill was disposed of;

(j) a copy of data from and reports of sampling, testing, monitoring and assessing carried out during spill response actions;

(k) a map of the spill site and the area surrounding the spill and photographs of the spill;

(l) the names of agencies on the scene;

(m) the names of other persons or agencies advised about the spill.

Lessons-learned report

7 (1) A director may order a responsible person in relation to a spill of a listed substance to submit a written report on the spill to the director.

(2) An order under subsection (1) must be made in writing and within 6 months after the emergency response completion date for the spill.

(3) A responsible person to whom an order under subsection (1) is directed must submit the report to the director in the manner and form specified by the director and must include

(a) a description of the effectiveness of the spill response actions,

(b) a description of actions taken to prevent future spills and improve response to future spills,

(c) if the responsible person is a regulated person,

(i) a description of any changes that the person intends to make to the person's spill contingency plan to improve response to future spills,

(ii) if the spill occurred in a geographic response area, a description of any changes that the person considers should be made to the related geographic response plan to improve response to future spills, and

(iii) if spill response actions were carried out by a PRO, a description of any changes that the person considers should be made to the PRO's area response plan to improve response to future spills, and

(d) responses to any specific questions the director asks in the order.

Emergency response completion date

8 For the purposes of this regulation, the emergency response completion date for a spill is the date on which all of the following criteria are met:

(a) the incident command post is disestablished;

(b) the source of the spill is under control and is neither spilling nor at imminent risk of spilling;

(c) emergency actions to stabilize, contain and remove the spill have been taken;

(d) the waste removed from the spill site has been

(i) received at a facility for disposal, or

(ii) received for transportation to a facility for disposal;

(e) if applicable, all notices respecting evacuation from the spill site have expired or been rescinded;

(f) all equipment, personnel and other resources used in emergency spill response actions have been removed from the spill site, other than equipment, personnel or other resources required for

(i) sampling, testing, monitoring or assessing at the spill site, or

(ii) recovery or restoration of the spill site.

Application to oil and gas permit holders

9 The following sections do not apply to a person who holds a permit to carry out an oil or gas activity to which the Emergency Management Regulation, B.C. Reg. 204/2013, applies:

(a) section 5 *[updates to minister]*;

(b) section 6 *[end-of-spill report]*;

(c) section 7 *[lessons-learned report]*.

SCHEDULE

Definitions

1 In this Schedule, **"Federal Regulations"** means the Transportation of Dangerous Goods Regulations made under the *Transportation of Dangerous Goods Act, 1992* (Canada).

Item	Column 1 **Substances**	Column 2 **Quantity**
1	Class 1, Explosives as defined in section 2.9 of the Federal Regulations	50 g, or less if the substance poses a danger to public safety
2	Class 2.1, Flammable Gases, other than natural gas, as defined in section 2.14 (a) of the Federal Regulations	10 kg
3	Class 2.2 Non-flammable and Non-toxic Gases as defined in section 2.14 (b) of the Federal Regulations	10 kg
4	Class 2.3, Toxic Gases as defined in section 2.14 (c) of the Federal Regulations	5 kg
5	Class 3, Flammable Liquids as defined in section 2.18 of the Federal Regulations	100 L
6	Class 4, Flammable Solids as defined in section 2.20 of the Federal Regulations	25 kg
7	Class 5.1, Oxidizing Substances as defined in section 2.24 (a) of the Federal Regulations	50 kg or 50 L

Item	Column 1 **Substances**	Column 2 **Quantity**
8	Class 5.2, Organic Peroxides as defined in section 2.24 (b) of the Federal Regulations	1 kg or 1 L
9	Class 6.1, Toxic Substances as defined in section 2.27 (a) of the Federal Regulations	5 kg or 5 L
10	Class 6.2, Infectious Substances as defined in section 2.27 (b) of the Federal Regulations	1 kg or 1 L, or less if the waste poses a danger to public safety or the environment
11	Class 7, Radioactive Materials as defined in section 2.37 of the Federal Regulations	Any quantity that could pose a danger to public safety and an emission level greater than the emission level established in section 20 of the Packaging and Transport of Nuclear Substances Regulations, 2015 (Canada)
12	Class 8, Corrosives as defined in section 2.40 of the Federal Regulations	5 kg or 5 L
13	Class 9, Miscellaneous Products, Substances or Organisms as defined in section 2.43 of the Federal Regulations	25 kg or 25 L
14	waste containing dioxin as defined in section 1 of the Hazardous Waste Regulation	1 kg or 1 L, or less if the waste poses a danger to public safety or the environment
15	leachable toxic waste as defined in section 1 of the Hazardous Waste Regulation	25 kg or 25 L
16	waste containing polycyclic aromatic hydrocarbon as defined in section 1 of the Hazardous Waste Regulation	5 kg or 5 L
17	waste asbestos as defined in section 1 of the Hazardous Waste Regulation	50 kg
18	waste oil as defined in section 1 of the Hazardous Waste Regulation	100 L
19	waste that contains a pest control product as defined in section 1 of the Hazardous Waste Regulation	5 kg or 5 L
20	PCB wastes as defined in section 1 of the Hazardous Waste Regulation	25 kg or 25 L
21	waste containing tetrachloroethylene as defined in section 1 of the Hazardous Waste Regulation	50 kg or 50 L
22	biomedical waste as defined in section 1 of the Hazardous Waste Regulation	1 kg or 1 L, or less if the waste poses a danger to public safety or the environment
23	a hazardous waste as defined in section 1 of the Hazardous Waste Regulation and not covered under items 1 to 22	25 kg or 25 L

Item	Column 1 **Substances**	Column 2 **Quantity**
24	a substance, not covered by items 1 to 23, that can cause pollution	200 kg or 200 L
25	natural gas	10 kg

APPENDIX H
LONG-TERM CAPITAL PLAN

XCG CONSULTING LIMITED
T 780 432 5770 | edmonton@xcg.com
10455 - 84th Avenue, Edmonton, Alberta, Canada T6E 2H3

December 20, 2017 **XCG File No. 4-2111-01-48**

Ms. Robyn Cooper
Manager, Solid Waste Services
Sunshine Coast Regional District
1975 Field Road
Sechelt, British Columbia V0N 3A1

Re: Long-term Capital Plan, Sechelt Landfill

Dear Ms. Cooper:

XCG Consulting Limited (XCG) is pleased to present this letter outlining the long-term capital plan for the development of the Sechelt Landfill. The objective of this letter is to outline the key long-term infrastructure projects associated with the implementation of the Design, Operations and Closure Plan (DOCP) for the Site. Accordingly, this cost estimate references the scope of work and development sequence outlined in the draft report entitled "Design, Operations and Closure Plan," dated December 20, 2017, prepared by XCG. As such, the costs presented herein represent estimated costs based on conceptual designs, the existing site conditions, current landfill performance, and estimated unit rates in 2017 dollars.

The long-term capital plan follows the development sequence for the Site as detailed in the DOCP in chronological order. The landfill development sequence is represented by landfilling stages F to final closure. It is noted that the long-term capital plan provides cost estimates for capital projects for the development of the Site within the existing limit of waste, and does not consider any potential future lateral expansions.

A summary of the details for the above-noted landfilling stages is provided in Table 1, including air space, cumulative air space, waste tonnage landfilled, cumulative waste tonnage landfilled, estimated stage life, and cumulative site life. The information presented in Table 1 indicates that the development sequence will provide a total of 172,800 cubic metres over a site life of approximately eight years.

Table 2 provides a summary of the costs for each of the landfilling stages and associated infrastructure projects. Based upon the calculated capital costs of $5,327,373 and the estimated remaining waste capacity of 172,800 tonnes, the calculated capital cost per tonne over the remaining life of the landfill is $28.07 in 2017 dollars.

An annual capital budget for the years 2017 through 2025 is provided in Table 3. Detailed capital budgets for each of the landfilling stages and infrastructure projects are provided in Tables 4 and 5.

Post-closure costs include maintenance and monitoring costs and are summarized in Table 6. Table 7 provides a summary of closure and post-closure costs for the landfill. The net present value for the closure and post-closure costs for the landfill is $9,504,102. The landfill liability as of December 2016 was $7,644,197.

Table 8 provides estimated closure costs for the contingency closure plan. The contingency closure plan would be implemented in the case that the landfill is not supported by the future SCRD solid waste management plans or is closed for any other reason prior to design capacity being reached, as discussed in the DOCP. A capital cost of $5,113,057 in 2017 dollars was estimated for the contingency closure plan.

Should you have any questions or require additional information, please do not hesitate to contact the undersigned.

Yours very truly,

XCG CONSULTING LIMITED

Chloe Stone, P.Eng.
Project Manager

Attachments: Tables 1 to 8

TABLES

Table 1 Landfilling Sequence

Development Stage	Air Space (m^3)	Cumulative Air Space (m^3)	Waste Capacity (tonnes)	Cumulative Waste Capacity (tonnes)	Life (months)	Cumulative Life (years)
Stage F	10,800	10,800	7,128	7,128	7	0.6
Stage G	21,600	32,400	14,256	21,384	13	1.6
Stage H	42,700	75,100	28,182	49,566	26	3.8
Stage I	28,200	103,300	18,612	68,178	17	5.2
Stage J	25,400	128,700	16,764	84,942	15	6.4
Stage K	24,700	153,400	16,302	101,244	14	7.6
Final Stage	19,400	172,800	12,804	114,048	11	8.5

Notes:

1. Airspace consumption based upon an apparent density of 0.66 tonnes per cubic metre.

Table 2 Development Cost Summary

Stage	Cost
Progressive Closure during Stage H	$ 2,072,634
Final Closure	$ 3,254,739
Total (Excluding GST)	**$ 5,327,373**

Table 3 Annual Development Capital Costs

Year / Stage	2017	2018	2019	2020	2021	2022	2023	2024	2025	Totals
Progressive Closure during Stage H					$2,072,634					$2,072,634
Final Closure									$3,254,739	$3,254,739
Total	$0	$0	$0	$0	$2,072,634	$0	$0	$0	$3,254,739	$5,327,373

Table 4 Progressive Closure during Stage H

Item	Description	Unit	Approx. Quantity	Unit Price	Total Price
Administration and Execution Requirements	Bonds, Insurance, Mobilization, Demobilization, Temporary Controls, and Closeout (15%)				$200,255
Operations	Temporary Haul Road - supply, place, and compact	L.M.	65	$175	$11,375
Closure	Ditch Realignment - fill in interior ditch, realign exterior ditch to pond, erosion control	L.M.	40	$75	$3,000
	Remove culvert by pond, construct inlet to pond with erosion control	L.S.	1	$2,500	$2,500
	Remove culvert on lower portion of the haul road ditch	L.M.	15	$75	$1,125
	Final Cover - district supplied native soils and topsoil, supply, place, compact, grade, seed	m^2	20,262	$65	$1,317,030
				Subtotal	$1,535,285
				Engineering (15%)	$230,293
				Contingency (20%)	$307,057
				Total (Excluding GST)	**$2,072,634**

Table 5 Final Closure

Item	Description	Unit	Approx. Quantity	Unit Price	Total Price
Administration and Execution Requirements	Bonds, Insurance, Mobilization, Demobilization, Temporary Controls, and Closeout (15%)				$314,468
Closure	Final Cover - district supplied native soils and topsoil, haul, place, compact, grade, and seed	m^2	31,680	$65	$2,059,200
	Culvert - Removal	L.M.	45	$50	$2,250
	Pond Overflow - construct primary emergency overflow and connect to existing stormwater gravity drain, elevate existing overflow for use as secondary overflow	L.S.	1	$5,000	$5,000
	Regrade Haul Road	L.M.	180	$50	$9,000
	Ditching - including erosion control	L.M.	280	$75	$21,000
				Subtotal	$2,410,918
				Engineering (15%)	$361,638
				Contingency (20%)	$482,184
				Total (Excluding GST)	**$3,254,739**

Table 6 Post-closure Costs

Item	Description	Unit	Unit Price
Environmental Monitoring	Groundwater, Surface water and Landfill Gas Monitoring	per year	$25,000
Maintenance	Post-closure site maintenance	per year	$20,750
		Total (Excluding GST)	**$45,750**

Table 7 Closure and Post-closure Costs

Stage	Cost	Year
Progressive Closure during Stage H	$2,072,634	2021
Final Closure	$3,254,739	2025
Post-Closure Costs	$45,750	2026 - 2126

Reference Figures	
General Inflation [a]	2.00%
Discount Rate [b]	2.15%
Real Discounted Interest Rate	0.15%

Net Present Value	
NPV - Capital	$5,269,437
NPV - Post-Closure	$4,234,665
NPV - Total	**$9,504,102**

Landfill Liability	
Total Landfill Volume (m^3) [c]	883,007
Volume Used as of December 2016 (m^3) [c]	710,207
Total Volume Available as of December 2016 (m^3)	172,800
Landfill Liability as of December 2016	**$7,644,197**

Notes:
a - General Inflation rate based on Bank of Canada target rate.
b - Discount rate based on Government of Canada long term bond yield, reported on May 8, 2017.
c - Volume estimated from historic waste tonnages and an apparent density of 0.65 tonnes per m^3.

Table 8 Contingency Closure Plan

Item	Description	Unit	Approx. Quantity	Unit Price	Total Price
Administration and Execution Requirements	Bonds, Insurance, Mobilization, Demobilization, Temporary Controls, and Closeout (15%)				$513,016
Closure	Ditch Realignment - fill in interior ditch, realign exterior ditch to pond, erosion control	L.M.	40	$75	$3,000
	Remove culvert by pond, construct inlet to pond with erosion control	L.S.	1	$2,500	$2,500
	Remove culvert on lower portion of the haul road ditch	L.M.	15	$75	$1,125
	Final Cover - district supplied native soils and topsoil, haul, place, compact, grade, and seed	m^2	51,942	$65	$3,376,230
	Culvert - Removal	L.M.	45	$50	$2,250
	Pond Overflow - construct primary emergency overflow and connect to existing stormwater gravity drain, elevate existing overflow for use as secondary overflow	L.S.	1	$5,000	$5,000
	Regrade Haul Road	L.M.	180	$50	$9,000
	Ditching - including erosion control	L.M.	280	$75	$21,000
				Subtotal	$3,933,121
				Engineering (10%)	$393,312
				Contingency (20%)	$786,624
				Total (Excluding GST)	**$5,113,057**