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

Prepared for:

SUNSHINE COAST REGIONAL DISTRICT (SCRD)
1975 Field Road
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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 dated July 8, 2014, (OC), and in general accordance with relevant British Columbia Ministry of the Environment (MOE, or the Ministry¹) acts, regulations, and guidance documents.

This DOCP 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 DOCP 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 DOCP is a comprehensive and integrated design document, which addresses all the aforementioned objectives. The DOCP includes a detailed development strategy for the existing landfill footprint, providing approximately 120,000 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 2030.

The limitations detailed in Section 14 apply to the entirety of this DOCP, including this executive summary. This executive summary is not intended as a stand-alone document, but instead is intended to be read in conjunction with the whole DOCP.

¹ Previously also known as the Ministry of the Environment (MOE), Ministry of the Environment and Energy (MOEE), and the Ministry of Environment and Climate Change (MOECC). Currently known as the Ministry of the Environment, Conservation and Parks (MECP).



TABLE OF CONTENTS

1.	INTRODUCTION, PURPOSE, AND USE	1-1
1.1	Site Description.....	1-2
1.2	Background	1-3
1.3	Previous Studies.....	1-6
2.	REGULATORY SETTING	2-1
2.1	Provincial Regulations	2-1
2.2	Landfill Operating Certificate.....	2-4
3.	REGIONAL AND SITE SETTING.....	3-1
3.1	Topography	3-1
3.2	Hydrology	3-1
3.3	Geology.....	3-1
3.4	Geotechnical and Seismic Assessment	3-2
3.5	Hydrogeology	3-3
3.6	Receptors.....	3-4
3.7	Climate.....	3-4
3.8	Leachate Management	3-4
3.9	Landfill Gas Management.....	3-4
4.	DESIGN CRITERIA	4-1
4.1	Design Constraints	4-1
4.2	Area Served and Population.....	4-1
4.3	Waste Characterization	4-1
4.3.1	Waste Tonnage	4-1
4.3.2	Waste Composition.....	4-2
4.3.3	Waste Density.....	4-2
4.3.4	Airspace Consumption	4-2
4.4	Landfill Limit.....	4-3
4.5	Buffer Zones	4-3
4.6	Ingress/Egress	4-4
5.	SITE DEVELOPMENT	5-1
5.1	Existing Conditions.....	5-1
5.2	Key Development Considerations	5-1
5.3	Footprint and Buffer Zones.....	5-2
5.4	Fill Progression	5-2
5.4.1	Preparation for the Biocover Pilot.....	5-2
5.4.2	Stage J.....	5-3
5.4.3	Site Modifications.....	5-3
5.4.4	Stage K.....	5-3
5.4.5	Stage L.....	5-4
5.4.6	Stage M.....	5-4
5.4.7	Stage N.....	5-5
5.4.8	Stage O.....	5-5
5.4.9	Stage P	5-5
5.4.10	Stage Q.....	5-6
5.4.11	Stage R.....	5-6



TABLE OF CONTENTS

5.5	Cover.....	5-7
5.5.1	Final Cover	5-7
5.5.2	Daily Cover	5-8
5.5.3	Interim Cover	5-8
6.	VOLUME AND SITE LIFE	6-1
6.1	Air Space.....	6-1
6.2	Soil Balance	6-1
6.3	Design Site Life	6-1
6.4	Contaminating Lifespan.....	6-1
7.	SURFACE WATER MANAGEMENT	7-1
7.1	Objectives	7-1
7.2	Hydrologic Model.....	7-1
7.2.1	Climatic Data.....	7-1
7.2.2	Model Results	7-1
7.3	Existing Drainage.....	7-2
7.4	Existing Drainage - Completion of Stage I.....	7-2
7.5	Post-Development Drainage	7-3
8.	LEACHATE MANAGEMENT	8-1
8.1	Objectives	8-1
8.2	Leachate Overview	8-1
8.2.1	Leachate Quality	8-1
8.2.2	Indicator Parameters	8-2
8.3	Leachate Generation	8-2
8.4	Existing Leachate Controls.....	8-3
8.5	Proposed Leachate Management Strategy	8-3
8.6	Leachate Seepage.....	8-3
9.	LANDFILL GAS MANAGEMENT.....	9-1
9.1	Objectives	9-1
9.2	Overview.....	9-1
9.2.1	Conditions Affecting Landfill Gas Generation.....	9-2
9.2.2	Landfill Gas Characteristics	9-2
9.2.3	Landfill Design Factors	9-4
9.2.4	Non-methane Organic Compounds.....	9-5
9.3	LFG Production Assessment.....	9-5
9.3.1	LFG Production Model.....	9-5
9.3.2	Model Input Parameters.....	9-6
9.3.3	Results	9-7
9.4	Landfill Gas Migration Assessment.....	9-8
9.4.1	Landfill Gas Migration Overview	9-8
9.4.2	Factors Affecting Lateral Migration Potential	9-8
9.4.3	Soil Gas Triggers	9-10
9.4.4	Migration Potential Assessment.....	9-10
9.5	LFG Collection System.....	9-11
10.	SITE FACILITIES.....	10-1
10.1	Existing Infrastructure	10-1
10.1.1	Fencing.....	10-1



TABLE OF CONTENTS

10.1.2	Maintenance Shed	10-1
10.1.3	Scale	10-1
10.1.4	Public Drop-Off Area.....	10-1
10.1.5	Access Roads	10-2
11.	SITE OPERATIONS	11-1
11.1	Site Access and Information	11-2
11.2	Hours of Operation	11-2
11.3	Site Supervision	11-2
11.4	Fire Prevention Measures	11-3
11.5	Recyclable Materials.....	11-4
11.6	Waste and Cover Soil Placement.....	11-4
11.6.1	Daily Cover Soil.....	11-5
11.6.2	Intermediate Cover.....	11-5
11.6.3	Final Cover	11-5
11.7	Surface Water Control	11-5
11.8	Litter Control	11-6
11.9	Noise Control.....	11-6
11.10	Odour Control.....	11-6
11.11	Dust Control.....	11-6
11.12	Vector and Wildlife Control	11-7
11.13	Emergency Response and Contingency Plan.....	11-7
12.	MONITORING, INSPECTION, AND REPORTING	12-1
12.1	Environmental Monitoring Program.....	12-1
12.1.1	Monitoring.....	12-1
12.1.2	Leachate Monitoring.....	12-2
12.1.3	Soil Gas Monitoring.....	12-2
12.2	Inspection and Record Keeping	12-3
12.2.1	Surface Water Management Systems	12-3
12.2.2	Leachate Management	12-3
12.2.3	Buffer Zones	12-4
12.2.4	Fencing and Site Security.....	12-4
12.2.5	Access Roads.....	12-4
12.2.6	Environmental Monitoring Infrastructure.....	12-4
12.3	Airspace Consumption.....	12-4
12.4	Annual Operations and Monitoring Report	12-5
13.	CLOSURE	13-1
13.1	Design Criteria	13-1
13.2	End Use.....	13-1
13.3	Closure Schedule	13-1
13.4	Site Rehabilitation.....	13-1
13.4.1	Final Cover System	13-2
13.4.2	Site Facilities.....	13-2
13.4.3	Surface Water Management.....	13-2
13.5	Post-Closure Maintenance	13-2
13.6	Post-Closure Environmental Monitoring.....	13-2
13.7	Long-term Capital Plan and Closure/Post-closure Costs.....	13-3
13.8	Contingency Closure Plan.....	13-3



14. LIMITATIONS.....	14-1
15. REFERENCES	15-1

TABLES

Table 3.1	Climate Normals	end of text
Table 4.1	Landfill Design Criteria Summary.....	end of text
Table 4.2	Waste Data	end of text
Table 4.3	Waste Composition (2008)	end of text
Table 4.4	Waste Composition (2014)	end of text
Table 4.5	Waste Composition (2023)	end of text
Table 5.1	Development Summary	end of text
Table 6.1	Final Cover Soil Requirements	end of text
Table 6.2	Projected Airspace Consumption by Stage.....	end of text
Table 6.3	Projected Airspace Consumption Summary	end of text
Table 7.1	Runoff Volume Summary	end of text
Table 8.1	Infiltration Rate Summary	end of text
Table 8.2	Leachate Generation Rate Summary	end of text
Table 9.1	LFG Generation Constants	end of text
Table 9.2	Soil Gas Trigger Concentrations.....	end of text

FIGURES

Figure 1.1	Site Location Map.....	end of text
Figure 1.2	Existing Site Plan.....	end of text
Figure 1.3	Proposed Site Plan	end of text
Figure 5.1	Final Conditions.....	end of text
Figure 7.1	Existing Subcatchments	end of text
Figure 7.2	Post Development Subcatchments.....	end of text
Figure 9.1	Landfill Gas Monitoring Locations	end of text
Figure 12.1	Groundwater Monitoring Locations	end of text
Figure 12.2	Surface Water Monitoring Locations	end of text



DRAWINGS

G-01	Title Page	end of text
C-01	Existing Conditions.....	end of text
C-02	Completion of Stage I	end of text
C-03	Preparation for Biocover Pilot	end of text
C-04	Stage J	end of text
C-05	Site Modifications	end of text
C-06	Stage K.....	end of text
C-07	Stage L	end of text
C-08	Stage L	end of text
C-09	Stage M	end of text
C-10	Stage N.....	end of text
C-11	Stage O.....	end of text
C-12	Stage P	end of text
C-13	Stage Q.....	end of text
C-14	Stage R.....	end of text
C-15	Final Conditions.....	end of text
D-01	Details I.....	end of text

APPENDICES

Appendix A	Operational Certificate No. 106060
Appendix B	Braun Geotechnical Report
Appendix C	Hydrologic Model Data
Appendix D	HELP Model Data
Appendix E	Landfill Gas Model Data
Appendix F	Emergency Response and Contingency Plan
Appendix G	Long-term Capital Plan



1. INTRODUCTION, PURPOSE, AND USE

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, dated July 8, 2014, (OC), and in general accordance with the following British Columbia Ministry of the Environment (MOE, or the Ministry²) 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 SCRCD with an updated DOCP that meets the following objectives:

- Adopt the requirements of the Site's OC;
- 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;

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- Review and update the environmental monitoring program;
- Provide a contingency plan to address environmental impact concerns and other non-compliance issues;
- Provide a Site 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 Site 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.

This DOCP has been prepared for the sole use by the SCRD and may not be used by any other person or entity without written authorization by XCG. Any use or reuse of this document, its findings, conclusions, and recommendations represented herein by users other than SCRD, is at the sole risk of said users.

1.1 Site Description

The Site is located at 4901 Dusty Road, Sechelt, approximately 6.5 kilometres northeast of the village of Sechelt. 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 location is shown on Figure 1.1.

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

Further, it is noted that Heidelberg Materials Limited (Heidelberg) 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, shíshálh Nation 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.

Figure 1.2 shows the auxiliary facilities associated with the on-Site landfill as of June 2023, which included:

- Site entrance and access roads;
- Scale house and scale;
- Office trailer;



- Public tipping area;
- Maintenance shed;
- Mattress sea can;
- Mattress Trailer
- Storage sea cans;
- Contact water pond;
- Equipment and haul roads; and
- Surface water management infrastructure.

Since April 2018, the following significant changes to the on-Site facilities have occurred:

- As of late summer, early fall of 2021, the special waste storage building/power shed was demolished. This shed was removed from the Site due to the construction of the new on-Site public drop off area.
- In 2013, environmental controls designed to reduce leachate generation and leachate mounding by reducing the size of the active landfilling area, diverting surface water from the limit of waste, were implemented on the Site. The specific environmental controls included:
 - progressive closure of the landfilling area by placing final cover over the north, east, and southeast slopes of the landfill;
 - construction of surface water ditching along the north, east, south, and south portion of the west side of the Site;
 - addition of a stormwater pipe alignment discharging into Dusty Road Ditch on the west side of Site; and
 - improvements to the contact water detention pond and forebay on west side of the Site.

In 2024 the current contact water pond, as shown on Figure 1.2, will be filled in with waste and a new contact water pond will be constructed, as shown on Figure 1.3.

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. 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, shíshálh Nation 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
 - Required groundwater quality monitoring and assessment, an 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 30-cubic meter (40-cubic 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.



2021

- The existing on-Site scale shed was relocated, and the power shed/tool storage building was removed. Additionally, the drop-off area was relocated and expanded to include up to ten 30-cubic meter (40-cubic yard) bins, a tire area, and a mattress storage container.
- Groundwater monitoring well MW-2 was decommissioned.
- Gas probes GP13-01 and GP13-02 were decommissioned and re-installed, however they were constructed in a manner that renders them unusable.

2022

- Groundwater monitoring well MW2 was replaced in the EMP with monitoring well MW2-21.
- Three additional groundwater monitoring wells were installed in the deep groundwater throughout the Site. Monitoring well MW22-01 was installed north and up-gradient of the landfill. Monitoring well MW22-02 was installed northeast of the landfill and north of Dusty Road to characterize deep groundwater up-gradient of the Site. Monitoring well MW22-03 was installed east and cross-gradient of the landfill.

1.3 Previous Studies

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

- 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.”
- 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.”
- 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.”
- 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.”



- Piteau Associates Engineering Ltd., April 2009. “2007/2008 Annual Environmental Monitoring Review – Sechelt Landfill, Sunshine Coast Regional District.”
- Ecoplans, August 2010. “Hydrogeological and Environmental Monitoring Review Sechelt Landfill, Sunshine Coast Regional District.”
- 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.”
- Dillon Consulting Ltd., December 2014. “Waste Composition Audit - Sunshine Coast Regional District.”
- 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.”
- Braun Geotechnical Ltd., March 2018, “Stability Assessment - Sechelt Landfill”
- XCG Consulting Limited, March 2017. “2016 Annual Report, Sechelt Landfill.”
- XCG Consulting Limited, March 2018. “2017 Annual Report, Sechelt Landfill.”
- XCG Consulting Limited, March 2019. “2018 Annual Report, Sechelt Landfill.”
- XCG Consulting Limited, March 2020. “2019 Annual Report, Sechelt Landfill.”
- XCG Consulting Limited, March 2020. “Landfill Gas Generation Supplementary Assessment Report 2021 – Sechelt Landfill.”
- XCG Consultants Ltd., August 2020. “Updated Hydrogeological Characterization and Impact Assessment, Sechelt Landfill.”
- XCG Consulting Limited, March 2021. “2020 Annual Report, Sechelt Landfill.”
- XCG Consulting Limited, March 2022. “2021 Annual Report, Sechelt Landfill.”
- XCG Consulting Limited, March 2023. “2022 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 Ministry, which regulate landfill design, operations, and monitoring:

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

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 an 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 criterion 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, temperature, oxidation-reduction potential (ORP), dissolved oxygen (DO), chemical oxygen demand (COD) specific conductivity (electrical conductivity), metals, ammoniacal nitrogen, and chloride; and
- For the monitoring of metals, the United States Environmental Protection Agency (US 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, ORP, specific conductance, temperature, and DO 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.

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 that relate to landfill gas (LFG) are as follows:

- It is considered that concentrations greater than 20 percent of the LEL in on-site and off-site structures, or concentrations that exceed the LEL in soils at the property boundary, warn of conditions, which could potentially be hazardous. LFG control systems should be designed to maintain concentrations well below these levels. The LEL for the LFG is equal to 5 percent methane, on a volumetric basis.
- The frequency of monitoring should be sufficient to detect LFG migration based on subsurface conditions.
- LFG probes should be installed in the more permeable strata, between the landfill unit and either the property boundary or structures where gas migration may pose a problem. Multiple or nested probes are useful in defining the vertical configuration of the migration pathway.

2.2 **Landfill Operating Certificate**

The Site is currently approved to operate under the OC. 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 OC 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 surrounding the Site drains from the northeast to the southwest, towards Chapman Creek, which runs in a south-westerly direction. Irgens Creek, which runs in a westerly direction, is located north of the landfill. The locations of both creeks in relation to the Site is 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 report titled “Stability Assessment - Sechelt Landfill” (BGL, 2018). A copy of this report is included for reference in Appendix B.

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 0.179g associated with an earthquake event with a return period of 1 in 475 years (10% probability in 50 years).

The assessment was completed in accordance with the Landfill Criteria for Municipal Solid Waste (MOE, 1993). 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 0.179g 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 1.9, which is 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**

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 locations of water wells near the Site are shown on Figure 5. The records for water wells near the Site indicate that the wells are completed in overburden at a depth ranging from 12 to 105 metres bgs, and groundwater is typically located at depths ranging from 8 to 72 metres bgs (Table 1).

Groundwater levels in the on-site monitoring wells are monitored on a quarterly basis as part of the current EMP 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 observed groundwater levels, perched groundwater appears to be present at the Site on top of the dense silt till layer from a depth of approximately 1 metre to 14 metres bgs (Piteau, 1999). The perched groundwater is reflected in the water levels observed in groundwater monitoring wells where a confining layer is present, or groundwater monitoring wells screened above the confining layer. The elevation of the perched groundwater during the 2022 monitoring period ranged from approximately 209 metres amsl at the north end of the Site, to approximately 215 metres amsl at the south end of the Site.

Deep overburden groundwater monitoring wells MW13-01 and MW13-02 are screened in the deep gravelly sediments which are interpreted to be hydraulically connected to underlying bedrock aquifer. The bedrock hydraulic conditions are reflected in the water levels for these deep groundwater monitoring wells where the confining layer is not present, or groundwater monitoring wells are screened below the confining layer. During the 2022 monitoring period the interpreted bedrock groundwater elevation at the Site ranges from approximately 192 metres to 200 metres amsl.

Historic groundwater elevations indicate seasonal fluctuations which are more pronounced in monitoring wells instrumented in the perched aquifer (XCG, 2023).

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 historic monitoring results, vertical gradients between the shallow and deep monitoring wells indicate a strong downward gradient (XCG, 2023).

Measurement of leachate levels in LFG extraction wells EX1 and EX2 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, 2015). 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 1×10^{-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 2030. Based on this data, the service area for the Site has an estimated population of approximately 33,254 in 2023. Population data is summarized in Table 4.2.

4.3 Waste Characterization

4.3.1 Waste Tonnage

Historic and future waste tonnages for the Site are summarized in Table 4.2. The waste tonnages summarized in Table 4.2 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 2023, it was estimated that the landfill service population would generate a rate of 0.37 tonnes of solid waste per person per year (based on the actual waste generation rate for 2023); and
- The SCRD will likely update its future waste diversion plans in 2024 therefore 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, Dillon Consulting Ltd. in 2014 and XCG in 2023. A summary of the results from the study are presented in Table 4.3 Table 4.4 and Table 4.5, 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 well-operated landfill sites can typically attain an apparent waste density of 0.5 to 1 tonnes of solid waste per cubic metre of air space consumed depending on the size of the landfill. A landfill like the Site would be anticipated to achieve an apparent solid waste density of 0.6 tonnes per cubic metre.

Efforts have been made to increase the apparent solid waste density by increasing compaction and minimizing daily cover. The use of steel plates as alternative daily cover was implemented as of February 2018 to further extend the Site life. Based upon a comparison of the December 16, 2021, and December 14, 2022, contours from topographic surveys completed from aerial photographs, generated by Bennett Land Surveying (Coastal) Ltd. Based upon a comparison of the 2021 and 2022 contours, a total airspace consumption of approximately 20,050 cubic metres was calculated. This air space was consumed by new waste, daily cover, and interim cover.

4.3.4 Airspace Consumption

Using the annual air space consumption of approximately 20,050 cubic metres provides a monthly airspace consumption of approximately 1,670 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 7.6 hectares. The existing conditions plan, derived from an aerial survey completed on December 14, 2022, by Bennett Land Surveying (Coastal) Ltd forms the basis for the DOCP presented herein.

It should be noted that in 2024 changes to the limit of waste are planned. Approximately 2,850 square metres of the limit of waste will be moved from the drop-off area and relocated to the existing contact water pond. The change will result in no additional limit of waste but will allow for the optimization of the landfill as well as the construction of a new contact water pond. The proposed changes to the Site layout are shown on Figure 1.3.

4.5 Buffer Zones

The permitted landfill area (Site boundaries) are 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. The auxiliary facilities associated with the on-Site landfill, as of June 2023, are shown on Figure 1.2, and included:

- Site entrance and access roads;
- Scale house and scale;
- Office trailer;
- Public tipping area;
- Maintenance shed;
- Mattress sea can;
- Mattress Trailer



- Storage sea cans;
- Contact water pond;
- 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-14. 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 14, 2022, 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. Drawing C-02 better represents where the landfill progress is at with regards to staging. XCG worked with SCR D staff to generate the “Completion of Stage I” drawing that represents the landfiling progress to the end of May 2023.

5.2 Key Development Considerations

Based on the design criteria presented in Section 4 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-14.

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 existing limit of waste (landfill footprint) illustrated on Figure 1.2, with a total area of 7.6 hectares and proposed limit of waste (landfill footprint) illustrated on Figure 1.3, with a total area of 7.6 hectares.

5.4 **Fill Progression**

The following section provides a narrative description of the fill sequence illustrated on Drawings C-03 to C-14. As indicated previously, the existing conditions and start of development are based on a topographical survey completed in December 2022; however, the best representation of the current status of landfilling at the Site is the Completion of Stage I. 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 has been historically calculated for apparent density in the Annual Reports.

Based on the Site conditions presented on Drawing C-02 (Completion of Stage I, end of May 2023) and the proposed final contours presented on Drawing C-14, the total remaining landfill capacity (airspace) is estimated to be 120,000 cubic metres as of the beginning of June 2023. Currently, landfilling is being completed in the Preparation for Biocover Pilot stage.

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 **Preparation for the Biocover Pilot**

The proposed Preparation for the Biocover Pilot contours and works are presented on Drawing C-03. The objectives of this stage of the development sequence are as follows:

- Fill the western top 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 top portion of the Site;
- Waste will be landfilled in order to construct a slope of 33 percent (3H:1V) as well as 10 percent (10H:1V) slopes; and
- Prepare the former tarped area of the landfill for the Biocover Pilot.

In conclusion, this stage will:

- Provide 5,750 cubic metres of air space;
- Accept 3,795 tonnes of waste;
- Require approximately 1,150 cubic metres of daily/intermediate cover; and



- Provide approximately four months of Site life.

In addition, this stage of Site development will require the removal of the temporary LFG extraction wells on the central portion of the Site, as well as the tarps currently used as interim cover.

5.4.2 **Stage J**

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

- Fill the top 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 top 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 9,500 cubic metres of air space;
- Accept 6,270 tonnes of waste;
- Require approximately 1,900 cubic metres of daily/intermediate cover; and
- Provide approximately six months of Site life.

5.4.3 **Site Modifications**

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

- Prepare the former contact water pond for landfilling.

These objectives will be achieved by implementing the following:

- Removing sediment and contact water from the former contact water pond.

In conclusion, this stage:

- Prepares the former contact water pond for landfilling; however, provides no site life.

5.4.4 **Stage K**

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

- Fill the former contact water pond with waste;
- Promote positive drainage off the landfill;
- Provide 20,500 square metres of landfill ready for final cover on the north and south faces; and
- Decrease leachate generation.



These objectives will be achieved by implementing the following:

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

In conclusion, this stage will:

- Provide 7,500 cubic metres of air space;
- Accept 4,950 tonnes of waste;
- Require approximately 1,500 cubic metres of daily/intermediate cover; and
- Provide approximately five months of Site life.

5.4.5 **Stage L**

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

- Construct, out of waste, a haul road down into the former contact water pond; and
- Promote positive drainage off the landfill.

These objectives will be achieved by implementing the following:

- Landfilling will take place in the former contact water pond for the Site; and
- Waste will be landfilled in order to construct a slope of 33 percent (3H:1V) and a haul road at an 8 percent grade.

In conclusion, this stage will:

- Provide 12,000 cubic metres of air space;
- Accept 7,920 tonnes of waste;
- Require approximately 2,400 cubic metres of daily/intermediate cover; and
- Provide approximately eight months of Site life.

5.4.6 **Stage M**

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

- Fill the former contact water pond with waste; and
- Promote positive drainage off the landfill.

These objectives will be achieved by implementing the following:

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

In conclusion, this stage will:

- Provide 11,500 cubic metres of air space;



- Accept 7,590 tonnes of waste;
- Require approximately 2,300 cubic metres of daily/intermediate cover; and
- Provide approximately seven months of Site life.

5.4.7 Stage N

The proposed Stage N contours and works are presented on Drawing C-09. The objectives of this stage of the development sequence are as follows:

- Fill the former contact water pond with waste; and
- Promote positive drainage off the landfill.

These objectives will be achieved by implementing the following:

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

In conclusion, this stage will:

- Provide 18,000 cubic metres of air space;
- Accept 11,880 tonnes of waste;
- Require approximately 3,600 cubic metres of daily/intermediate cover; and
- Provide approximately eleven months of Site life.

5.4.8 Stage O

The proposed Stage O contours and works are presented on Drawing C-10. The objectives of this stage of the development sequence are as follows:

- Fill the former contact water pond with waste; and
- Promote positive drainage off the landfill.

These objectives will be achieved by implementing the following:

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

In conclusion, this stage will:

- Provide 11,500 cubic metres of air space;
- Accept 7,590 tonnes of waste;
- Require approximately 2,300 cubic metres of daily/intermediate cover; and
- Provide approximately seven months of Site life.

5.4.9 Stage P

The proposed Stage P contours and works are presented on Drawing C-11. The objectives of this stage of the development sequence are as follows:



- Fill the southwestern top 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 southwestern top 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 17,000 cubic metres of air space;
- Accept 11,220 tonnes of waste;
- Require approximately 3,400 cubic metres of daily/intermediate cover; and
- Provide approximately eleven months of Site life.

5.4.10 Stage Q

The proposed Stage Q contours and works are presented on Drawing C-12. The objectives of this stage of the development sequence are as follows:

- Fill the north 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 north 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 8,000 cubic metres of air space;
- Accept 5,280 tonnes of waste;
- Require approximately 1,600 cubic metres of daily/intermediate cover; and
- Provide approximately five months of Site life.

5.4.11 Stage R

The proposed Stage R contours and works are presented on Drawing C-13. 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;
- Provide 20,500 square metres of landfill ready for final cover on the north and south faces; 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 239 masl, and a slope of 10 percent (10H:1V) for elevation 240 masl; and
- Construct final cover on the west and central portion of the Site.

In conclusion, this stage will:

- Provide 18,000 cubic metres of air space;
- Accept 11,880 tonnes of waste;
- Require approximately 3,600 cubic metres of daily/intermediate cover; and
- Provide approximately eleven months of Site life.

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, as discussed 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 will 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 will 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 was placed in conjunction with interim cover material (composite intermediate cover system) on slopes less than 10 percent grade.



6. VOLUME AND SITE LIFE

6.1 Air Space

Total remaining landfill capacity (airspace) is estimated to be 120,000 cubic metres as of the beginning of June 2023.

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 2022 waste deposition rate of 12,308 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 0.37 tonnes per person per year. Based on these assumptions, the Site is estimated to reach design capacity in 2030. 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 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 1,500 cubic metres (approximately one month of filling at the current rate).
- Ensuring that grading beside 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 C, 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) in the past.

Based on the conditions of the landfill at present (Existing Conditions), the conditions that are proposed and once the landfill reaches its capacity (Post-Development), a hydrological modelling was performed to analyse the surface water generation over the site using the MIDUSS software. The sub-catchments for the existing conditions and post-development site conditions were delineated based on the natural grades and proposed grades presented on Figures 7.1 and 7.2, respectively. As shown in Table 7.1, the proposed design meets the objective of matching post -development



conditions to existing conditions flows. The detailed modelling results are included in Appendix C.

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 drop-off area drains behind the lock block walls and is conveyed by pipes to the stormwater ditch that runs along the north and west sides of the drop-off area. The stormwater ditches to the north and south of the drop-off area drain to the stormwater ditch along Dusty Road.
- Run-off north of the perimeter fence runs into a ditch along Dusty Road;
- 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 the contact water pond; and
- Run-off from the tarped area is directed via a combination of ditches and culverts around the perimeter road into a ditch along Dusty Road and the other half to stormwater ditch west of the property. It should be noted that the tarps will be removed in late summer of 2023.

7.4 **Existing Drainage - Completion of Stage I**

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 existing drainage conditions route surface run off to the north and west by a series of ditches, pipes, and culverts that discharge directly to the Dusty Road roadside ditch. The Dusty Road roadside ditch in turn conveys water westward, eventually draining into Irgens Creek. Irgens Creek runs in a westerly direction, eventually discharging to Porpoise Bay. Surface water run-off from active areas and interim covered areas of the landfill is routed to the existing contact water pond, where it evaporates or infiltrates into the ground. The retention capacity of the existing 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 Heidelberg property.

7.5 Post-Development Drainage

Post-development surface water management is based upon the diversion of surface water flow to the new contact water pond, shifting the location of the old contact water pond and making it the new contact water pond (retention pond) with an infiltration pond adjacent to it, situated on the western portion of the Site.

The contact water pond location is shown on Figure 7.2. The design retention capacity of the retention pond will be at approximately 6,500 cubic metres and infiltration pond with a total capacity of 1,600 cubic meters. The retention pond is designed to accommodate flows up to one, 200-year storm, and the flows exceeding the design volume of 6,500 cubic meters, will be first discharged to the infiltration pond through overflow pipes. In the worst-case scenario of the pond reaching the design capacity, the excess water will overflow to the Heidelberg property through the overflow weirs.

The northern face of the landfill will be closed with final closure. Surface water from this closed area will be routed to ditches and culverts which will discharge directly to the Dusty Road roadside ditch.

The south face of the landfill will be closed with either final closure or a temporary closure. Surface water from this closed area will be routed to ditches and culverts which will discharge directly to the Dusty Road roadside ditch.

The west side of the landfill along with the top of the landfill will remain active. Surface water run-off from active areas and interim covered areas of the landfill will be routed to the relocated contact water pond.



8. LEACHATE MANAGEMENT

8.1 Objectives

The objectives of leachate management are to minimize the impact of landfill operations on the environment (e.g., impacts to groundwater and surface water quality) 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 volume. 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 Ministry as any liquid which has percolated through or drained from a municipal solid waste disposal facility (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 also vary significantly.

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

- Organics;
- Nitrogen;
- Chlorides;
- Phosphates;
- Dissolved 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 leachate 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 (USEPA, 2020) 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 D.

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 463 millimetres of infiltration per square metre of landfill area at a 3 percent slope, and 459 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 448 millimetres of infiltration at a 3 percent slope, 435 millimetres of infiltration at a 12 percent slope, and 432 millimetres of infiltration at a 33 percent slope. The annual leachate generation of the landfill haul road, at an 8 percent slope is 446 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 13,973 cubic metres. The total volume of leachate generated at the Site will decrease to approximately 2,018 cubic metres per year upon final closure of the landfill.

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. Progressive closure is used to reduce leachate generation on the 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 leachate 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 or the contact water pond.

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 coarse 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 greenhouse gas (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:

1. Aerobic, Non-Methanogenic.
2. Anoxic, Non-Methanogenic.
3. Anaerobic, Methanogenic, Unsteady.
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.

GHG 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 (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 (L_0); 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:

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

Where:

Q_T = total LFG emissions (50 percent CH₄ and 50 percent CO₂ by volume)

k = LFG generation constant (year⁻¹)

L_o = methane generation potential (m³ CH₄ /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:

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

Where:

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

k = LFG generation constant (year⁻¹)

L_o = waste methane generation potential (m³ CH₄ 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 0.37 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 (L_o) 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 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.

In 2023 XCG completed a waste composition study for the Sechelt Landfill. A summary of the results from the study are presented in Table 4.5. As indicated in Table 4.5, approximately 30 percent of the total waste landfilled at the Site in 2022 was composed of decomposable waste, approximately 46 percent was composed of moderately decomposable waste, and approximately 21 percent of the waste was composed of relatively inert material.

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 an LFG collection system.

The peak methane emission rate was estimated to be approximately 874 tonnes per year. Current 2023 methane emissions are estimated to be approximately 853 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 an LFG collection system is not required.

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



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 permeable, 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.

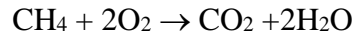
Civil works adjacent to the landfill may also impact migration potential. Paved areas provide a barrier to venting; thus, increasing the potential for lateral migration of LFG. In addition, utility corridors, backfilled with non-cohesive and free draining bedding material, may provide a conduit for migration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



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.

The soil gas trigger concentrations are summarized 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.

One new nested LFG monitoring well was installed adjacent to the maintenance shed in Summer 2017. Two LFG monitoring locations were damaged during construction of the new drop-off area and are planned to be replaced / relocated in 2024 with the construction of the new contact water pond. 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 874 cubic tonnes per year, an active LFG collection system is not required for the Site

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 Preparation for Biocover Pilot stage.



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. Site access and exit are 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 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 Public Drop-Off Area

A well-signed public drop-off area, equipped with eight operational roll-off bin lock block bays, is located west of the weigh scale and there is space for two additional roll-off bins to the east. 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 drop-off 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 16-metre (53-foot) transport trailer for storage and transportation of mattresses and box springs for processing recycling, and a lock block bay for a 16-metre (53-foot) transport trailer for storage of mattresses and box springs.

In 2023 the SCRD partnered with the Ocean Legacy Foundation to establish an Ocean Plastics Depot at the landfill. Dock foam, fishing nets, rope, and buoys are diverted from the landfill and recycled.



10.1.5 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 drop-off 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 the OC dated 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 measures 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 measures 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

Site access and exit are provided via Dusty Road, approximately 6.5 kilometres northeast of the District of Sechelt. 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 9:00 AM to 5:00 PM Tuesday to 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 Site is operated by the SCR D staff, which handles the front end of the operations with a contractor responsible for supplying and operating heavy equipment.

The SCR D 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 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 F.

11.5 Recyclable Materials

The SCRDC 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 SCRDC 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.

11.6 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 have been employed at the Site as a form of alternative daily cover since early 2018.

11.6.1 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.

11.6.2 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 were 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. It should be noted that the tarps will be removed as part of the biocover pilot project in late summer 2023.

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

11.6.3 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.

11.7 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.



11.8 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 should be conducted by the SCRDP personnel and Site contractor.

11.9 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.

11.10 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.

11.11 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.

11.12 Vector and Wildlife Control

The terms vector and wildlife refer to objectionable insects, rodents, birds, and bears that sometimes visit / frequent 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.

11.13 Emergency Response and Contingency Plan

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



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:

- The OC dated July 8, 2014 ;
- 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 “2022 Annual Report” prepared for the SCRD, dated March 31, 2023.

Groundwater Monitoring

The current groundwater monitoring program includes the quarterly monitoring and sampling of thirteen monitoring wells for water levels, pH, conductivity, temperature, DO and ORP. Laboratory analyses of water samples is performed for the following chemical parameters: pH, electrical conductivity, hardness, chemical COD, 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, DO, and ORP. 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.

As discussed in the Updated Leachate Management Plan prepared by XCG in November 2020, comparison of historic monitoring data from various groundwater monitoring wells MW-4, MW-4A, MW13-4 (used for background water quality) and MW-3. MW-3 provides the closest approximation of leachate quality at the Site. Monitoring well MW-3 is located at the southwestern corner of the landfill, near the former sludge disposal pits and for these reasons, is considered to represent leachate quality at the Site, as it is the most down-gradient shallow well.

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 (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 sidewalls, and dredging of sediment build-up.

Riprap should be periodically inspected for signs of erosion. If erosion has occurred, the deteriorated section shall be regraded, and riprap restored.

It is recommended that all surface water courses and riprap with excessive sediment buildup be hydro vacuumed every two years or as required.

The contact water 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 every 3 years 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. Portions of the Site not being used as part of the waste transfer operations would be restricted to passive use, such as wildlife habitat area, community trails, or green space.

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 120,000 cubic metres and the assumptions presented in Section 6.2, the current estimated closure date is 2030. 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 house, scale, and maintenance 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 G.

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 \$6,528,572 is anticipated for this work. A detailed cost summary for an early closure is included in Table 8 of Appendix G.



14. *LIMITATIONS*

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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 1×10^{-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 TM) 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	0.37	10,446	437,901
2015	30,359	27,498	0.37	11,067	448,968
2016	31,300	31,300	0.37	12,667	461,635
2017	31,267	31,267	0.37	11,569	473,204
2018	31,550	31,550	0.37	11,674	484,877
2019	31,737	31,737	0.37	11,743	496,620
2020	31,910	31,910	0.37	11,807	508,427
2021	32,306	32,306	0.37	11,953	520,380
2022	32,823	32,823	0.37	12,145	532,525
2023	33,254	33,254	0.37	12,304	544,829
2024	33,649	33,649	0.37	12,450	557,279
2025	34,026	34,026	0.37	12,590	569,868
2026	34,398	34,398	0.37	12,727	582,596
2027	34,764	34,764	0.37	12,863	595,458
2028	35,131	35,131	0.37	12,998	608,457
2029	35,495	35,495	0.37	13,133	621,590
2030	35,853	35,853	0.37	13,266	634,855
Notes: a - Accounts for Pender Harbour Landfill from 1977 until its closure in July of 2015. 1. Historic and future (1985 - 2030) 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 SCR​D 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 SCR​D 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 SCR​D. 8. Per capita waste generation (2017 - 2022) based on annual liability letters completed by XCG. 9. Per capita waste generation (2023 - 2030) based on historical annual liability letters completed by XCG.					

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 4.5 Waste Composition (2023)

Waste Category	Waste Composition Sechelt Landfill ^{a,b}
Relatively Inert	
Non-refundable glass (PPP)	2.0%
Refundables (glass and non-glass)	1.0%
Plastic [Film PPP EPR, Rigid PPP EPR, styrofoam (PPP EPR)]	6.0%
Plastic (Film - all other film plastic, other plastics, styrofoam - all other)	8.0%
Electronic Waste	1.0%
Metals	3.0%
Total	21.0%
Moderately Decomposable	
Fibre	8.0%
Building material	10.0%
Household hygiene	5.0%
Refuse	8.0%
Textiles	5.0%
Furniture (not including plastic furniture)	7.0%
Fines	3.0%
Total	46.0%
Decomposable	
Food scraps and kitchen waste	13.0%
Yard and garden waste	4.0%
Pet waste	6.0%
Food soiled papers	7.0%
Total	30.0%
Notes: a - XCG Consulting Ltd., January 2023. "Solid Waste Composition Study - 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
Preparation for Biocover Pilot	5,750	5,750	4	0.3	2023
Stage J	9,500	15,250	6	0.8	2024
Site Modifications	0	15,250	0	0.8	2024
Stage K	7,500	22,750	5	1.2	2024
Stage L	12,000	34,750	8	1.8	2025
Stage M	11,500	46,250	7	2.4	2025
Stage N	18,000	64,250	11	3.4	2026
Stage O	11,500	75,750	7	4.0	2027
Stage P	17,000	92,750	11	4.9	2028
Stage Q	8,000	100,750	5	5.3	2029
Stage R	18,000	118,750	11	6.3	2030

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		
<u>Daily/intermediate Cover</u>		
Total volume of native fill material required for daily/intermediate cover	23,750	m ³
<u>Final Cover</u>		
Volume topsoil required for final cover	8,050	m ³
Volume native fill material required for final cover	26,833	m ³
Volume sand required for final cover	16,100	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	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)
Preparation for Biocover Pilot	5,750	5,750	1,150	1,150
Stage J	9,500	15,250	1,900	3,050
Site Modifications	0	15,250	0	3,050
Stage K	7,500	22,750	1,500	4,550
Stage L	12,000	34,750	2,400	6,950
Stage M	11,500	46,250	2,300	9,250
Stage N	18,000	64,250	3,600	12,850
Stage O	11,500	75,750	2,300	15,150
Stage P	17,000	92,750	3,400	18,550
Stage Q	8,000	100,750	1,600	20,150
Stage R	18,000	118,750	3,600	23,750
Notes: 3. Daily/intermediate cover consumption based upon a 4:1 waste to daily/intermediate cover ratio.				

Table 6.3 Projected Airspace Consumption Summary

Year	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)
2023	9,500	9,500	1,900	1,900
2024	17,500	27,000	3,500	5,400
2025	17,500	44,500	3,500	8,900
2026	17,500	62,000	3,500	12,400
2027	17,500	79,500	3,500	15,900
2028	17,500	97,000	3,500	19,400
2029	17,500	114,500	3,500	22,900
2030	4,250	118,750	850	23,750
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 (m³)	10-Year (m³)	100-Year (m³)
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%	463
Existing Daily Cover	HELP	12%	459
Existing Intermediate Cover	HELP	3%	448
Existing Intermediate Cover (Road)	HELP	8%	446
Existing Intermediate Cover	HELP	12%	432
Existing Intermediate Cover	HELP	33%	435
Proposed Final Cover	HELP	10%	1
Proposed Final Cover	HELP	33%	1
Note: 1. Hydrological Evaluation of Landfill Performance (HELP) Model (USEPA, 2020)			

Table 8.2 Leachate Generation Rate Summary

Development Stage	Total Leachate Generation Rate (m ³ /yr)
Existing Conditions	13,973
Proposed Final Conditions	2,018
Note: 1. Hydrological Evaluation of Landfill Performance (HELP) Model (USEPA, 2020)	

Table 9.1 LFG Generation Constants

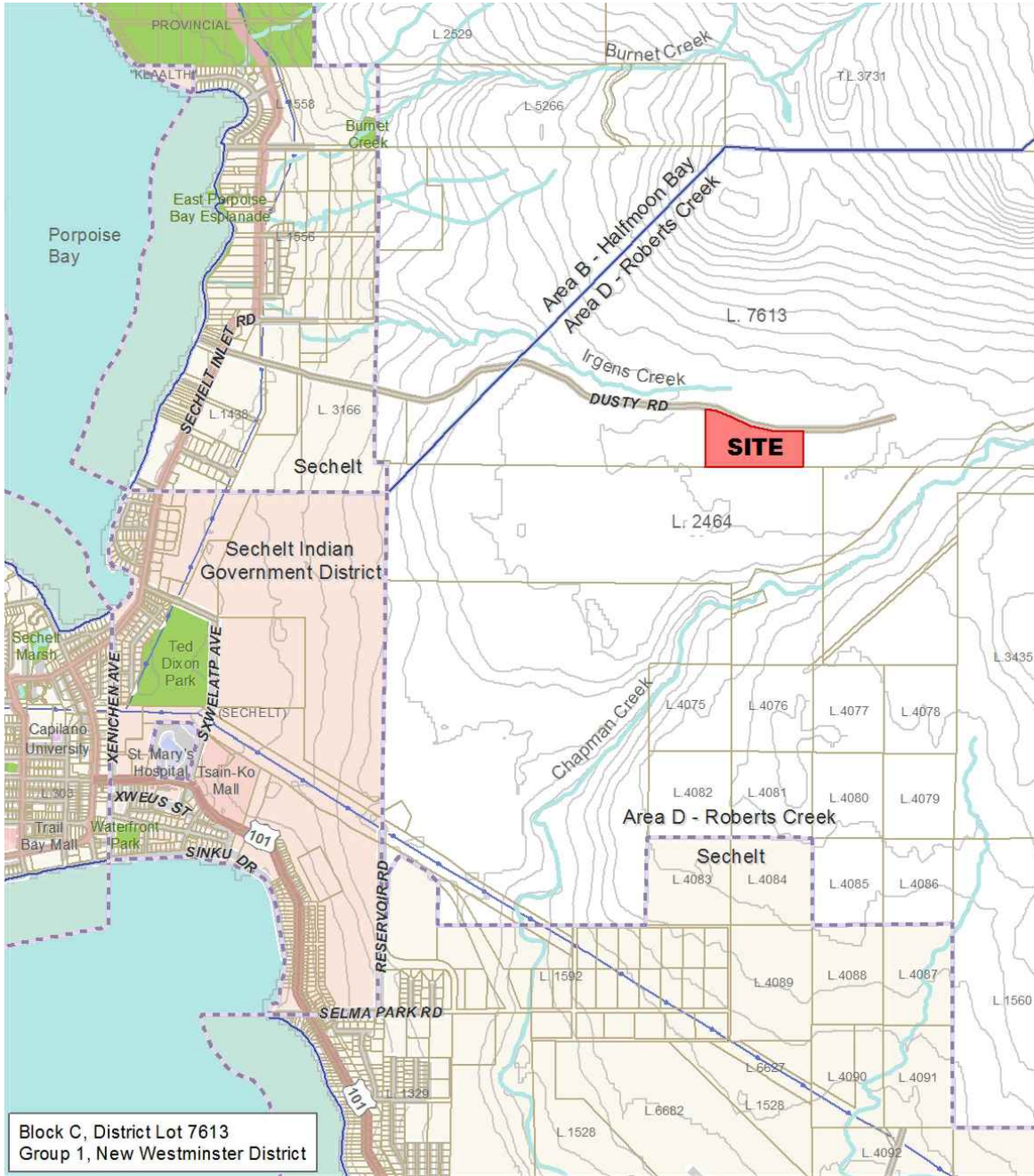
Material Type	K (yr ⁻¹)	Lo (m ³ /tonne)
Inert	0.02	20
Moderately Decomposable	0.06	120
Decomposable	0.11	160
Note:		
1. Source: CRA (2009).		

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

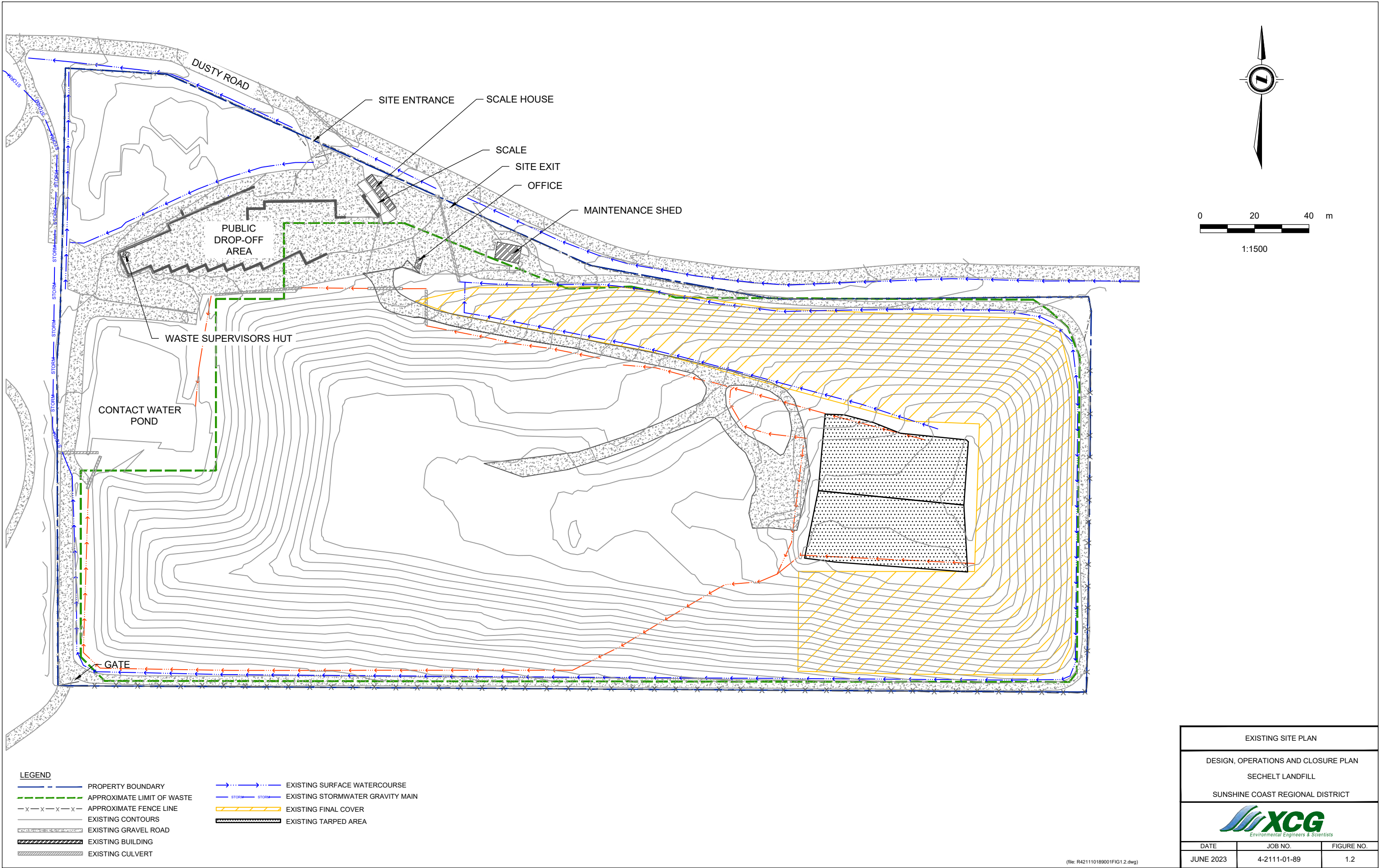


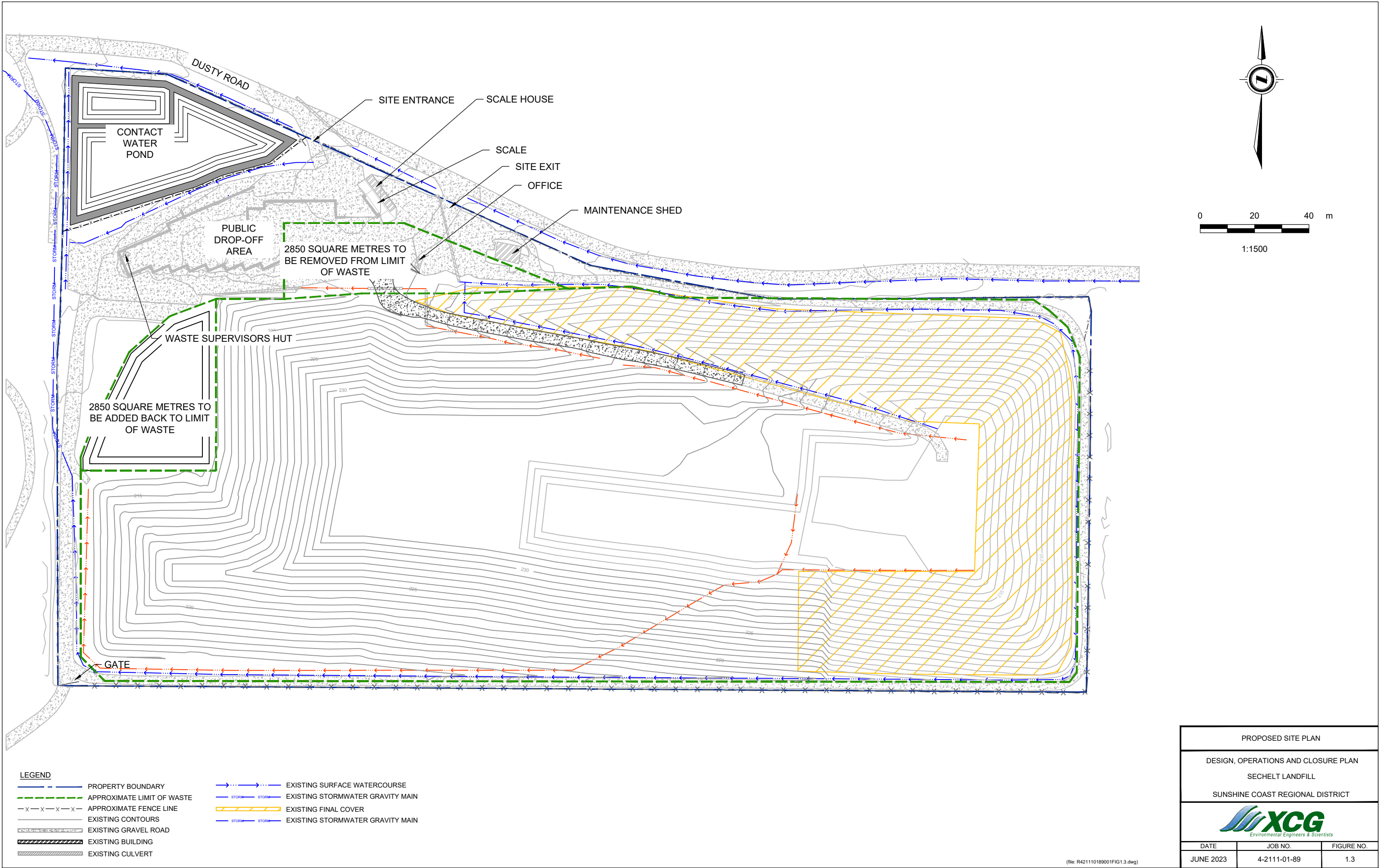
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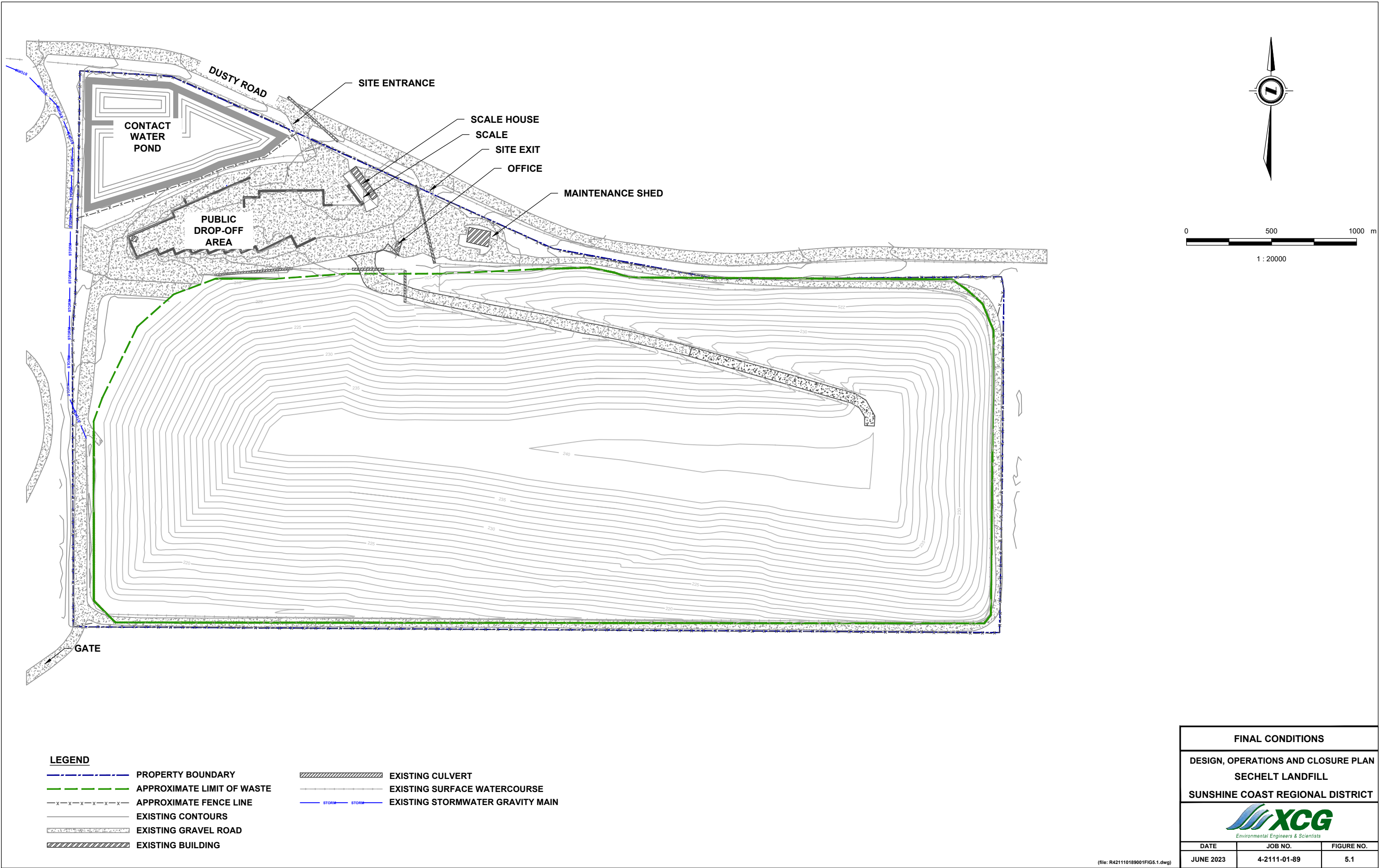
DESIGN, OPERATIONS AND CLOSURE PLAN
SECHelt LANDFILL
SUNSHINE COAST REGIONAL DISTRICT

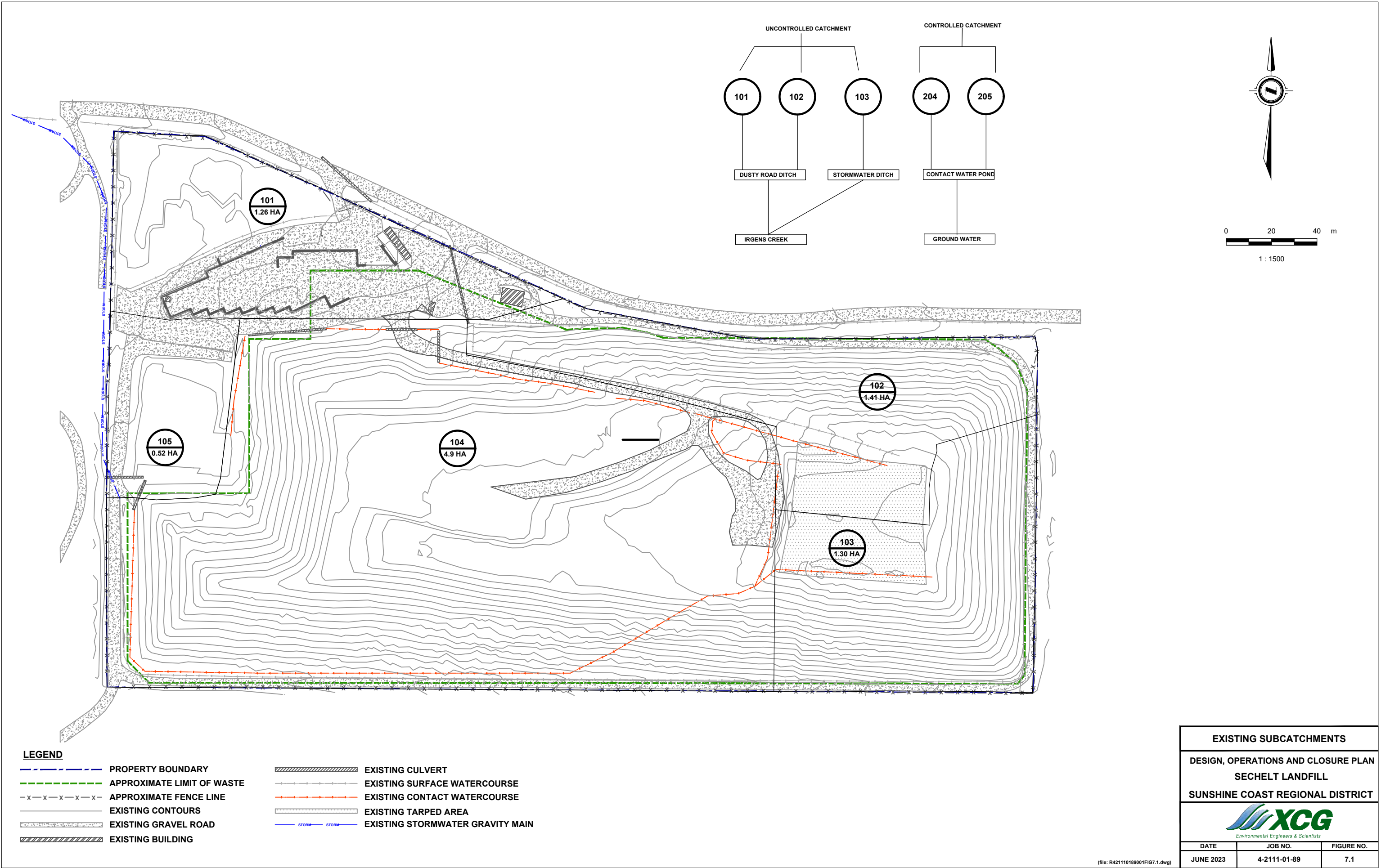


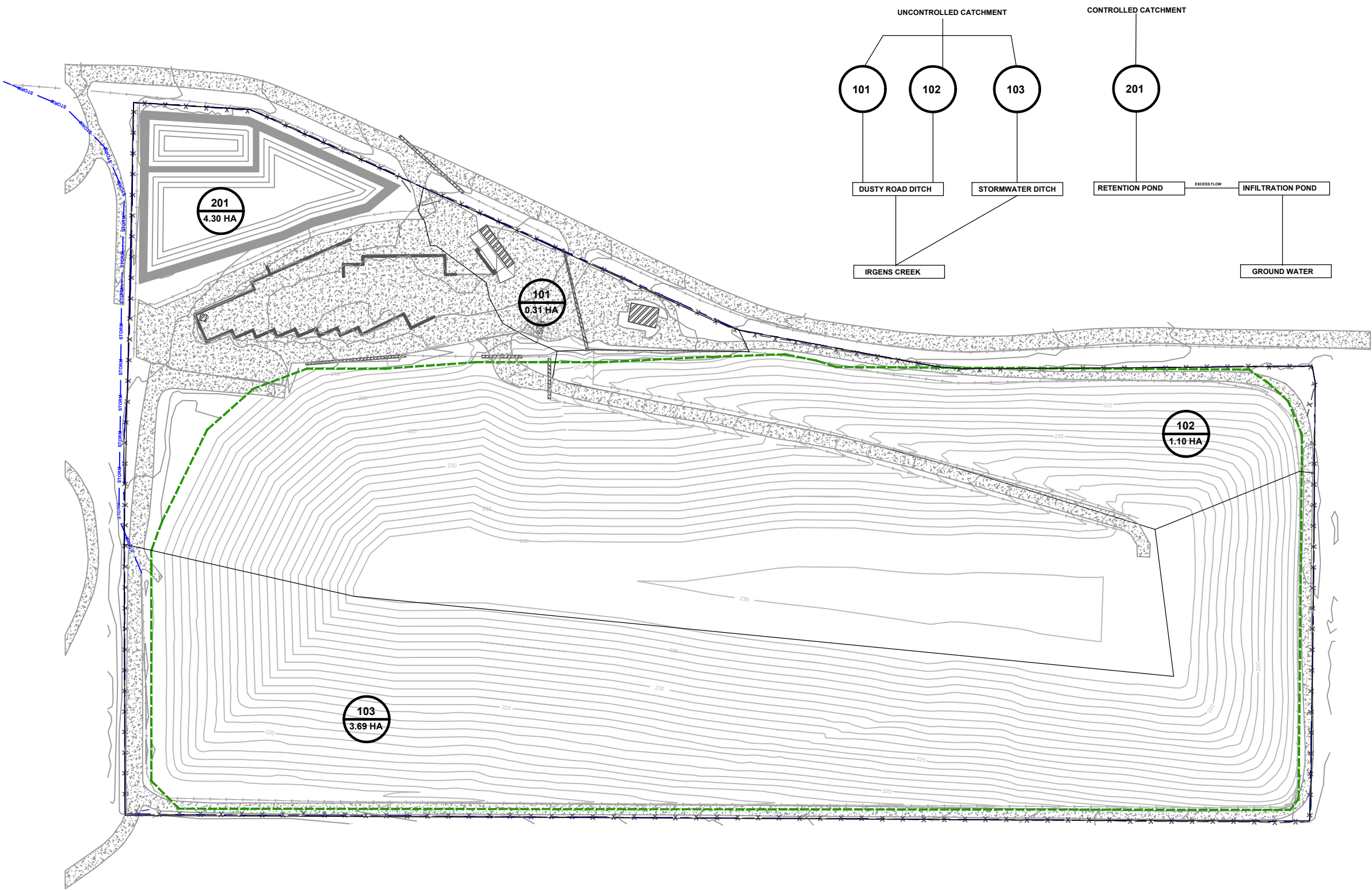
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LEGEND

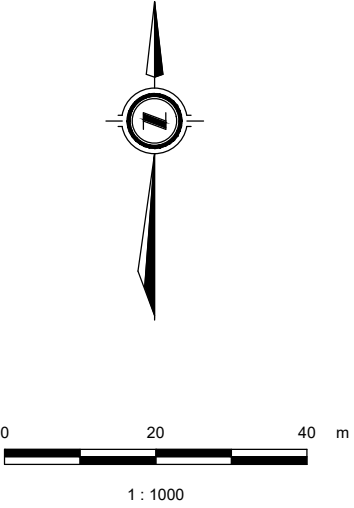
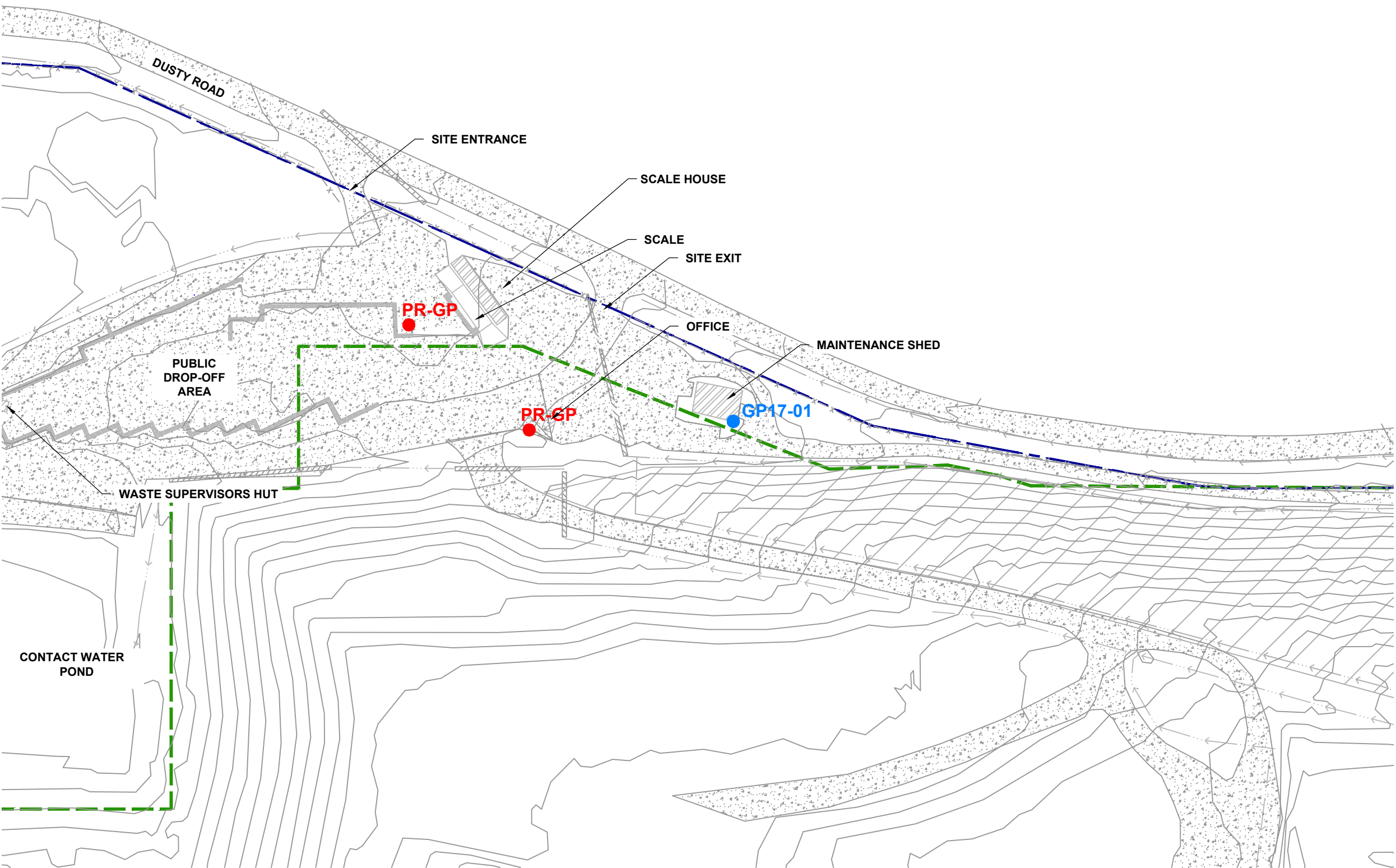
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|--|----------------------------|--|----------------------------------|
| | PROPERTY BOUNDARY | | EXISTING CULVERT |
| | APPROXIMATE LIMIT OF WASTE | | EXISTING SURFACE WATERCOURSE |
| | APPROXIMATE FENCE LINE | | EXISTING STORMWATER GRAVITY MAIN |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

POST DEVELOPMENT SUBCATCHMENTS


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



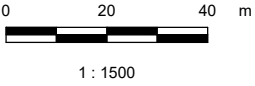
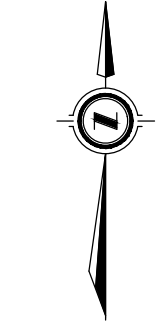
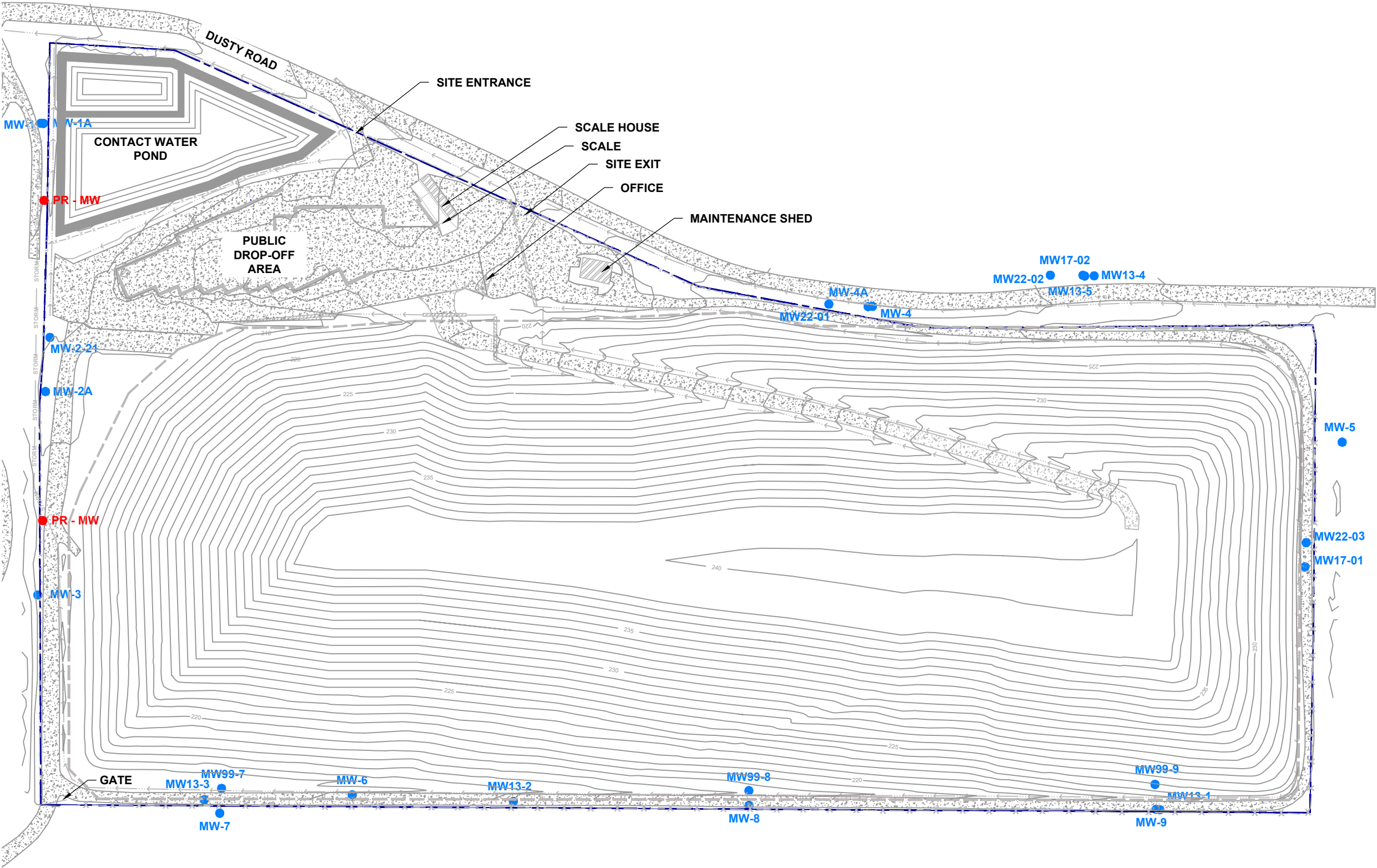
DATE	JOB NO.	FIGURE NO.
JUNE 2023	4-2111-01-89	7.2



LEGEND	
	PROPERTY BOUNDARY
	APPROXIMATE LIMIT OF WASTE
	APPROXIMATE FENCE LINE
	EXISTING CONTOURS
	EXISTING ASPHALT ROAD
	EXISTING GRAVEL ROAD
	EXISTING BUILDING
	EXISTING FINAL COVER
	EXISTING CULVERT
	EXISTING SURFACE WATER
	EXISTING STORMWATER GRAVITY MAIN
	GP17-01 EXISTING LANDFILL GAS MONITORING WELL
	PR - GP PROPOSED LANDFILL GAS MONITORING WELL

LANDFILL GAS MONITORING LOCATIONS		
DESIGN, OPERATIONS AND CLOSURE PLAN		
SECHELT LANDFILL		
SUNSHINE COAST REGIONAL DISTRICT		
		
DATE	JOB NO.	FIGURE NO.
june 2023	4-2111-01-89	9.1

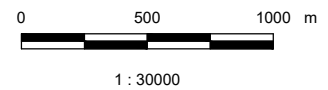
NOTE: EXISTING CONDITIONS AS OF DECEMBER 14, 2023 (file: R421110189001FIG9.1.dwg)



LEGEND			
	PROPERTY BOUNDARY		EXISTING SURFACE WATERCOURSE
	APPROXIMATE LIMIT OF WASTE		EXISTING STORMWATER GRAVITY MAIN
	APPROXIMATE FENCE LINE		EXISTING GROUNDWATER MONITORING WELL
	EXISTING CONTOURS		PROPOSED GROUNDWATER MONITORING WELL
	EXISTING GRAVEL ROAD		
	EXISTING BUILDING		
	EXISTING CULVERT		

GROUNDWATER MONITORING LOCATIONS		
DESIGN, OPERATIONS AND CLOSURE PLAN		
SECHULT LANDFILL		
SUNSHINE COAST REGIONAL DISTRICT		
DATE	JOB NO.	FIGURE NO.
JUNE 2023	4-2111-01-89	12.1

(file: R421110189001FIG12.1.dwg)



LEGEND

- SITE A SURFACE WATER SAMPLING LOCATION
- HISTORIC SURFACE WATER SAMPLING LOCATION

SURFACE WATER MONITORING LOCATIONS

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



DATE	JOB NO.	FIGURE NO.
JUNE 2023	4-2111-01-89	12.2



DRAWINGS



KEY MAP

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

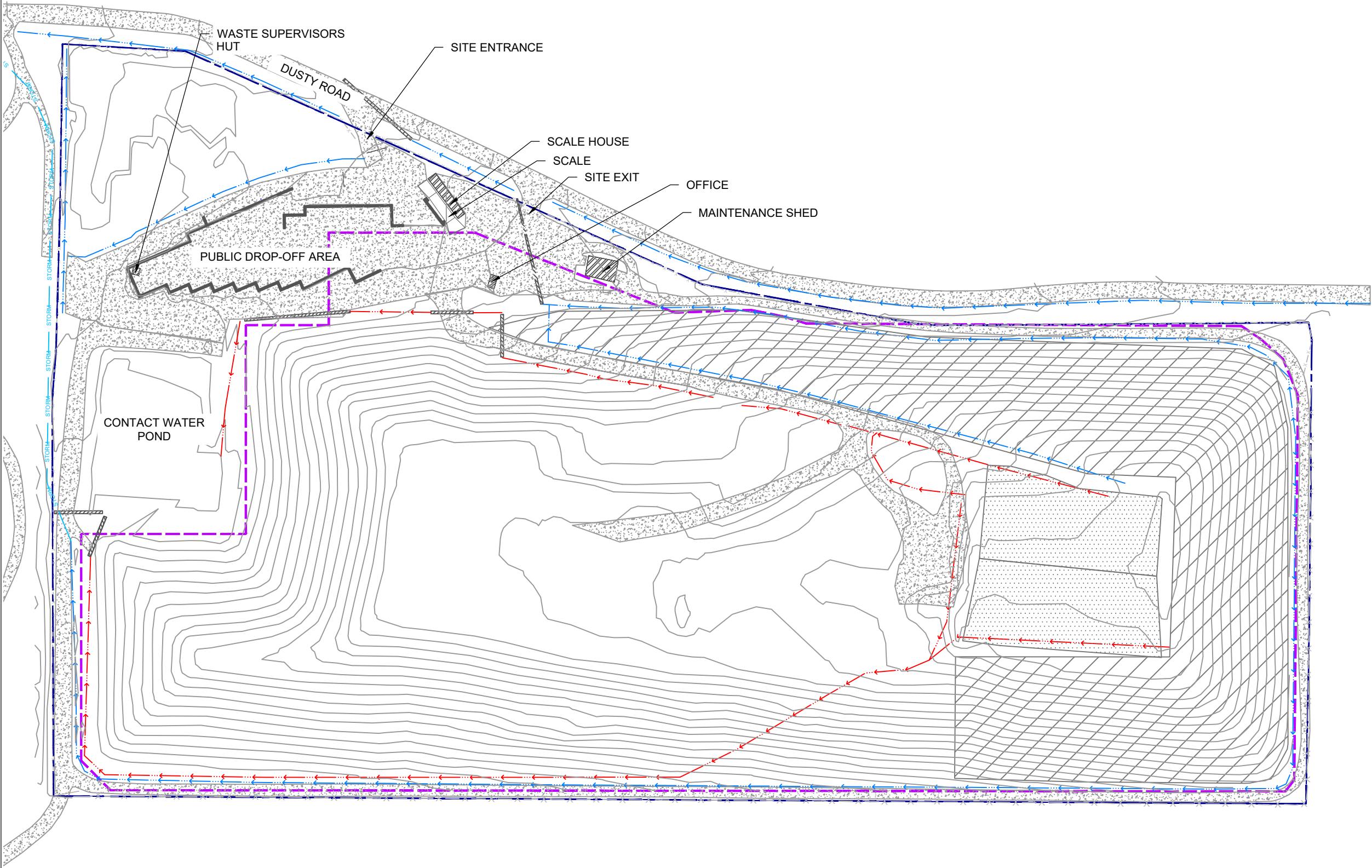
SUNSHINE COAST REGIONAL
DISTRICT

DRAWING INDEX

SHEET	REV. #	DATE	TITLE
G-01	1	JUNE 2023	TITLE PAGE
C-01	1	JUNE 2023	EXISTING CONDITIONS
C-02	1	JUNE 2023	COMPLETION OF STAGE I
C-03	1	JUNE 2023	PREPARATION FOR BIOCOVER PILOT
C-04	1	JUNE 2023	STAGE J
C-05	1	JUNE 2023	SITE MODIFICATIONS
C-06	1	JUNE 2023	STAGE K
C-07	1	JUNE 2023	STAGE L
C-08	1	JUNE 2023	STAGE M
C-09	1	JUNE 2023	STAGE N
C-10	1	JUNE 2023	STAGE O
C-11	1	JUNE 2023	STAGE P
C-12	1	JUNE 2023	STAGE Q
C-13	1	JUNE 2023	STAGE R
C-14	1	JUNE 2023	FINAL CONDITIONS
D-01	1	JUNE 2023	DETAILS I



EXISTING CONDITIONS NOTES:
- EXISTING CONDITIONS AS OF DECEMBER 14, 2022



- LEGEND**
- PROPERTY BOUNDARY
 - APPROXIMATE LIMIT OF WASTE
 - APPROXIMATE FENCE LINE
 - EXISTING CONTOURS
 - EXISTING GRAVEL ROAD
 - EXISTING BUILDING
 - EXISTING FINAL COVER
 - EXISTING CULVERT
 - EXISTING SURFACE WATERCOURSE
 - EXISTING CONTACT WATERCOURSE
 - EXISTING TARPED AREA
 - EXISTING STORMWATER GRAVITY MAIN

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
0	ISSUED FOR REVIEW	JUNE 2023	TAM
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DESIGN, OPERATIONS AND CLOSURE PLAN

SECHELT LANDFILL

SUNSHINE COAST REGIONAL DISTRICT

VERIFY SCALE

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EXISTING CONDITIONS

Date: JUNE 2023

Location: SECHELT, B.C.

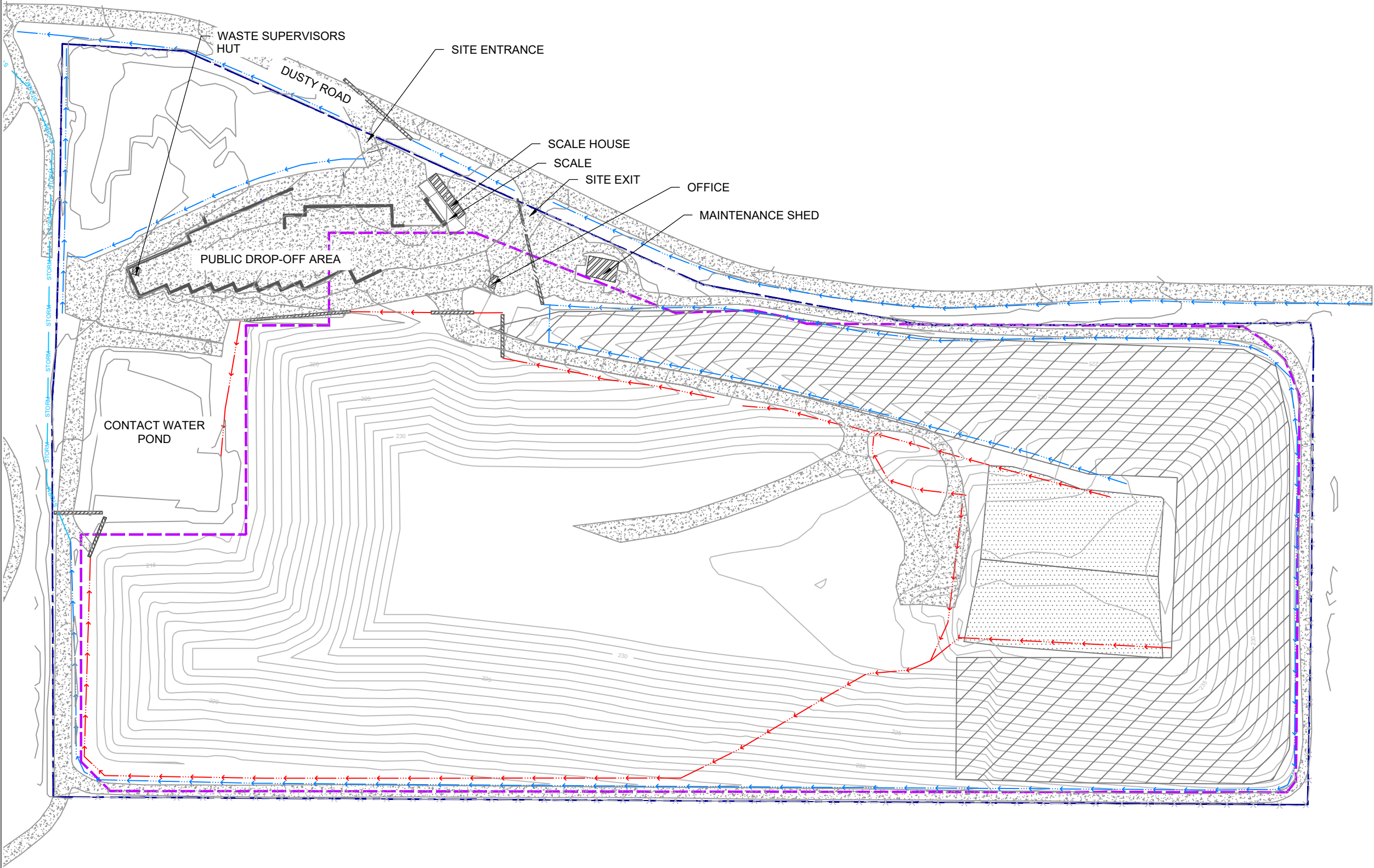
Rev: 1

Scale: 1 : 1500

4-2111-01-89

Sheet: C-01

COMPLETION OF STAGE I NOTES:
- ESTIMATED COMPLETION OF STAGE I IS THE BEGINNING OF JUNE 2023



- LEGEND**
- PROPERTY BOUNDARY
 - APPROXIMATE LIMIT OF WASTE
 - APPROXIMATE FENCE LINE
 - EXISTING CONTOURS
 - EXISTING GRAVEL ROAD
 - EXISTING BUILDING
 - EXISTING FINAL COVER
 - EXISTING CULVERT
 - EXISTING SURFACE WATERCOURSE
 - EXISTING CONTACT WATERCOURSE
 - EXISTING TARPED AREA
 - EXISTING STORMWATER GRAVITY MAIN

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DESIGN, OPERATIONS AND CLOSURE PLAN

SECHELT LANDFILL

SUNSHINE COAST REGIONAL DISTRICT

VERIFY SCALE

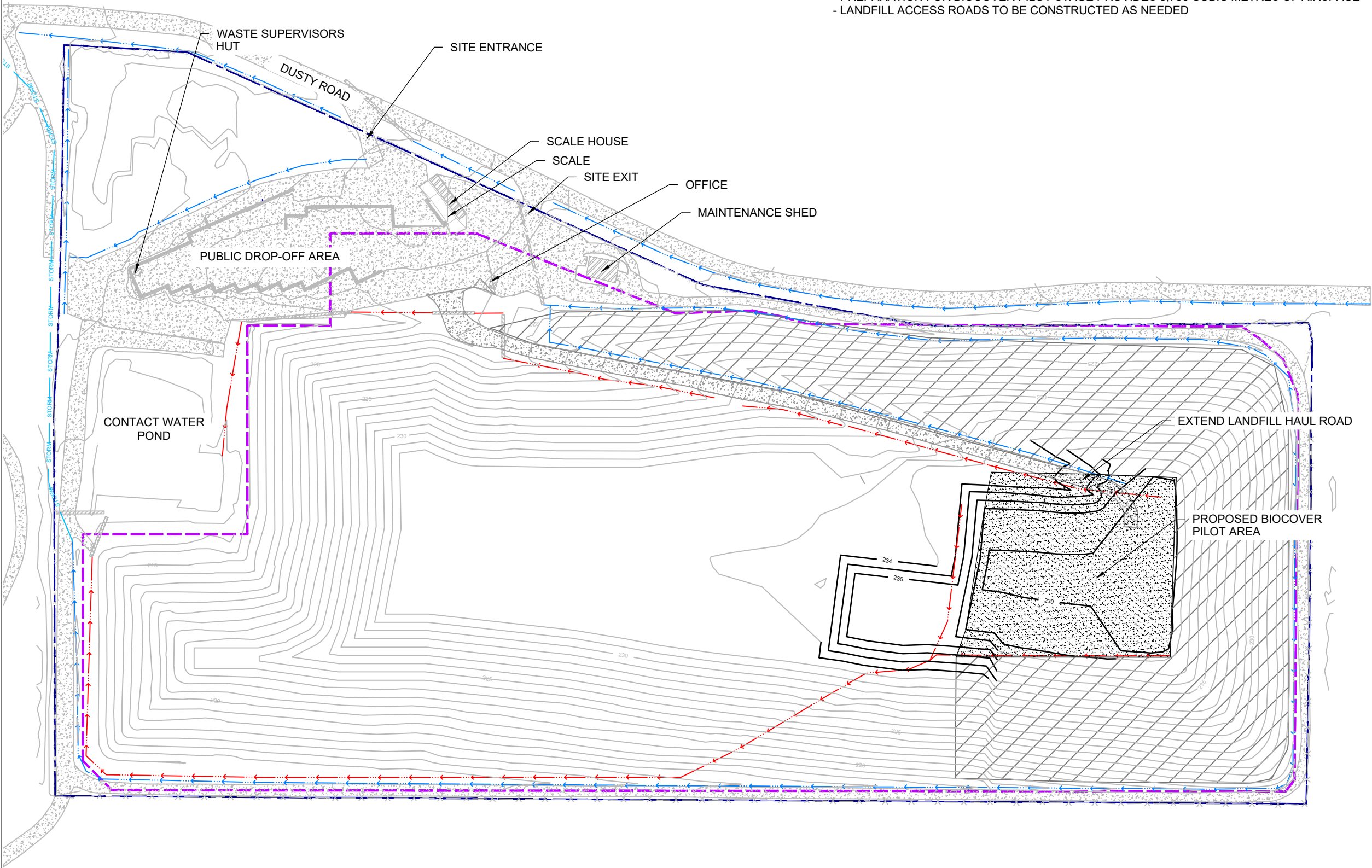
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COMPLETION OF STAGE I

Date:	JUNE 2023	Location:	SECHELT, B.C.	Rev.	1
Scale:	1 : 1500		4-2111-01-89	Sheet:	C-02

PREPARATION FOR BIOCOVER PILOT NOTES:

- EAST SIDE OF THE TOP OF THE LANDFILL TO BE FILLED TO ELEVATION 238 METRES AMSL
- EXTEND THE HAUL ROAD TO THE TOP OF THE LANDFILL
- PREPARATION FOR BIOCOVER PILOT STAGE PROVIDES 5,750 CUBIC METRES OF AIRSPACE
- LANDFILL ACCESS ROADS TO BE CONSTRUCTED AS NEEDED



LEGEND	
	PROPERTY BOUNDARY
	APPROXIMATE LIMIT OF WASTE
	APPROXIMATE FENCE LINE
	EXISTING CONTOURS
	EXISTING GRAVEL ROAD
	EXISTING BUILDING
	EXISTING FINAL COVER
	EXISTING CULVERT
	EXISTING SURFACE WATERCOURSE
	EXISTING CONTACT WATERCOURSE
	EXISTING TARPED AREA
	EXISTING STORMWATER GRAVITY MAIN

REVISIONS			
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DESIGN, OPERATIONS AND CLOSURE PLAN

SECHELT LANDFILL

SUNSHINE COAST REGIONAL DISTRICT

VERIFY SCALE
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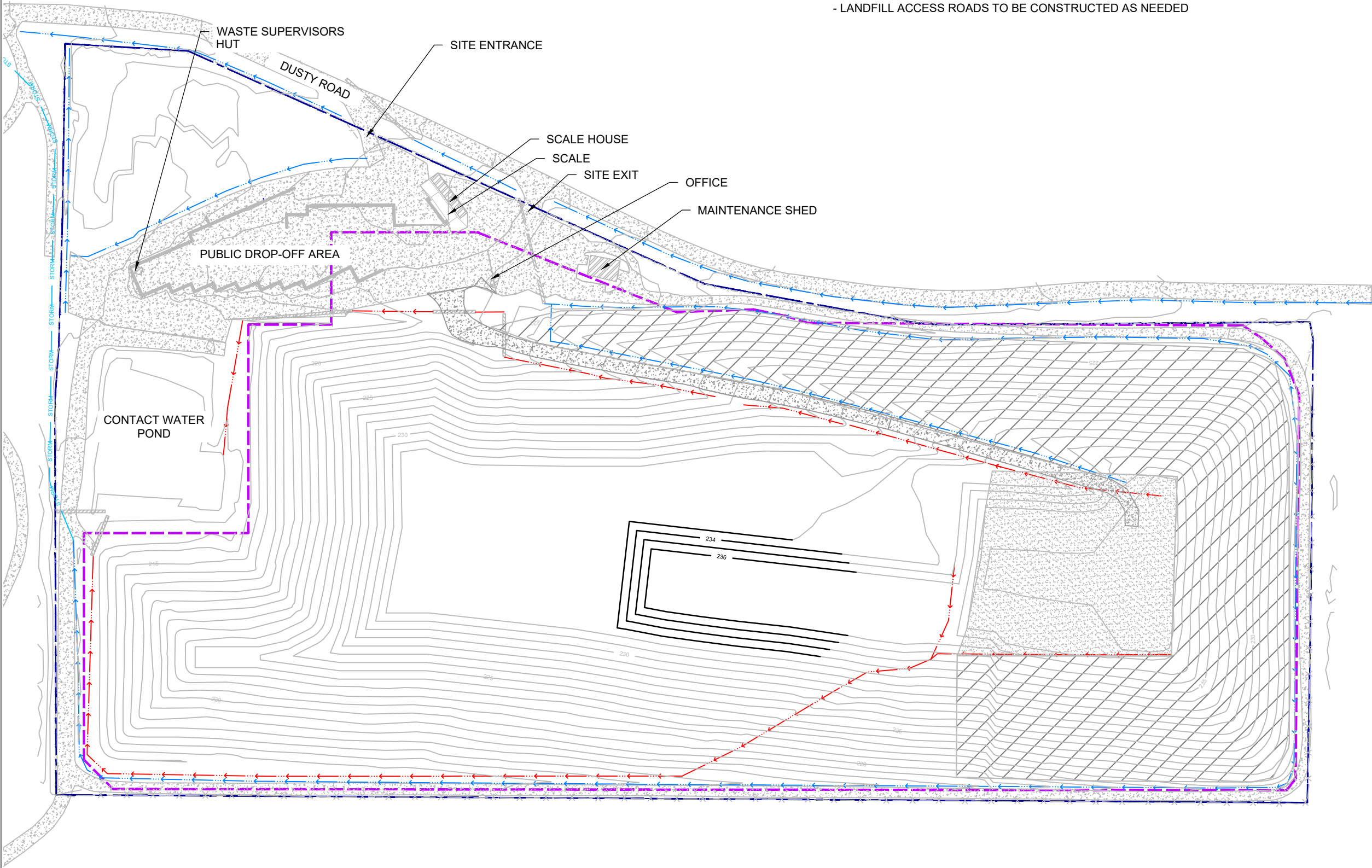
PREPARATION FOR BIOCOVER PILOT



Date:	JUNE 2023	Location:	SECHELT, B.C.	Rev:	1
Scale:	1 : 1500		4-2111-01-89	Sheet:	C-03

STAGE J NOTES:

- PLACE WASTE ALONG THE SOUTH SIDE OF THE TOP OF THE LANDFILL
- STAGE J TO BE FILLED TO ELEVATION OF 236 METRES AMSL
- STAGE J PROVIDES 9,500 CUBIC METRES OF AIRSPACE
- LANDFILL ACCESS ROADS TO BE CONSTRUCTED AS NEEDED



LEGEND

- PROPERTY BOUNDARY
- APPROXIMATE LIMIT OF WASTE
- APPROXIMATE FENCE LINE
- EXISTING CONTOURS
- EXISTING GRAVEL ROAD
- EXISTING BUILDING
- EXISTING FINAL COVER
- EXISTING CULVERT
- EXISTING SURFACE WATERCOURSE
- EXISTING CONTACT WATERCOURSE
- EXISTING TARPED AREA
- EXISTING STORMWATER GRAVITY MAIN

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
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DESIGN, OPERATIONS AND CLOSURE PLAN

SECHELT LANDFILL

SUNSHINE COAST REGIONAL DISTRICT

VERIFY SCALE

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IF NOT 10 mm ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

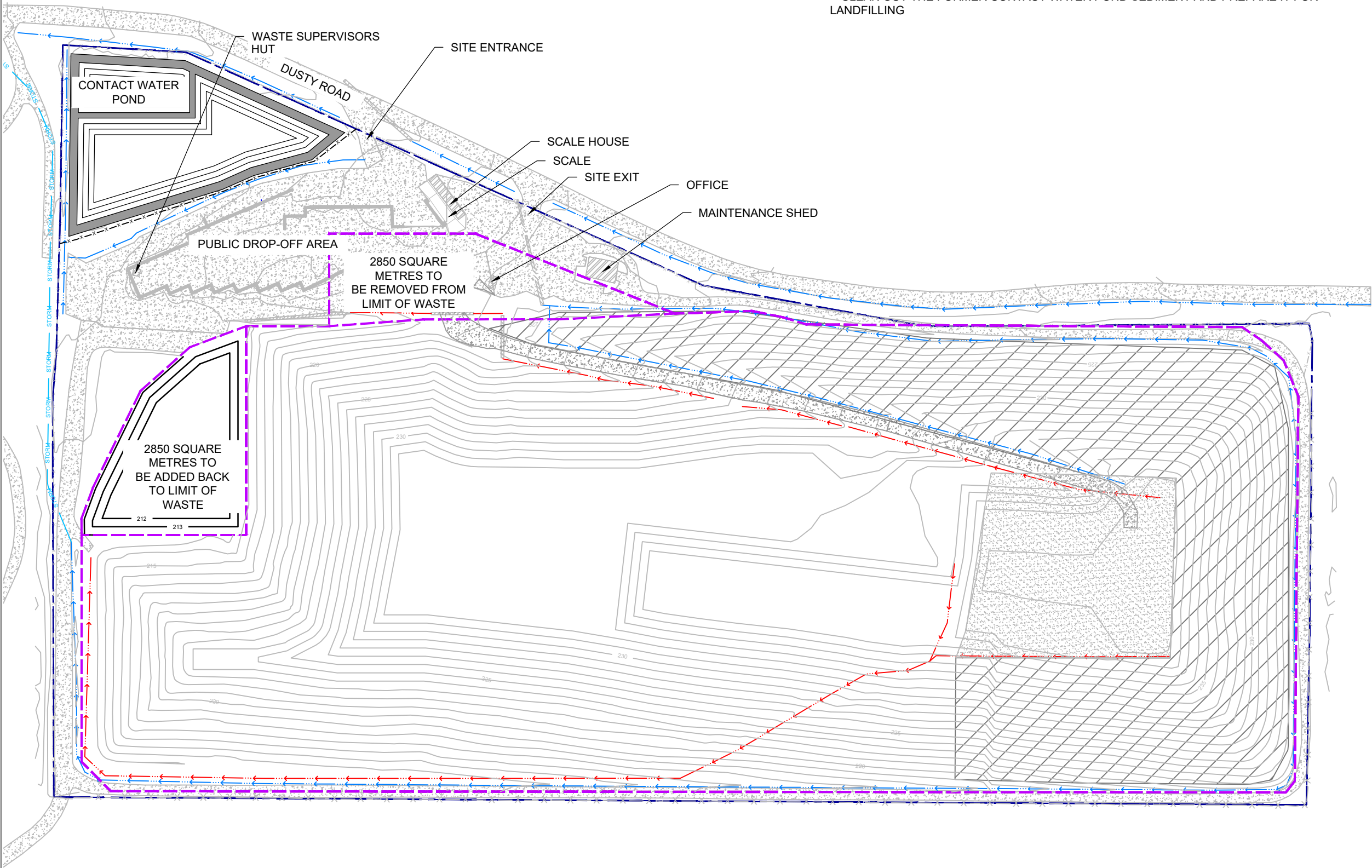
STAGE J



Date:	JUNE 2023	Location:	SECHELT, B.C.	Rev.	1
Scale:	1 : 1500		4-2111-01-89	Sheet:	C-04

SITE MODIFICATIONS NOTES:

- CONSTRUCT THE NEW CONTACT WATER POND
- MODIFY THE LIMITS OF WASTE AS SHOWN
- CLEAN OUT THE FORMER CONTACT WATER POND SEDIMENT AND PREPARE IT FOR LANDFILLING



LEGEND

- PROPERTY BOUNDARY
- APPROXIMATE LIMIT OF WASTE
- APPROXIMATE FENCE LINE
- EXISTING CONTOURS
- EXISTING GRAVEL ROAD
- EXISTING BUILDING
- EXISTING FINAL COVER
- EXISTING CULVERT
- EXISTING SURFACE WATERCOURSE
- EXISTING CONTACT WATERCOURSE
- EXISTING TARPED AREA
- EXISTING STORMWATER GRAVITY MAIN

REVISIONS			
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DESIGN, OPERATIONS AND CLOSURE PLAN

SECHELT LANDFILL

SUNSHINE COAST REGIONAL DISTRICT

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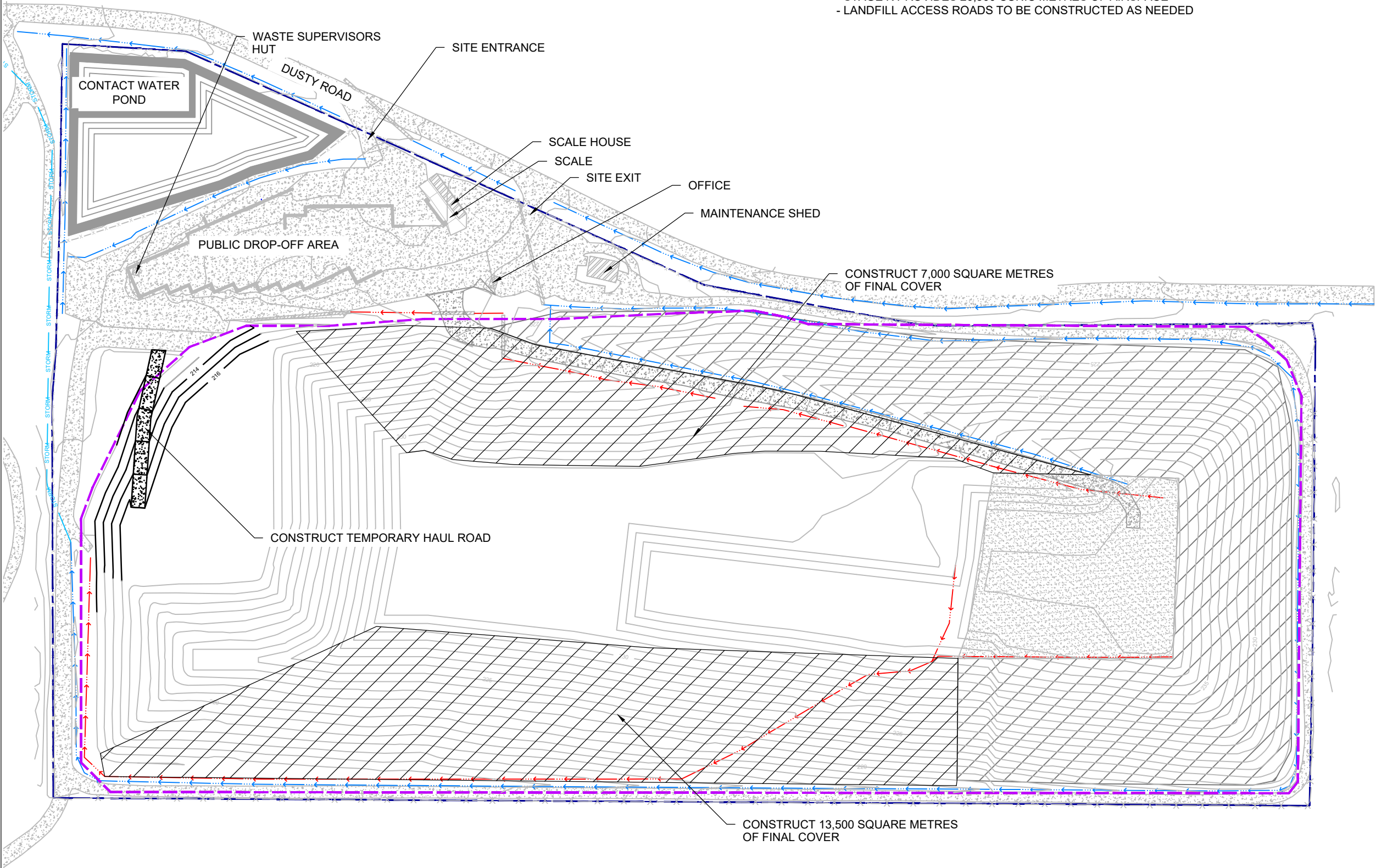
SITE MODIFICATIONS



Date:	JUNE 2023	Location:	SECHELT, B.C.	Rev.	1
Scale:	1 : 1500		4-2111-01-89	Sheet:	C-05

STAGE K NOTES:

- PLACE WASTE IN THE AREA OF THE FORMER CONTACT WATER POND
- STAGE K TO BE FILLED TO ELEVATION OF 216 METRES AMSL
- STAGE K PROVIDES 20,500 CUNIC METRES OF AIRSPACE
- LANDFILL ACCESS ROADS TO BE CONSTRUCTED AS NEEDED



LEGEND

- PROPERTY BOUNDARY
- APPROXIMATE LIMIT OF WASTE
- APPROXIMATE FENCE LINE
- EXISTING CONTOURS
- EXISTING GRAVEL ROAD
- EXISTING BUILDING
- EXISTING FINAL COVER
- EXISTING CULVERT
- EXISTING SURFACE WATERCOURSE
- EXISTING CONTACT WATERCOURSE
- EXISTING TARPED AREA
- EXISTING STORMWATER GRAVITY MAIN

REVISIONS			
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DESIGN, OPERATIONS AND CLOSURE PLAN

SECHELT LANDFILL

SUNSHINE COAST REGIONAL DISTRICT

VERIFY SCALE

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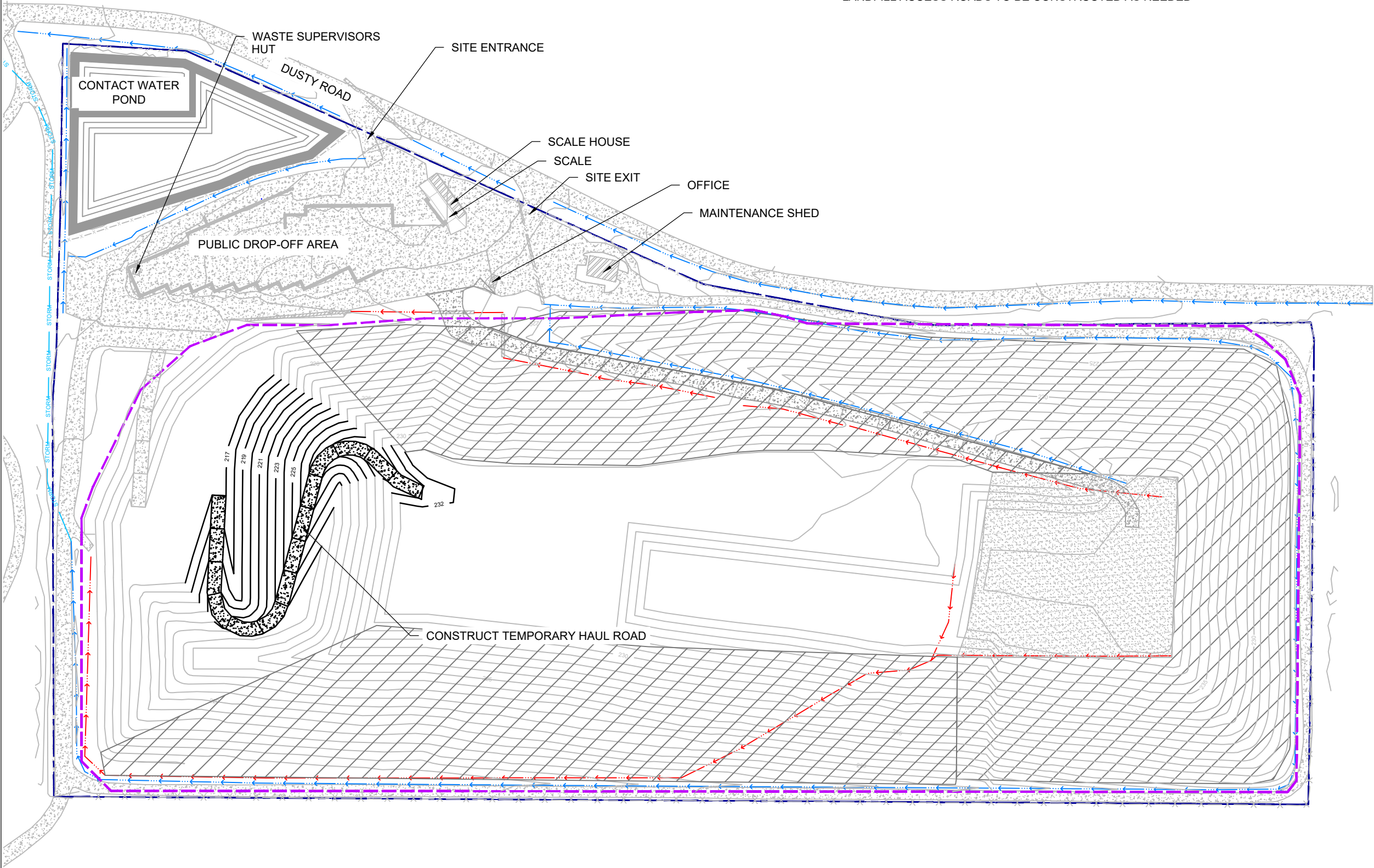
STAGE K



Date:	JUNE 2023	Location:	SECHELT, B.C.	Rev.	1
Scale:	1 : 1500		4-2111-01-89	Sheet:	C-06

STAGE L NOTES:

- CONSTRUCT HAUL ROAD DOWN IN TO THE AREA OF THE FORMER CONTACT WATER POND
- THE CONSTRUCTION OF THE HAUL ROAD PROVIDES 12,000 CUBIC METRES OF AIRSPACE
- LANDFILL ACCESS ROADS TO BE CONSTRUCTED AS NEEDED



LEGEND

- PROPERTY BOUNDARY
- APPROXIMATE LIMIT OF WASTE
- APPROXIMATE FENCE LINE
- EXISTING CONTOURS
- EXISTING GRAVEL ROAD
- EXISTING BUILDING
- EXISTING FINAL COVER
- EXISTING CULVERT
- EXISTING SURFACE WATERCOURSE
- EXISTING CONTACT WATERCOURSE
- EXISTING TARPED AREA
- EXISTING STORMWATER GRAVITY MAIN

REVISIONS			
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DESIGN, OPERATIONS AND CLOSURE PLAN

SECHELT LANDFILL

SUNSHINE COAST REGIONAL DISTRICT

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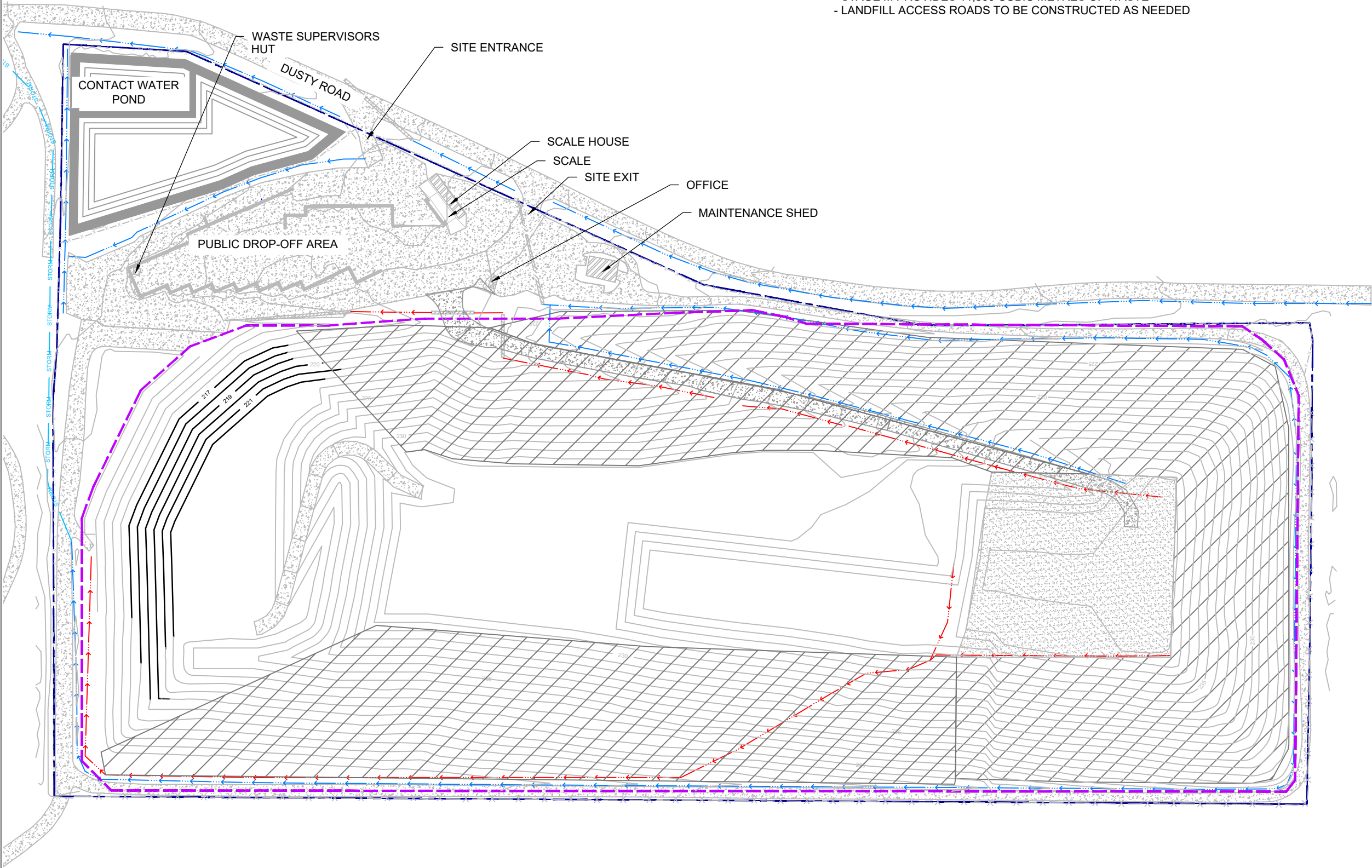
STAGE L



Date:	JUNE 2023	Location:	SECHELT, B.C.	Rev.	1
Scale:	1 : 1500		4-2111-01-89	Sheet:	C-07

STAGE M NOTES:

- PLACE WASTE IN THE AREA OF THE FORMER CONTACT WATER POND
- STAGE M TO BE FILLED TO ELEVATION OF 222 METRES AMSL
- STAGE M PROVIDES 11,500 CUBIC METRES OF WASTE
- LANDFILL ACCESS ROADS TO BE CONSTRUCTED AS NEEDED



LEGEND

- PROPERTY BOUNDARY
- APPROXIMATE LIMIT OF WASTE
- APPROXIMATE FENCE LINE
- EXISTING CONTOURS
- EXISTING GRAVEL ROAD
- EXISTING BUILDING
- EXISTING FINAL COVER
- EXISTING CULVERT
- EXISTING SURFACE WATERCOURSE
- EXISTING CONTACT WATERCOURSE
- EXISTING TARPED AREA
- EXISTING STORMWATER GRAVITY MAIN

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
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DESIGN, OPERATIONS AND CLOSURE PLAN

SECHELT LANDFILL

SUNSHINE COAST REGIONAL DISTRICT

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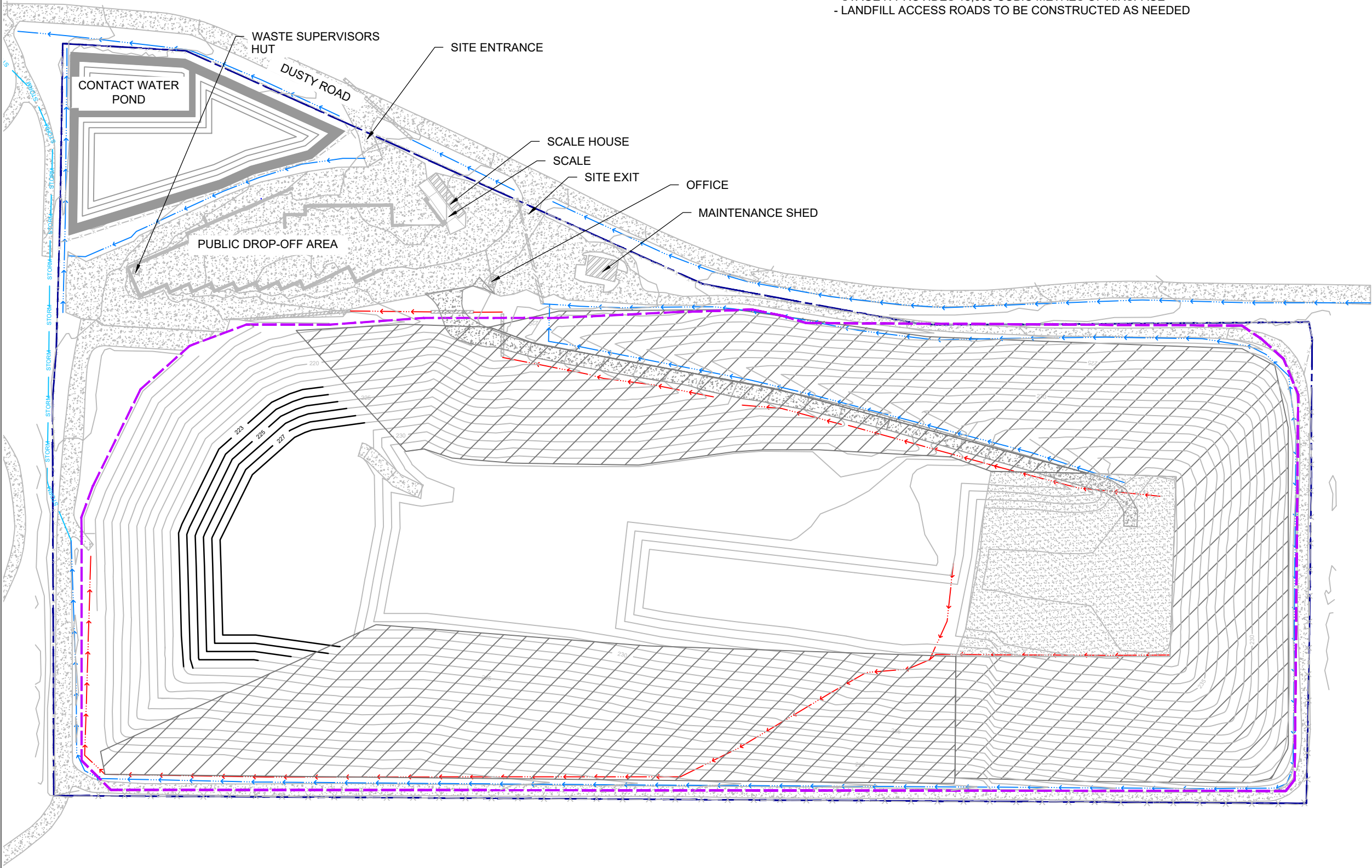
STAGE M



Date:	JUNE 2023	Location:	SECHELT, B.C.	Rev.	1
Scale:	1 : 1500		4-2111-01-89	Sheet:	C-08

STAGE N NOTES:

- PLACE WASTE IN THE AREA OF THE FORMER CONTACT WATER POND
- STAGE N TO BE FILLED TO ELEVATION OF 228 METRES AMSL
- STAGE N PROVIDES 18,000 CUBIC METRES OF AIRSPACE
- LANDFILL ACCESS ROADS TO BE CONSTRUCTED AS NEEDED



LEGEND

- PROPERTY BOUNDARY
- APPROXIMATE LIMIT OF WASTE
- APPROXIMATE FENCE LINE
- EXISTING CONTOURS
- EXISTING GRAVEL ROAD
- EXISTING BUILDING
- EXISTING FINAL COVER
- EXISTING CULVERT
- EXISTING SURFACE WATERCOURSE
- EXISTING CONTACT WATERCOURSE
- EXISTING TARPED AREA
- EXISTING STORMWATER GRAVITY MAIN

REVISIONS			
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DESIGN, OPERATIONS AND CLOSURE PLAN

SECHELT LANDFILL

SUNSHINE COAST REGIONAL DISTRICT

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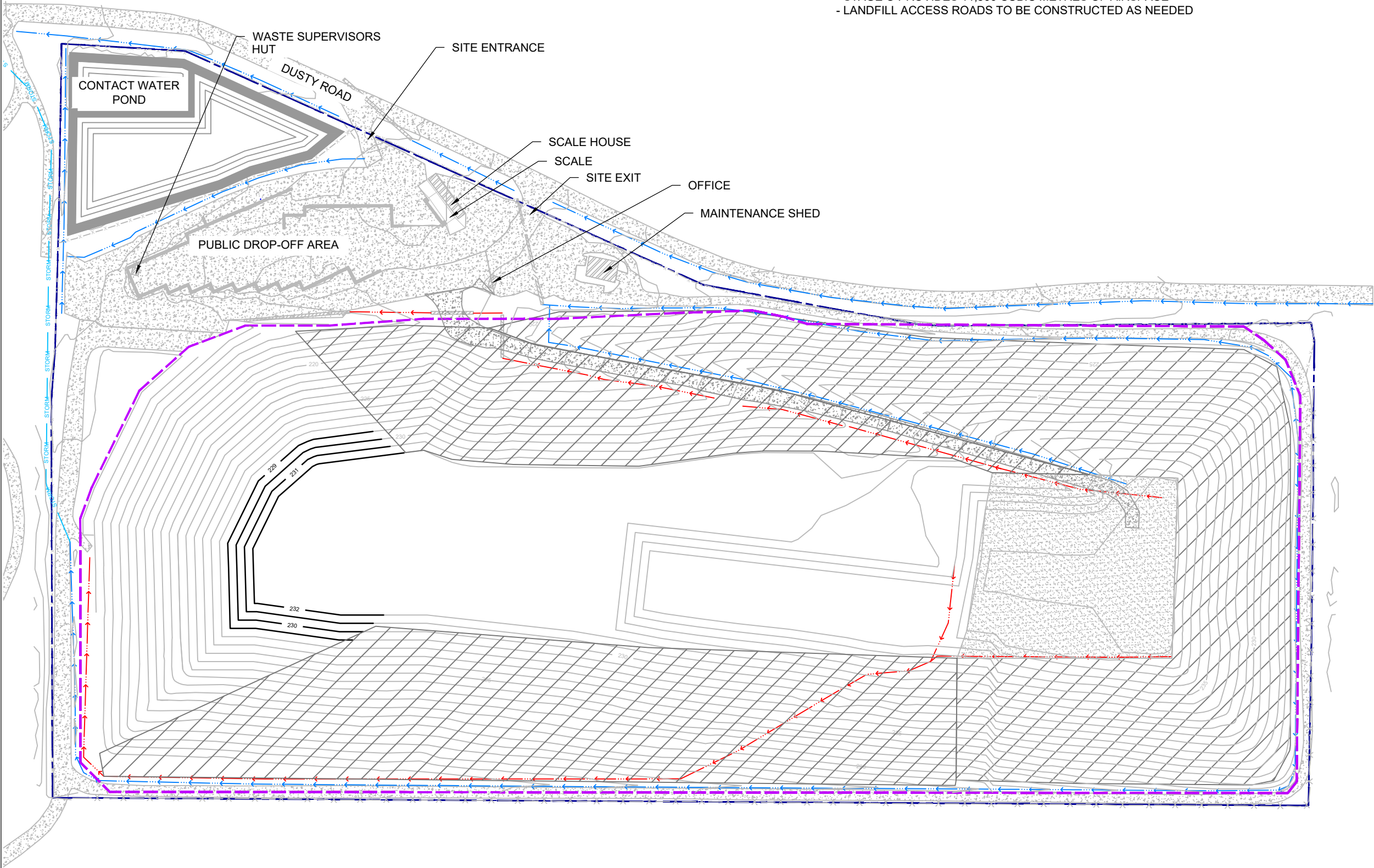
STAGE N



Date:	JUNE 2023	Location:	SECHELT, B.C.	Rev.	1
Scale:	1 : 1500		4-2111-01-89	Sheet:	C-09

STAGE O NOTES:

- PLACE WASTE IN THE AREA OF THE FORMER CONTACT WATER POND
- STAGE O TO BE FILLED TO ELEVATION OF 235 METRES AMSL
- STAGE O PROVIDES 11,500 CUBIC METRES OF AIRSPACE
- LANDFILL ACCESS ROADS TO BE CONSTRUCTED AS NEEDED



LEGEND

- PROPERTY BOUNDARY
- APPROXIMATE LIMIT OF WASTE
- APPROXIMATE FENCE LINE
- EXISTING CONTOURS
- EXISTING GRAVEL ROAD
- EXISTING BUILDING
- EXISTING FINAL COVER
- EXISTING CULVERT
- EXISTING SURFACE WATERCOURSE
- EXISTING CONTACT WATERCOURSE
- EXISTING TARPED AREA
- EXISTING STORMWATER GRAVITY MAIN

REVISIONS			
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DESIGN, OPERATIONS AND CLOSURE PLAN

SECHELT LANDFILL

SUNSHINE COAST REGIONAL DISTRICT

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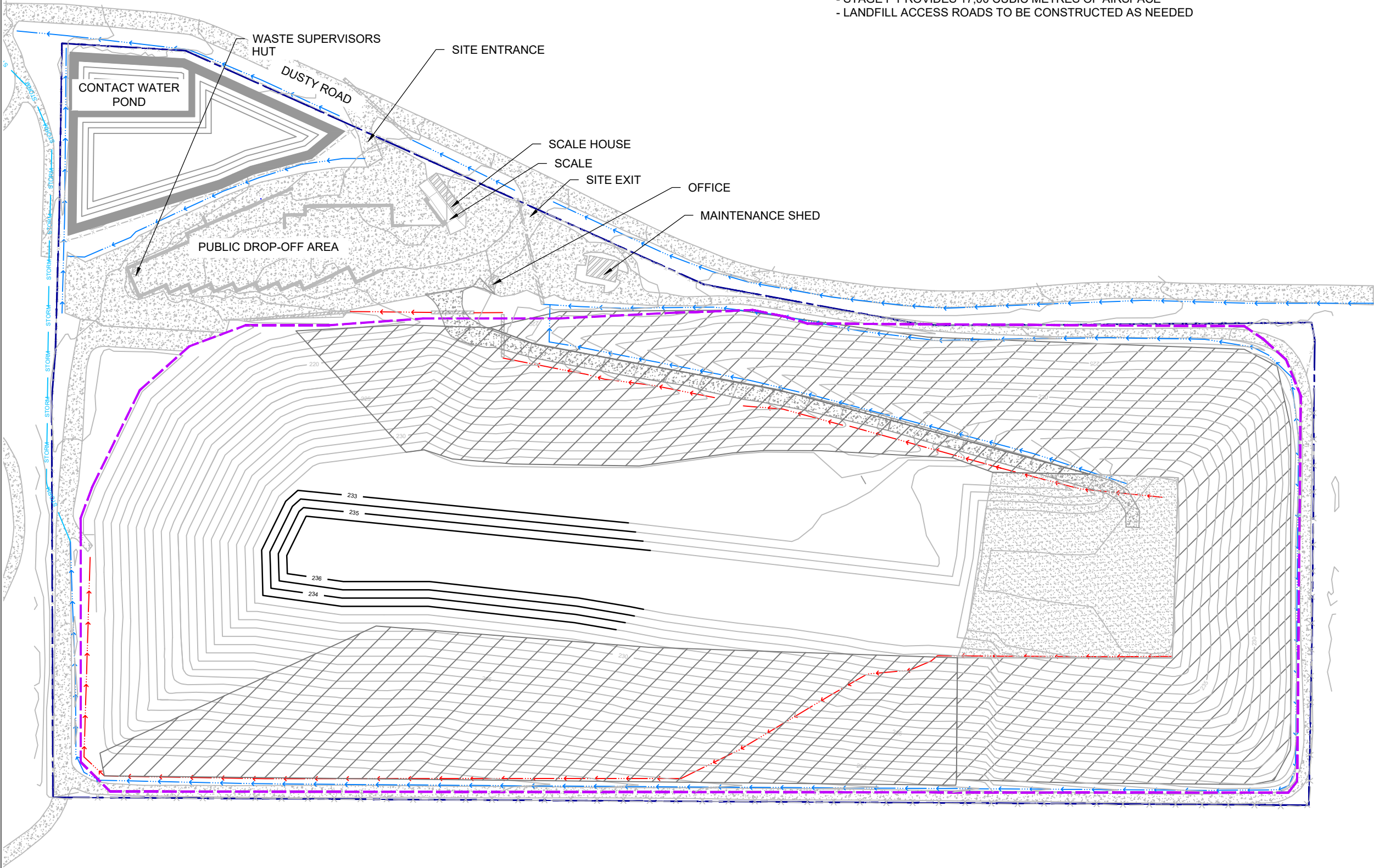
STAGE O



Date:	JUNE 2023	Location:	SECHELT, B.C.	Rev.	1
Scale:	1 : 1500		4-2111-01-89	Sheet:	C-10

STAGE P NOTES:

- PLACE WASTE ALONG THE SOUTH SIDE OF THE TOP OF THE LANDFILL
- STAGE P TO BE FILLED TO ELEVATION OF 236 METRES AMSL
- STAGE P PROVIDES 17,00 CUBIC METRES OF AIRSPACE
- LANDFILL ACCESS ROADS TO BE CONSTRUCTED AS NEEDED



LEGEND

- PROPERTY BOUNDARY
- APPROXIMATE LIMIT OF WASTE
- APPROXIMATE FENCE LINE
- EXISTING CONTOURS
- EXISTING GRAVEL ROAD
- EXISTING BUILDING
- EXISTING FINAL COVER
- EXISTING CULVERT
- EXISTING SURFACE WATERCOURSE
- EXISTING CONTACT WATERCOURSE
- EXISTING TARPED AREA
- EXISTING STORMWATER GRAVITY MAIN

REVISIONS			
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DESIGN, OPERATIONS AND CLOSURE PLAN

SECHELT LANDFILL

SUNSHINE COAST REGIONAL DISTRICT

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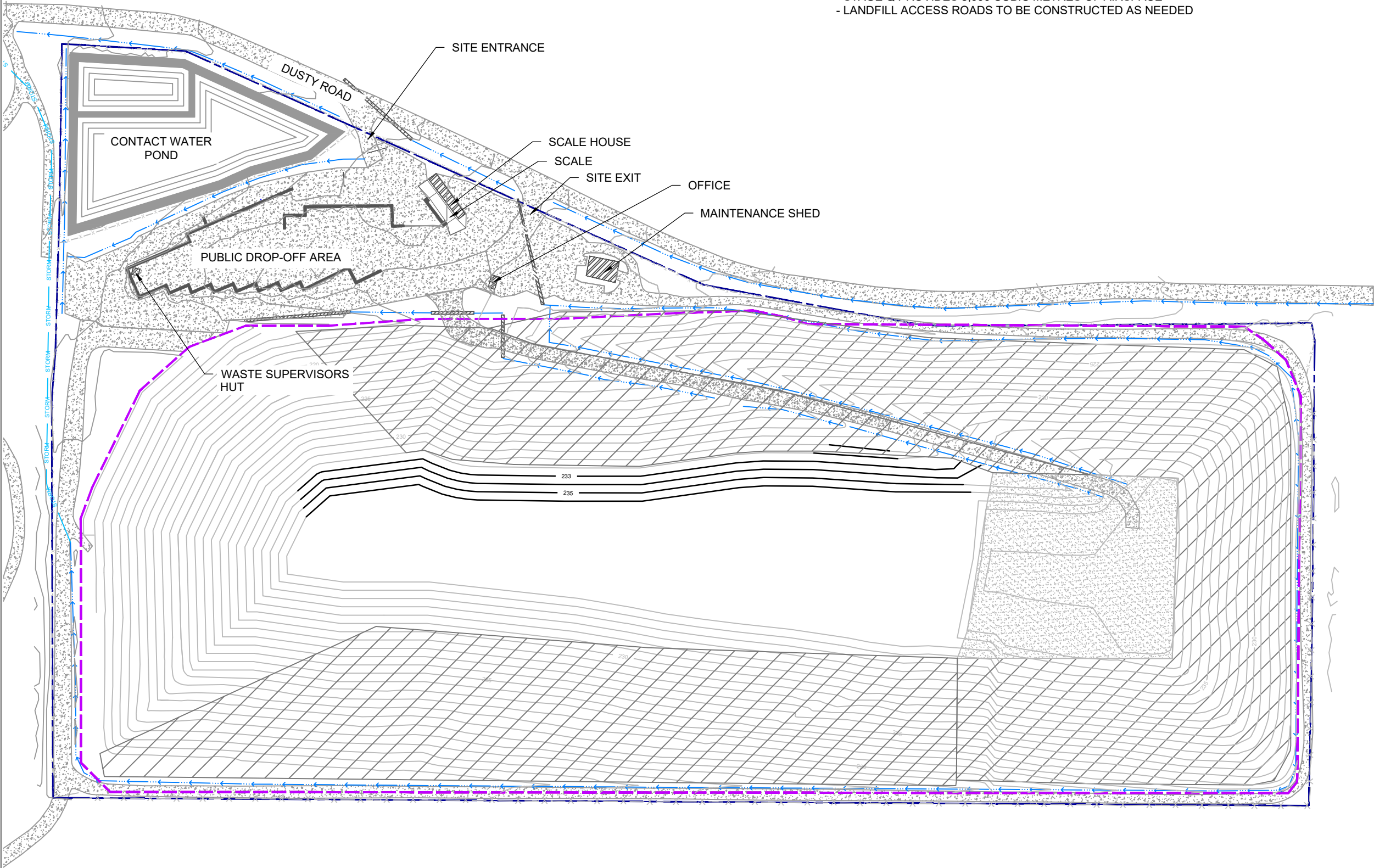
STAGE P



Date:	JUNE 2023	Location:	SECHELT, B.C.	Rev.	1
Scale:	1 : 1500		4-2111-01-89	Sheet:	C-11

STAGE Q NOTES:

- PLACE WASTE ALONG THE NORTH SIDE OF THE TOP OF THE LANDFILL
- STAGE Q TO BE FILLED TO ELEVATION OF 236 METRES AMSL
- STAGE Q PROVIDES 8,000 CUBIC METRES OF AIRSPACE
- LANDFILL ACCESS ROADS TO BE CONSTRUCTED AS NEEDED



LEGEND

- PROPERTY BOUNDARY
- APPROXIMATE LIMIT OF WASTE
- APPROXIMATE FENCE LINE
- EXISTING CONTOURS
- EXISTING GRAVEL ROAD
- EXISTING BUILDING
- EXISTING FINAL COVER
- EXISTING CULVERT
- EXISTING SURFACE WATERCOURSE
- EXISTING CONTACT WATERCOURSE
- EXISTING TARPED AREA
- EXISTING STORMWATER GRAVITY MAIN

REVISIONS			
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DESIGN, OPERATIONS AND CLOSURE PLAN

SECHELT LANDFILL

SUNSHINE COAST REGIONAL DISTRICT

VERIFY SCALE

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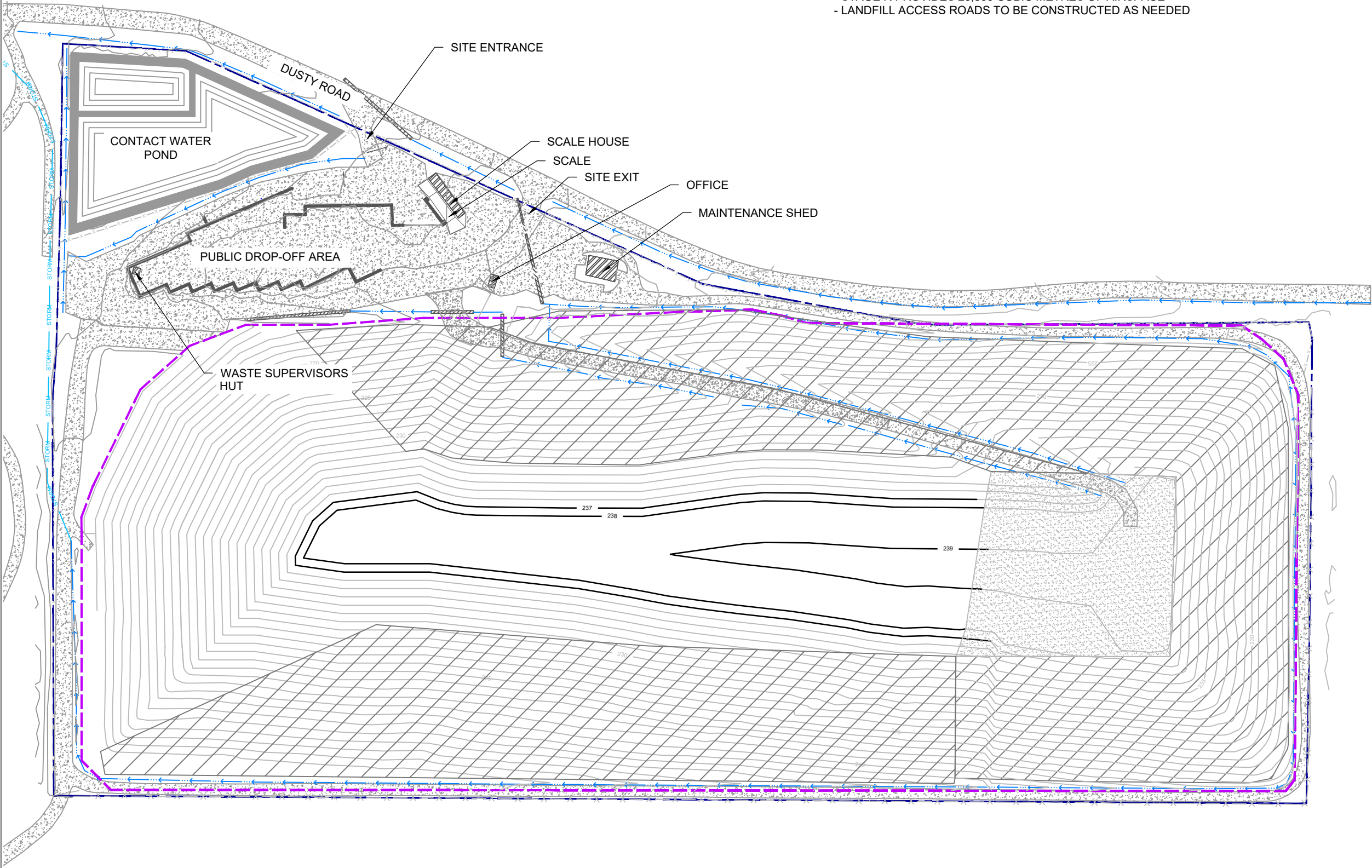
STAGE Q



Date:	JUNE 2023	Location:	SECHELT, B.C.	Rev.	1
Scale:	1 : 1500		4-2111-01-89	Sheet:	C-12

STAGE R NOTES:

- PLACE WASTE ON THE ENTIRE OF THE TOP OF THE LANDFILL
- STAGE R TO BE FILLED TO ELEVATION OF 239 METRES AMSL
- STAGE R PROVIDES 20,500 CUBIC METRES OF AIRSPACE
- LANDFILL ACCESS ROADS TO BE CONSTRUCTED AS NEEDED



LEGEND

- PROPERTY BOUNDARY
- APPROXIMATE LIMIT OF WASTE
- APPROXIMATE FENCE LINE
- EXISTING CONTOURS
- EXISTING GRAVEL ROAD
- EXISTING BUILDING
- EXISTING FINAL COVER
- EXISTING CULVERT
- EXISTING SURFACE WATERCOURSE
- EXISTING CONTACT WATERCOURSE
- EXISTING TARPED AREA
- EXISTING STORMWATER GRAVITY MAIN

REVISIONS			
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DESIGN, OPERATIONS AND CLOSURE PLAN

SECHELT LANDFILL

SUNSHINE COAST REGIONAL DISTRICT

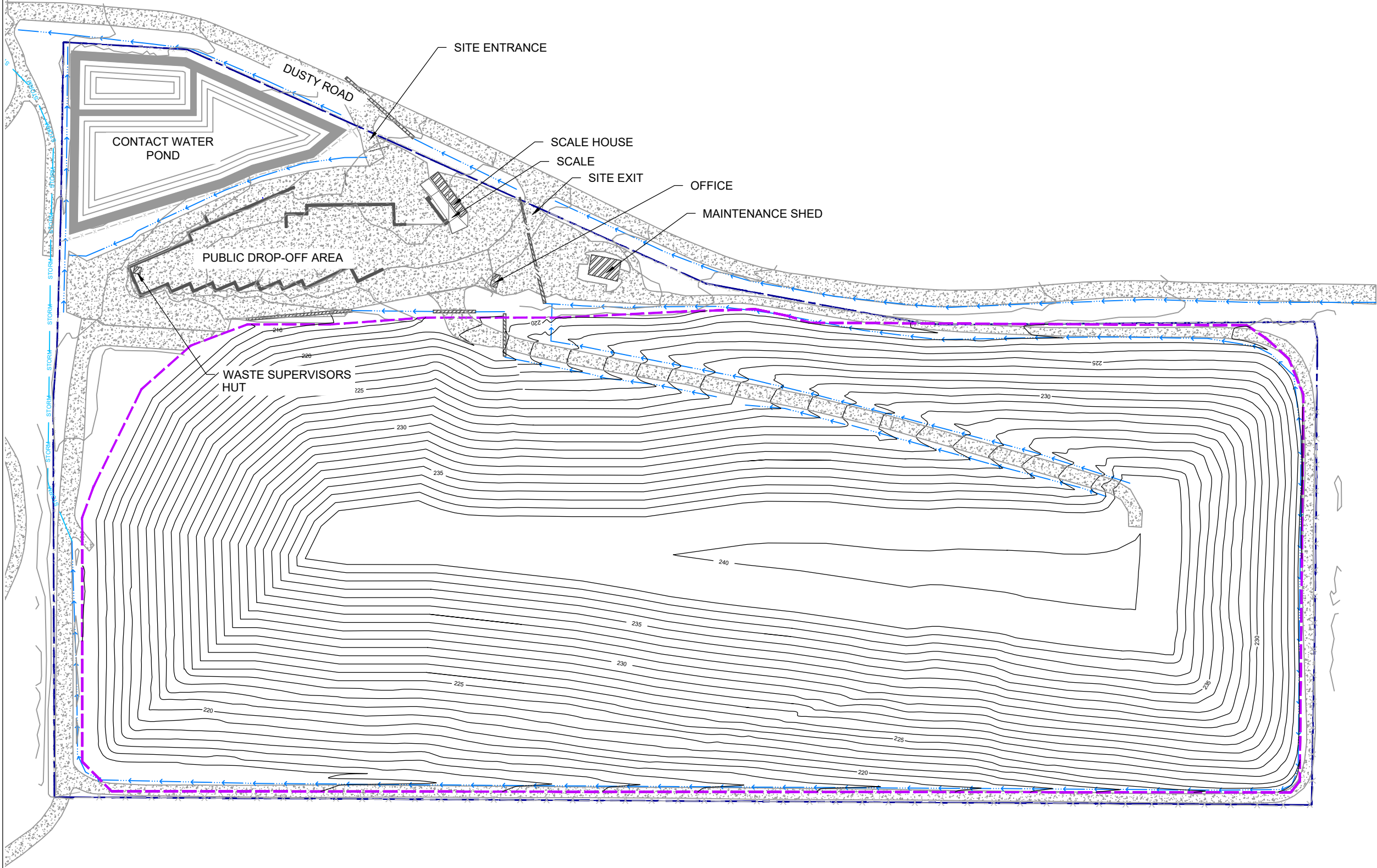
VERIFY SCALE

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STAGE R



Date:	JUNE 2023	Location:	SECHELT, B.C.	Rev.	1
Scale:	1 : 1500		4-2111-01-89	Sheet:	C-13



- LEGEND**
- — — — — PROPERTY BOUNDARY
 - - - - - APPROXIMATE LIMIT OF WASTE
 - x - x - x - x - x - APPROXIMATE FENCE LINE
 - EXISTING CONTOURS
 - EXISTING GRAVEL ROAD
 - EXISTING BUILDING
 - EXISTING FINAL COVER
 - EXISTING CULVERT
 - EXISTING SURFACE WATERCOURSE
 - EXISTING CONTACT WATERCOURSE
 - EXISTING TARPED AREA
 - STORM — STORM — EXISTING STORMWATER GRAVITY MAIN

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
0	ISSUED FOR REVIEW	JUNE 2023	TAM
1	ISSUED FINAL	JUNE 2023	TJK

DESIGN, OPERATIONS AND CLOSURE PLAN

SECHELT LANDFILL

SUNSHINE COAST REGIONAL DISTRICT

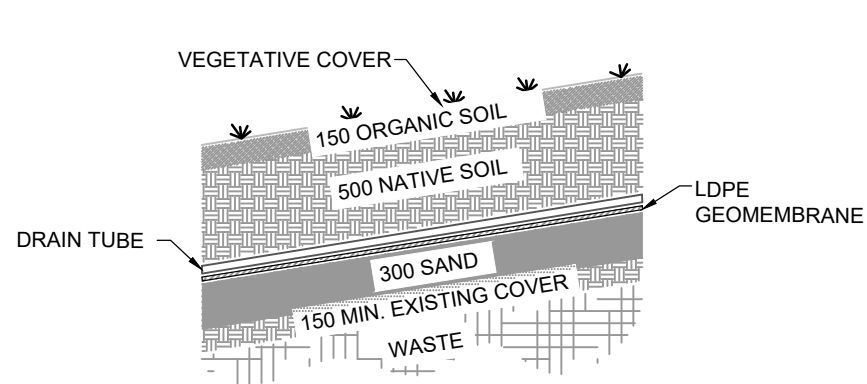
VERIFY SCALE

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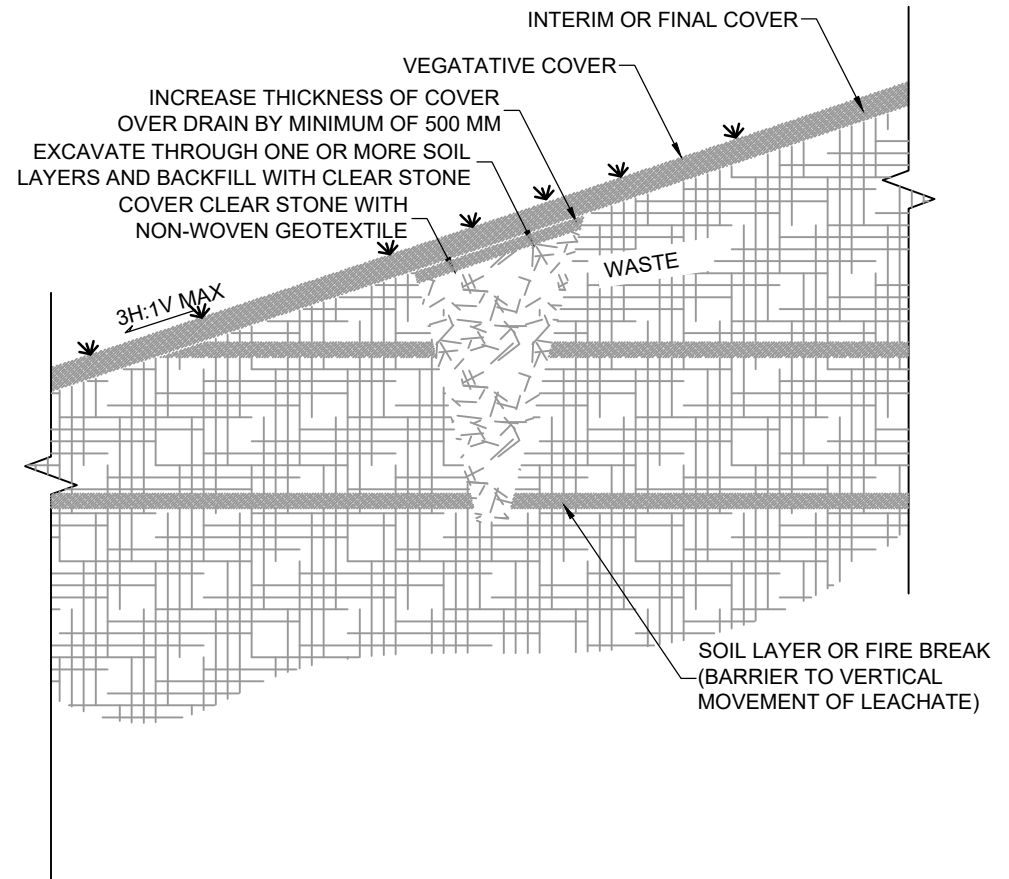
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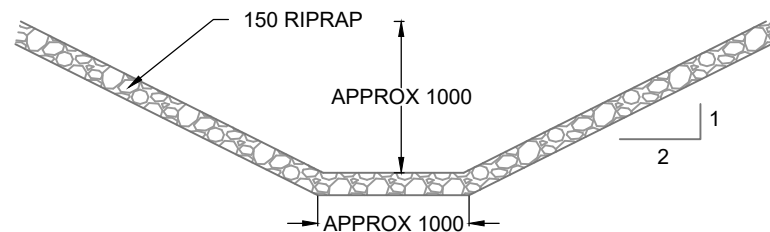
Date:	JUNE 2023	Location:	SECHELT, B.C.	Rev.	1
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DETAIL 1 FINAL COVER
N.T.S. C-06/C-14



DETAIL 2 LEACHATE SEEPAGE REPAIR
N.T.S.



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

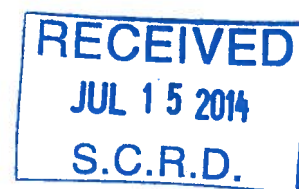
REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
0	ISSUED FOR REVIEW	JUNE 2023	TAM
1	ISSUED FINAL	JUNE 2023	TJK

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

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	Date: JUNE 2023	Location: SECHELT, B.C.	Rev. 1
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APPENDIX A
OPERATING CERTIFICATE 106060



July 8, 2014

Tracking Number: 243546
Authorization Number: 106060

REGISTERED MAIL

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

MASTER FILE COPY

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

RECEIVED

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



**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



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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 off 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



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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.

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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.

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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.

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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



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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.

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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



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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_manual_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



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- 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.

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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**

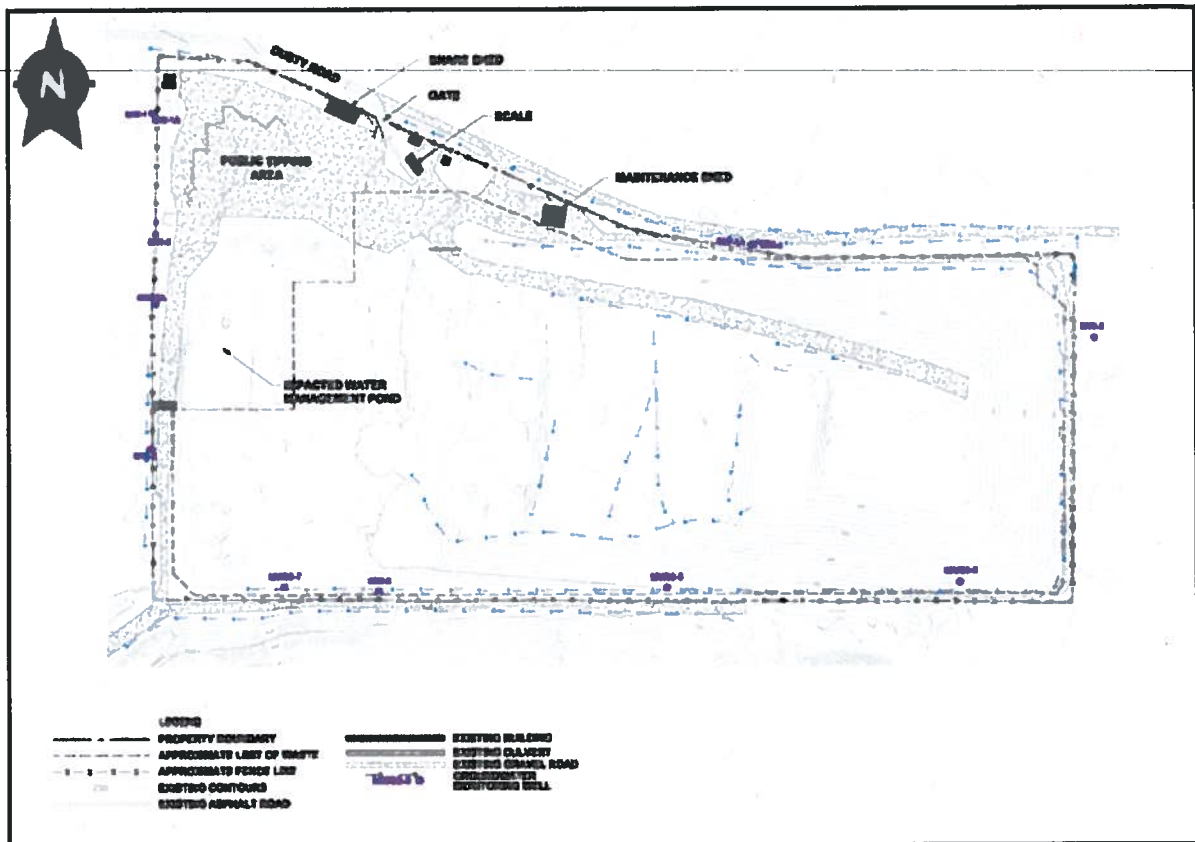
In accordance with Section 40 of the *Environmental Management Act* and Part 2 of the Contaminated Sites Regulation, the operational certificate holder must submit a site profile to the Director not less than 10 days prior to decommissioning the facilities authorized in Section 1.

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for Director, *Environmental Management Act*
South Coast Region

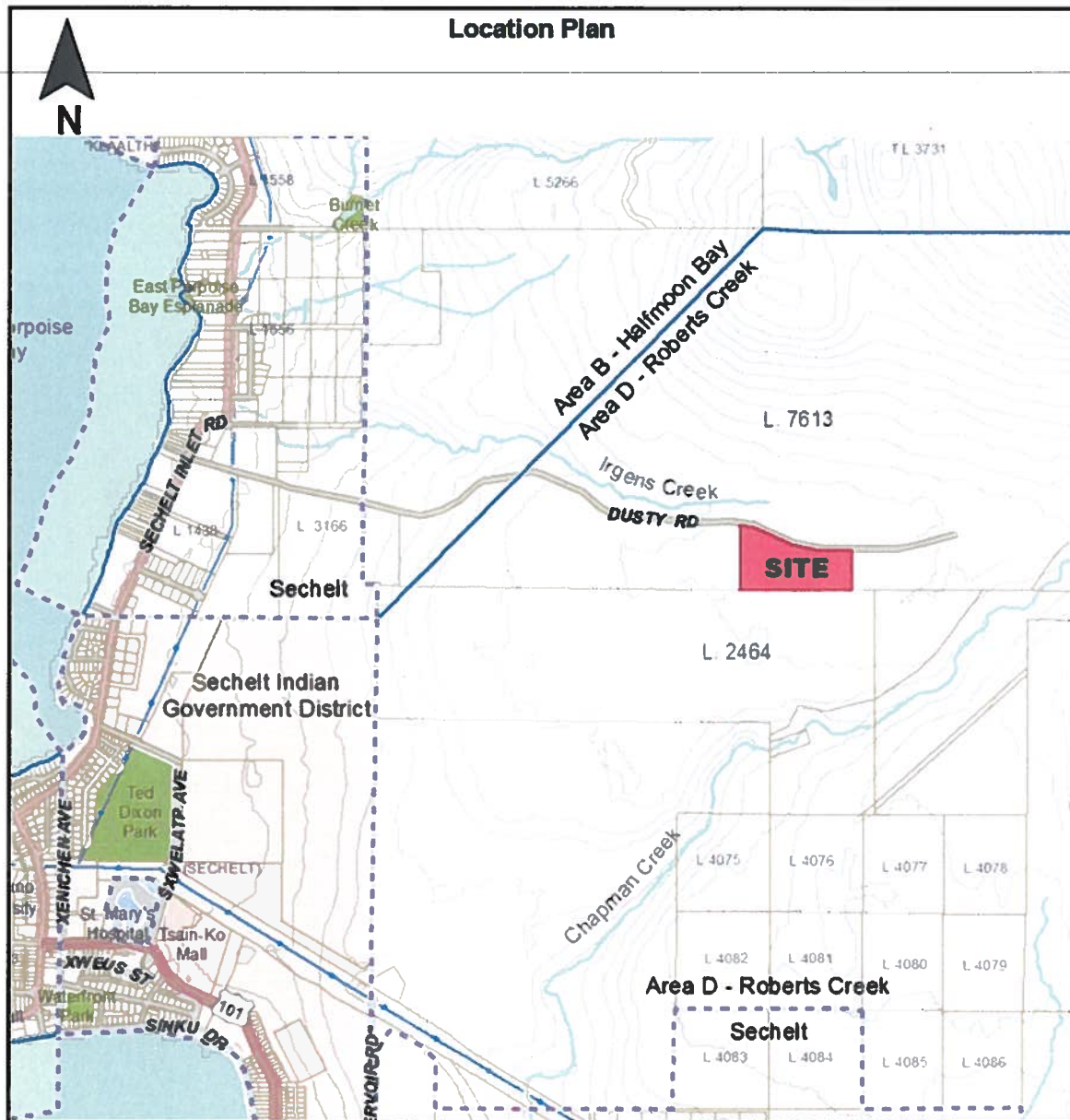
SITE PLAN A



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South Coast Region

SITE PLAN B



Date issued: July 8, 2014

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for Director, *Environmental Management Act*
South Coast Region



APPENDIX B
BRAUN GEOTECHNICAL REPORT

***Foundations,
Excavation &
Shoring
Specialists***

Braun Geotechnical
106A -9785 192 St.
Surrey, BC V4N 4C7
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***



May 24, 2018

Our File: 18-7659

Via email: chloe.stone@xcg.com

XCG Consulting Limited

10455 84th Avenue
Edmonton, Alberta
T6E 2H3

Attention: Chloe Stone, B.Sc., P.Eng.

**Re: Stability Assessment-Sechelt Landfill
4901 Dusty Road, Sechelt, BC
MSW Slope Stability Assessment**

1.0 INTRODUCTION

The study site is located at 4901 Dusty Road, Sechelt, BC and is an active landfill. Current site grades within the areas proposed for Municipal Solid Waste (MSW) generally range from approximately El. 213m to 240m. Based on the "Design, Operations, and Closure Plan Drawings" provided by XCG Consulting Limited (XCG), it is understood that MSW mass is to extend up to a maximum elevation of approximately El. 240m. MSW placement is to occur in stages over an area of approximately 470x180m as indicated in the XCG drawings. The side slopes of the MSW mass are to be inclined at 3H:1V (Horizontal to Vertical) or flatter.

It is understood that the final cover has already been placed on the east part of the landfill. It is understood that a base liner is not present below the existing MSW mass, and would not be installed below future phases.

The geotechnical work scope included review of the available geotechnical data, site characterization, development of geotechnical design parameters, completion of Limit Equilibrium slope stability analyses, and provision of preliminary comments and recommendations pertaining to geotechnical slope stability of the proposed MSW mass configuration.

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

2.0 AVAILABLE INFORMATION

The following information was provided by XCG and reviewed for this stage of work:

- Design, Operations and Closure Plan Drawings by XCG dated Dec. 2017
- Borehole Logs and Report by DAYTON & KNIGHT Ltd. dated July. 1993
- Monitoring Wells Construction Program by PITEAU ASSOCIATES dated Feb. 1997 & Dec. 1999
- Monitoring Well Logs by XCG dated Sep. 2013 & Aug. 2017
- Sechelt Landfill Slope Stability Assessment by Braun Geotechnical dated April 18, 2013

3.0 GEOTECHNICAL SITE CHARACTERIZATION

Based on available geotechnical data obtained during monitoring well installation programs by Piteau Associates and XCG, the proposed footprint of the MSW mass is expected to be underlain by variable sand and gravel. Geotechnical information provided by XCG indicates that a thin layer of relatively shallow intermittent silt till is present at an approximate elevation of 190m amsl. Bedrock is present below an elevation of approximately 155m. Due to their relatively deep depth, the till and bedrock are not considered to impact the results of the slope stability assessment.

Available geotechnical information by XCG indicates that perched water is present above the silt till. The groundwater elevation varies from approximately El. 197 to 210m. The bedrock aquifer water level is at approximately El. 189m, just below the silt till layer.

4.0 MATERIAL PROPERTIES

The assumed material properties used in the limit equilibrium slope stability analyses are discussed below.

Sand and Gravel

Variable compact to dense sand and gravel soils were encountered within monitoring wells installed in the vicinity of the landfill. A friction angle of 36 degree and unit weight of 20kN/m³ were assumed for the assessment.

Silt Till

It has been assumed that the silt till layer at approximately El. 189m possesses infinite strength for use within the slope stability analysis. Due to the considerable depth to this layer, this assumption is not considered to impact the results of the analysis.

Municipal Solid Waste

MSW material was modelled adopting a cohesion intercept (c) of 15 kPa and a stress dependent friction angle ϕ_σ obtained from the following empirical correlation developed by Bray et al (2009). According to Bray, MSW should be considered an anisotropic mass (i.e. strength properties vary with direction). The recommended shear strength is for the weakest plane.

$$\phi_\sigma = \phi_o - \Delta\phi \cdot \log(\sigma_v / 100)$$

Where

ϕ_o = 36 deg, internal friction angle at an effective vertical stress of 100 kPa

$\Delta\phi$ = 5 deg

σ_v = effective vertical stress in kPa

Assuming a maximum effective vertical stress within the MSW mass of approximately 300 kPa, a friction angle of 33.6 degrees was calculated. Accordingly, a design friction angle of 33.6 degrees and cohesion of 15kPa were assumed in the slope stability analysis.

An average unit weight of 1.14 T/m³ (11.2kN/m³) was adopted based on the information provided by XCG.

5.0 SEISMIC CONDITIONS

It is understood that the 1:475 year return period earthquake (10% probability of exceedance in 50 years) using NBC 2015 is to be considered for this project as the design earthquake. Seismic hazard calculation information was obtained from National Resources Canada (NRC), and is attached. Based on the above, a design PGA of 0.179g was used.

6.0 SLOPE STABILITY ANALYSIS

6.1 General

The purpose of the slope stability assessment was to evaluate the stability of the proposed interim and final grades of the MSW mass for static and seismic loading conditions. The slope assessment was based on the available site information and findings from the site exploration work by others, as well as on parameters and geometry information provided by XCG.

Slope stability analyses were performed using the two dimensional limit equilibrium software SLIDE 8.0 developed by Rocscience. The Morgenstern-Price method, which satisfies force and moment equilibrium, was utilized.

Static and pseudo-static analyses were completed to model both static and seismic loading conditions.

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. Typically, a pseudo-static factor of safety greater than 1.0 indicates that significant movements will not occur under seismic loading conditions. A pseudo-static factor of safety less than 1.0 typically requires estimation of seismically induced displacements.

A minimum factor of safety of 1.3 has been adopted for this assessment. Further, the seismic hazard probability with a 10% probability of exceedance in 50 years (~1:475 return period) has been adopted in the seismic slope stability assessment as indicated above.

6.2 Results of Slope Stability Analysis

The results of selected analyses are attached in graphical form. The location of the section analyzed is shown on the attached section plan (Dwg.18-7659-01).

The calculated factors of safety for the MSW mass for static and pseudo-static loading conditions are 3.0 and 1.9, respectively. These values are considered satisfactory for geotechnical considerations.

The above factors of safety were calculated for the final landfill configuration. The internal friction angle of MSW decreases with increasing vertical stress. Further, the overall slope height and average slope angle are expected to increase to the final stage of filling. As such, the calculated factors of safety for the current MSW mass configuration are expected to be greater than the final configuration.

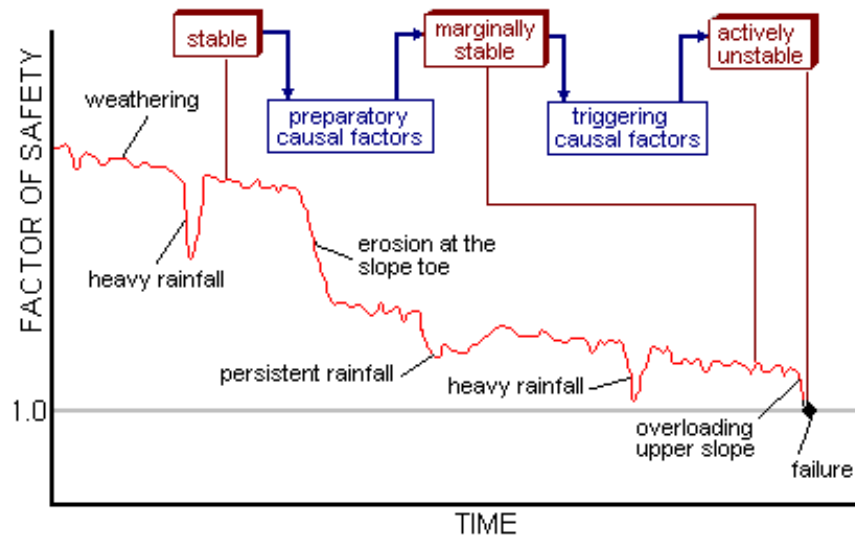
7.0 DISCUSSIONS ON SLOPE STABILITY

Limit equilibrium slope stability analysis assumes a rigid body for the sliding mass. It also assumes the FoS is constant along the slip surface. These simplifying assumptions may lead to considerable approximation/inaccuracies. However, the limit equilibrium method is the state of practice for simplified analysis and low consequence structures.

Factor of Safety Discussion

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
- 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 drought, disease or fire.
- MSW decomposition

8.0 SETTLEMENTS

Based on reference information provided by XCG previously, typical average settlement of the waste mass of 11 percent of the overall depth can be expected (McBean et al, 1995). Settlement of the underlying natural subgrade soils over time is anticipated to be negligible relative to settlements typically experienced in MSW.

Settlement is expected to improve stability of the MSW slopes. In the case of uniform settlement, the unit weight of the MSW increases and thickness decreases, thus improving stability as the MSW mass ages. Note that for non-uniform settlement, there may be a tendency to promote infiltration of surface water into the MSW mass and potentially increase porewater pressures resulting in decreased stability.

9.0 BEARING CAPACITY

Soils comprising compact to dense sand and gravel are present immediately below the proposed and existing MSW mass. The bearing capacity of the subgrade soils is considered suitable for the proposed increases in vertical stresses imposed by the design addition of MSW.

10.0 CLOSURE


This report is prepared for the exclusive use of XCG Consulting Limited 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 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.

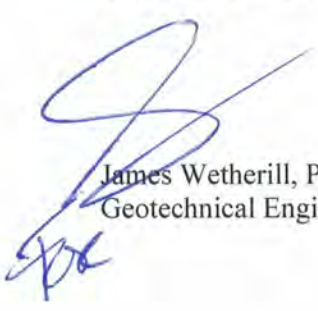
Yours truly,

Braun Geotechnical Ltd.


Sonny Singha, P.Eng.
Geotechnical Engineer



Braun Geotechnical Ltd.


James Wetherill, P.Eng.
Geotechnical Engineer

Encl: Report Interpretation and Limitation
Section Plan
Select SLIDE Output (2)
NBC 2015 Seismic Hazard Calculation

REFERENCES

McBean, E.A., F.A. Rovers, and G.J. Farquhar. Solid Waste Landfill Engineering and Design, New Jersey: Prentice Hall, 1995

J. D. Bray, D. Zekkos, E. Kavazanjian, G.A. Athanasopoulos, and M.F. Riemer, Shear Strength of Municipal Solid Waste, Journal of Geotechnical and Geoenvironmental Engineering, June 2009

Slide 8.0 by RocScience

X:\2018 Projects\18-7659 Seismic Assessment for Sechelt Landfill\Report 18-7659 2018-05-24.docx

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 as 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.

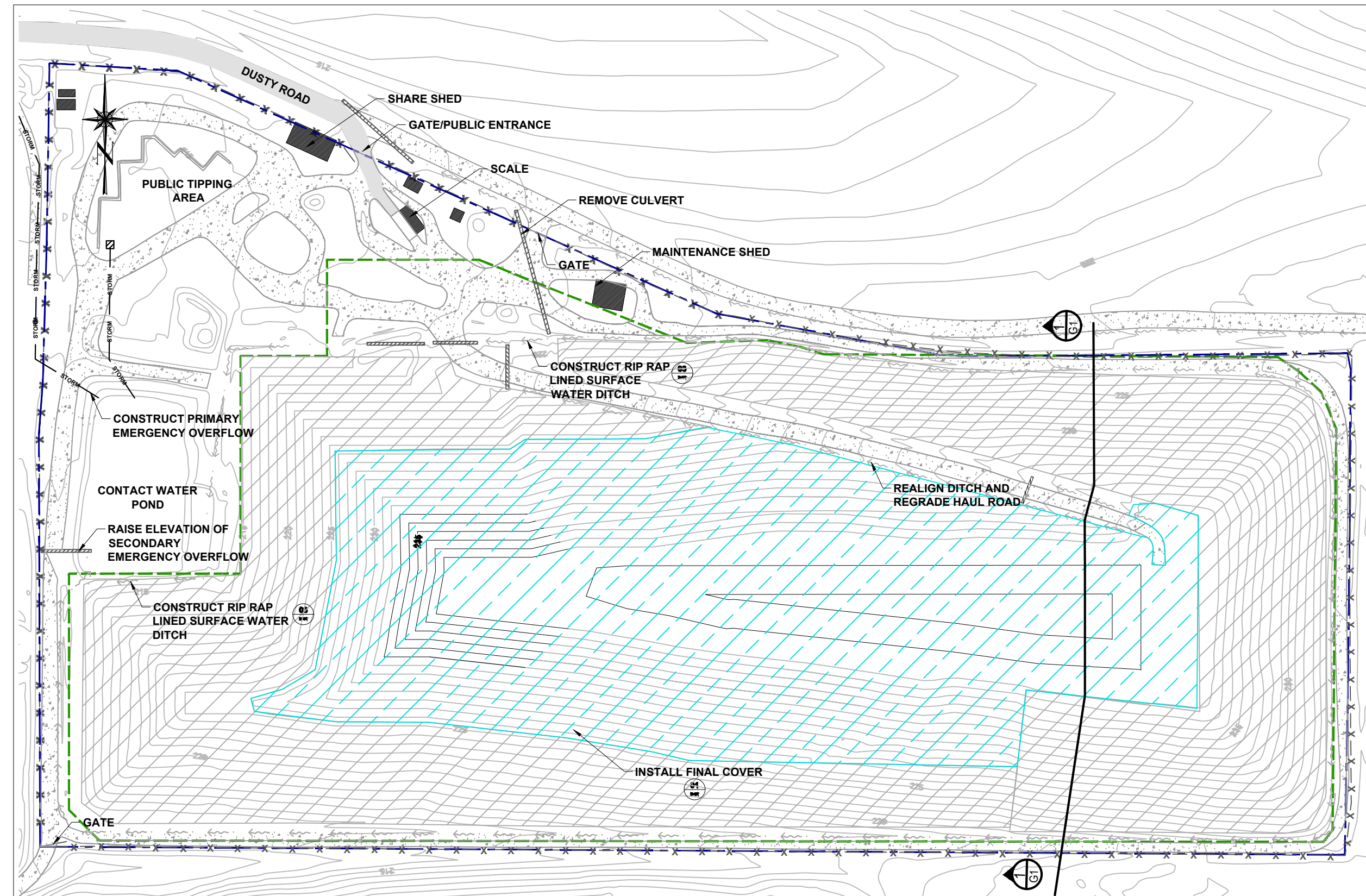
8. SUBCONSULTANTS AND CONTRACTORS

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.



- LEGEND**
- PROPERTY BOUNDARY
 - APPROXIMATE LIMIT OF WAST
 - 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
 - PROPOSED FINAL COVER

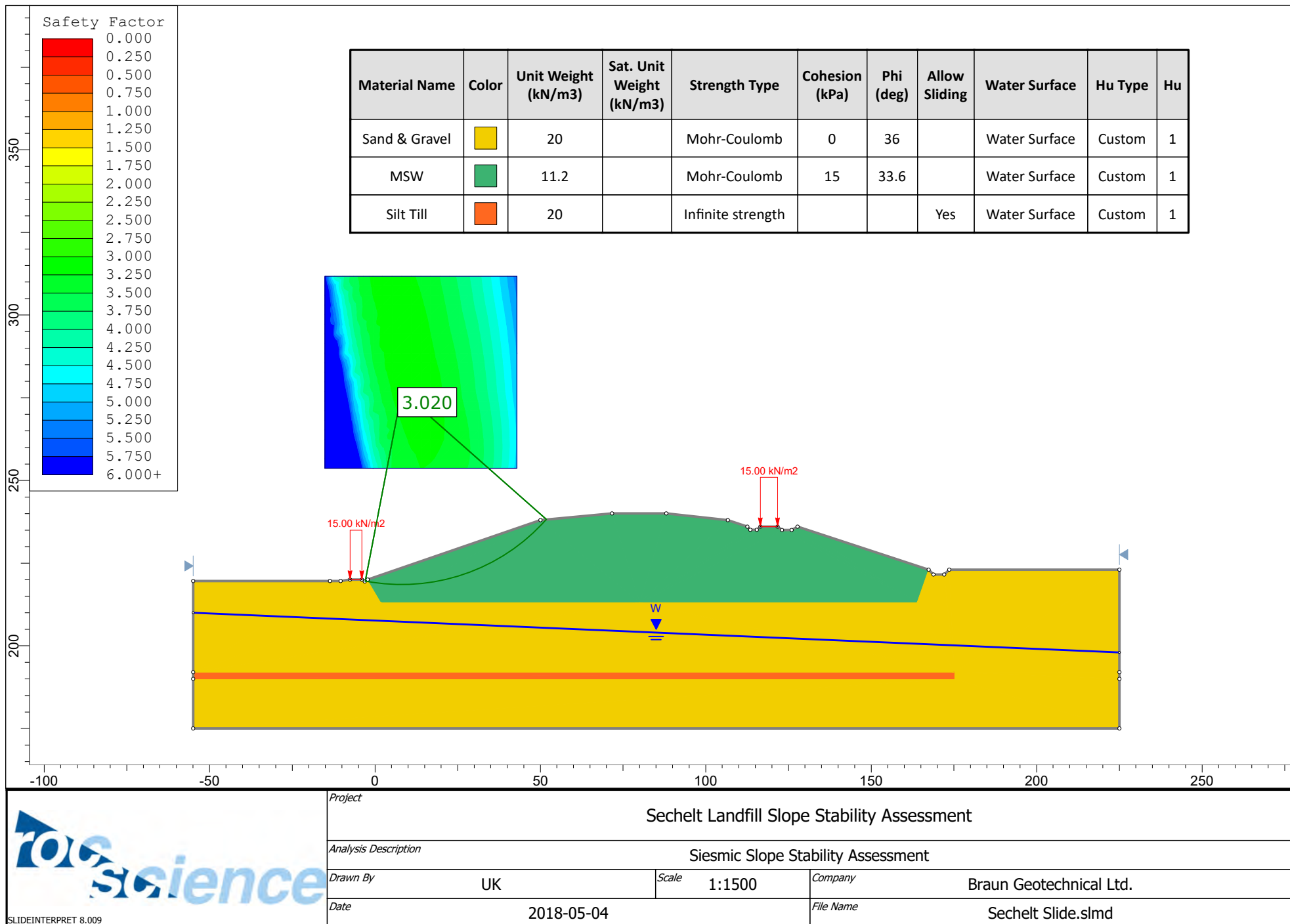
NOTES: EXISTING CONDITIONS AS OF DECEMBER 4, 2016.
BASE IMAGE OBTAINED FROM: XCG CONSULTANTS

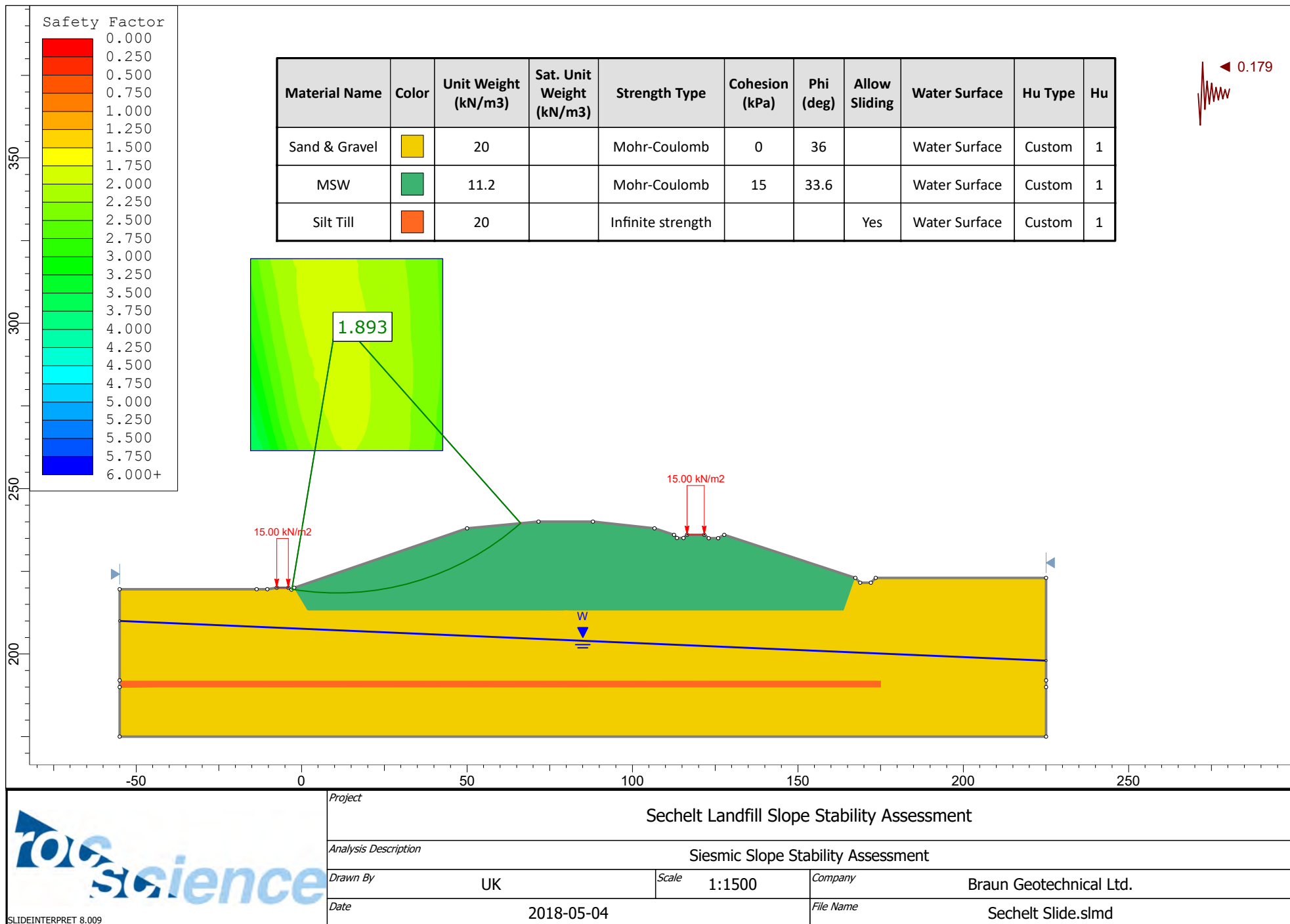


Rev.	Description	Date

Client	XCG Consultants		
Project	Disposal and Landfill Facility, Sechelt, BC 4901 Dusty Road, Sechelt, BC		
Project no.	18-7659	Drawn	UK
		Design	SS
		Checked	JW

Title		LOCATION PLAN		
Date	April 20, 2018	Scale	1:1500	Drawing no.
				18-7659-01





2015 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

May 04, 2018

Site: 49.4742 N, 123.7546 W User File Reference:

Requested by: ,

National Building Code ground motions: 2% probability of exceedance in 50 years (0.000404 per annum)

Sa(0.05)	Sa(0.1)	Sa(0.2)	Sa(0.3)	Sa(0.5)	Sa(1.0)	Sa(2.0)	Sa(5.0)	Sa(10.0)	PGA (g)	PGV (m/s)
0.432	0.658	0.815	0.824	0.735	0.427	0.261	0.085	0.030	0.356	0.546

Notes. Spectral ($S_a(T)$, where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s . Values are for "firm ground" (NBCC 2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are specified in **bold** font. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. *These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.*

Ground motions for other probabilities:

Probability of exceedance per annum	0.010	0.0021	0.001
Probability of exceedance in 50 years	40%	10%	5%
Sa(0.05)	0.091	0.213	0.298
Sa(0.1)	0.139	0.327	0.456
Sa(0.2)	0.174	0.410	0.571
Sa(0.3)	0.175	0.417	0.580
Sa(0.5)	0.144	0.362	0.510
Sa(1.0)	0.074	0.197	0.288
Sa(2.0)	0.040	0.113	0.171
Sa(5.0)	0.0094	0.029	0.049
Sa(10.0)	0.0035	0.010	0.017
PGA	0.075	0.179	0.250
PGV	0.090	0.251	0.368

References

National Building Code of Canada 2015 NRCC no. 56190;
Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

User's Guide - NBC 2015, Structural Commentaries NRCC no. xxxxxx (in preparation)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

See the websites www.EarthquakesCanada.ca and www.nationalcodes.ca for more information

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APPENDIX C
HYDROLOGIC MODEL DATA

Table C1 Subcatchment Parameters

Subcatchment	Area (ha)	Flow Length (metres)	Slope (m/m)	Impervious Area (%)
Existing Conditions				
101	1.26	57	0.03	4
102	1.41	65	0.33	13
103	1.30	90	0.03	15
104	4.90	100	0.20	0
105	0.52	58	0.20	0
Post-Development Conditions				
201	4.30	100	20.00	0
101	0.31	60	0.03	0
102	1.10	80	0.33	0
103	3.69	85	0.33	0



Table C2 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
204	C	Newly Graded		0.1	91
205	C	Newly Graded		0.1	91
Post-Development Conditions					
201	C	Newly Graded		0.1	91
101	C	Grassland	Good	0.4	74
102	C	Grassland	Good	0.4	74
103	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 C3 Design Storm Events - Runoff Volumes (m^3)

Subcatchment	1:5 (24hr)	1:10 (24hr)	1:100 (24hr)
Existing Conditions			
101	543	593	787
102	629	686	903
103	582	635	837
104	2091	2288	3038
105	222	243	322
Total	4067	4445	5887
Post-Development Conditions			
201	1835	2431	2666
101	131	174	191
102	224	331	375
103	752	1111	1260
Total	2942	4047	4492



Table C4 Design Storm Events - Peak Discharge (m^3/s)

Subcatchment	1:5 (24hr)	1:10 (24hr)	1:100 (24hr)
Existing Conditions			
101	0.0470	0.0560	0.0950
102	0.0670	0.0720	0.1170
103	0.0420	0.0450	0.0740
104	0.2060	0.2470	0.4330
105	0.0250	0.0300	0.0470
Post-Development Conditions			
201	0.1810	0.2480	0.3800
101	0.0120	0.0160	0.0240
102	0.0290	0.0450	0.0470
103	0.0870	0.0970	0.1470



APPENDIX D
HELP MODEL DATA

Table D1 Infiltration Rate Summary

Cover Type	Model	Slope (%)	Infiltration Rate (mm/yr)
Existing Daily Cover	HELP	3%	463
Existing Daily Cover	HELP	12%	459
Existing Intermediate Cover	HELP	3%	448
Existing Intermediate Cover (Road)	HELP	8%	446
Existing Intermediate Cover	HELP	12%	432
Existing Intermediate Cover	HELP	33%	435
Proposed Final Cover (Evapotranspiration)	HELP	10%	1
Proposed Final Cover (Evapotranspiration)	HELP	33%	1
Note: 1. Hydrological Evaluation of Landfill Performance (HELP) Model (USEPA, 2020)			

Table D2 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	463	987
Existing Daily Cover (12%)	2,750	459	1,262
Existing Intermediate Cover (3%)	26,609	448	11,921
Intermediate Cover (Road) (8%)	1,533	446	684
Existing Intermediate Cover (12%)	2,276	432	983
Existing Intermediate Cover (33%)	18,660	435	8,117
Existing Final Cover (33%)	18,929	1	19
	72,889		23,973
Stage H			
Existing Intermediate Cover (3%)	30,319	463	14,038
Intermediate Cover (Road) (8%)	1,533	446	684
Existing Intermediate Cover (33%)	4,365	435	1,899
Existing Final Cover (33%)	36,672	1	37
	72,889		16,657
Proposed Final Cover			
Intermediate Cover (3%)	2,734	463	1,266
Intermediate Cover (Road) (8%)	1,533	446	684
Proposed Final Cover (10%)	11,746	1	12
Proposed Final Cover (33%)	56,876	1	57
	72,889		2,018



APPENDIX E
LANDFILL GAS MODEL DATA

Table E1 LFG Assessment Summary

Year	LFG Emission Rate (m ³ /hr)	Methane Emission Rate (tonne/yr)	CO ₂ e Emission Rate (tonne/yr)	NMOC Emission Rate (tonne/yr)
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

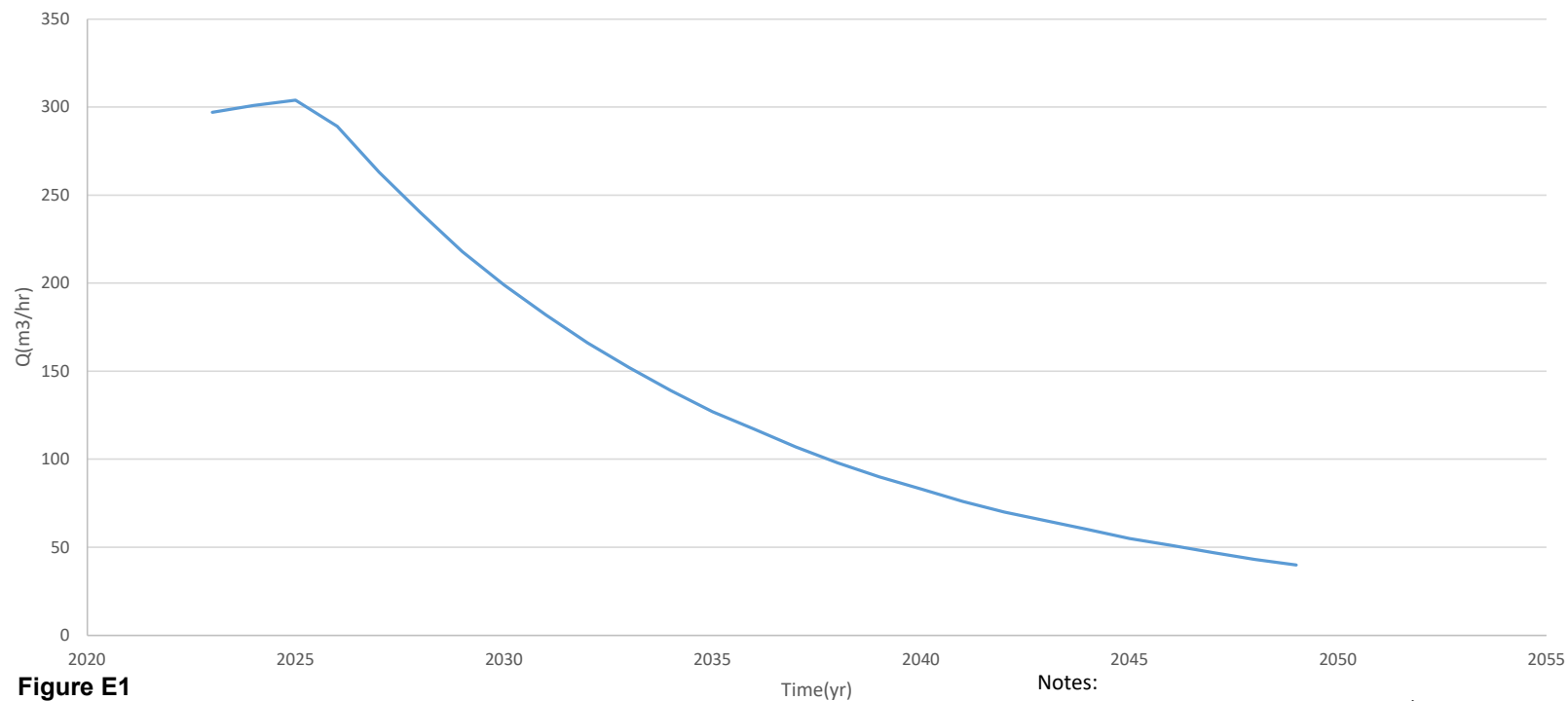
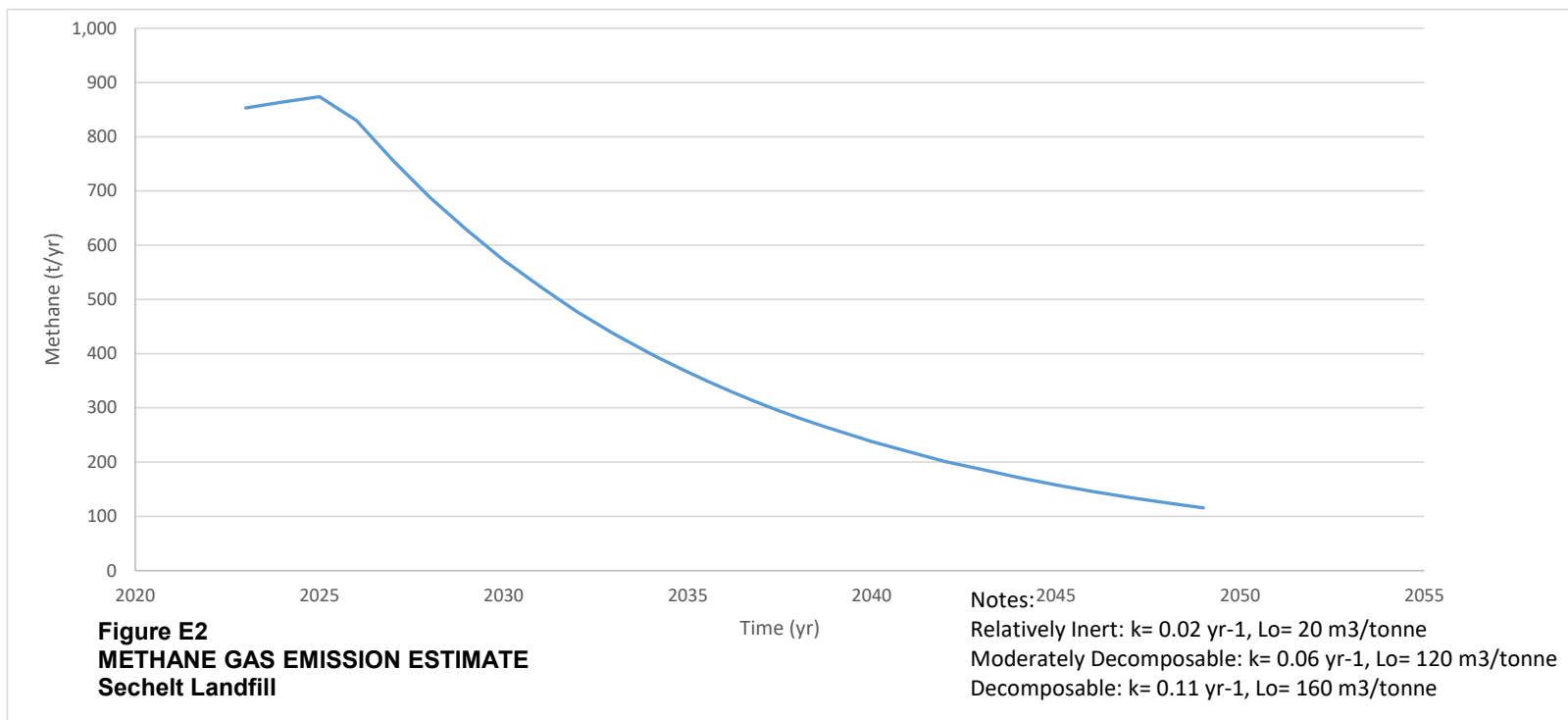


Figure E1
LFG PRODUCTION ESTIMATE
Sechelt Landfill

Notes:
Relatively Inert: $k = 0.02 \text{ yr}^{-1}$, $L_o = 20 \text{ m}^3/\text{tonne}$
Moderately Decomposable: $k = 0.06 \text{ yr}^{-1}$, $L_o = 120 \text{ m}^3/\text{tonne}$



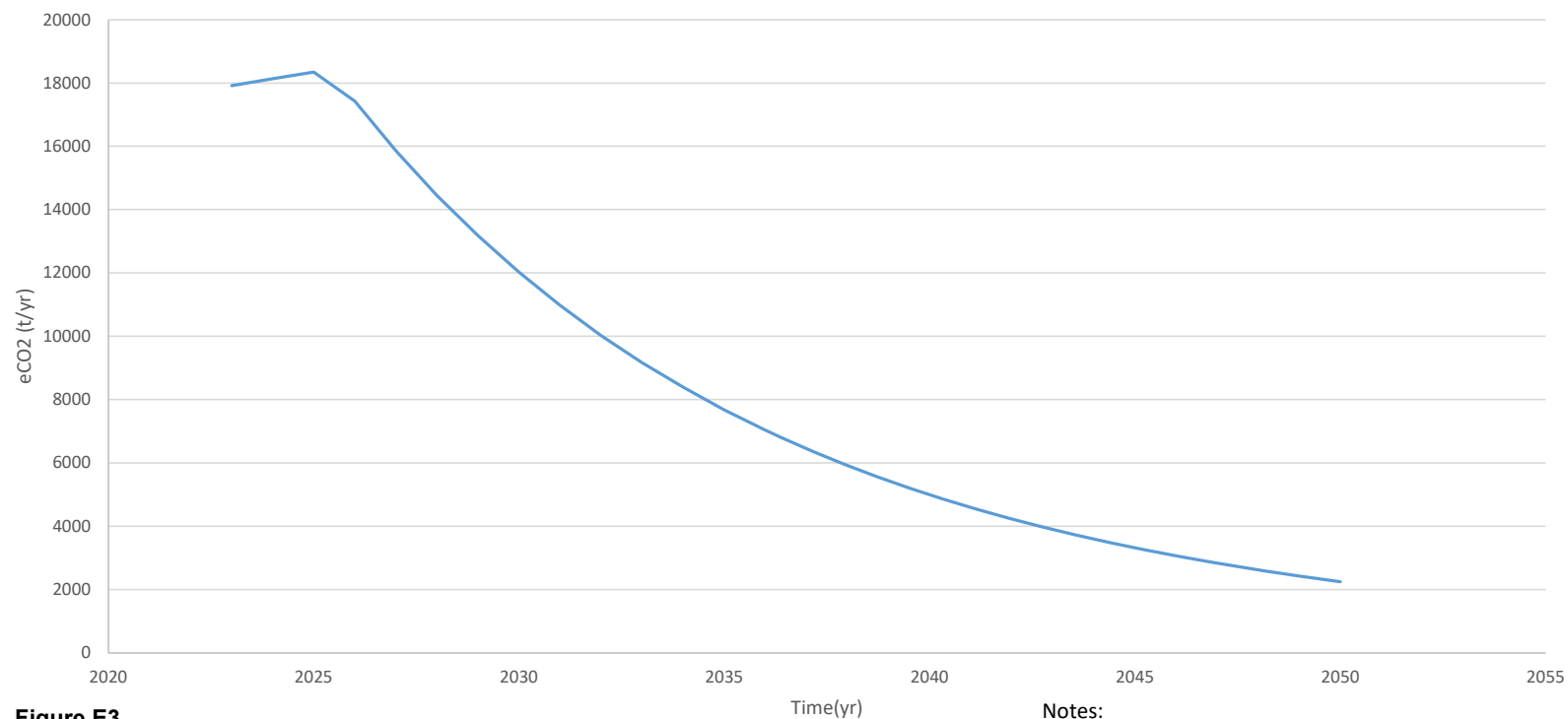


Figure E3
GREENHOUSE GAS EMISSION
ESTIMATE
Sechelt Landfill

Notes:
Relatively Inert: $k = 0.02 \text{ yr}^{-1}$, $Lo = 20 \text{ m}^3/\text{tonne}$
Moderately Decomposable: $k = 0.06 \text{ yr}^{-1}$, $Lo = 120 \text{ m}^3/\text{tonne}$
Decomposable: $k = 0.11 \text{ yr}^{-1}$, $Lo = 160 \text{ m}^3/\text{tonne}$

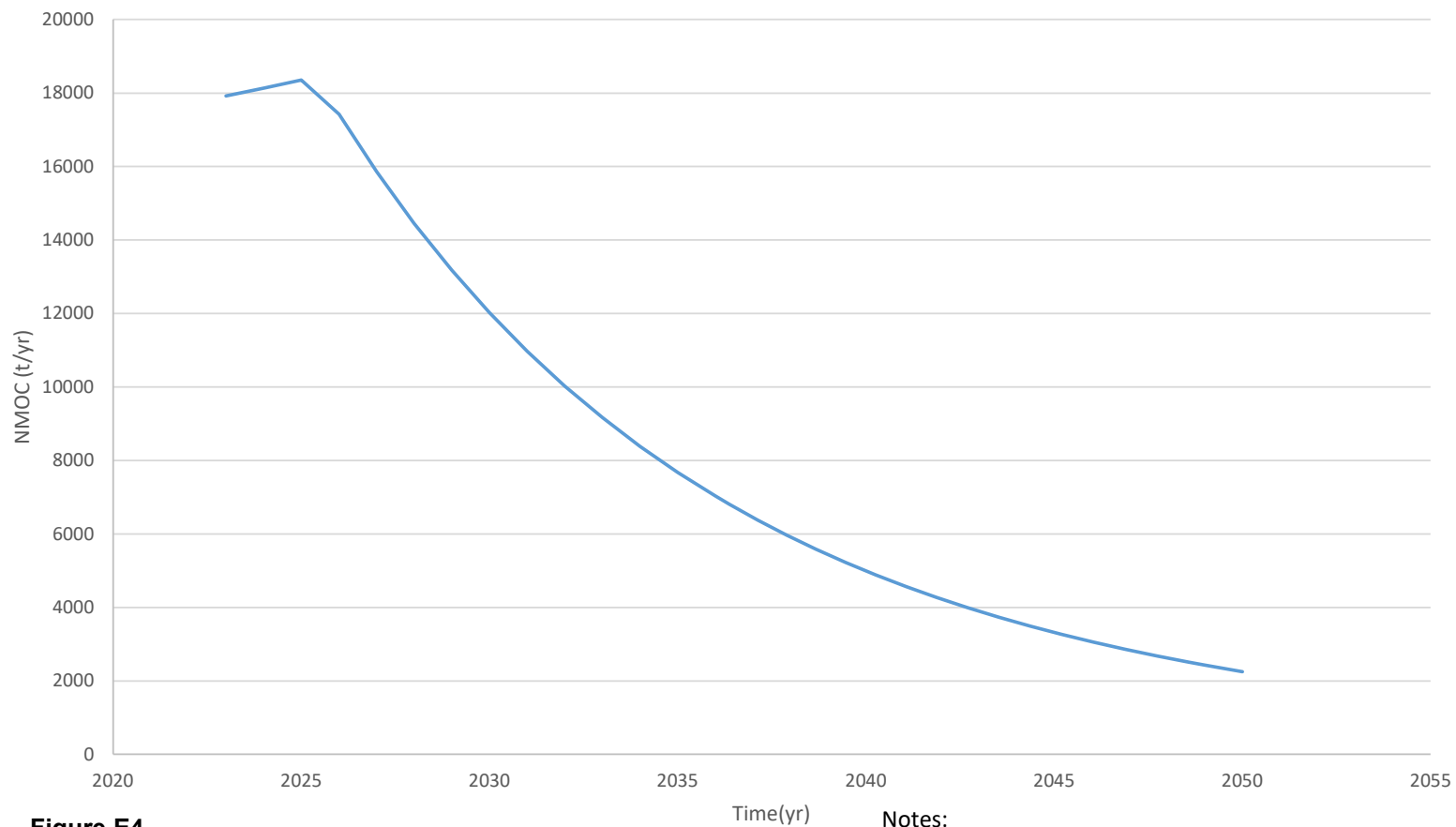


Figure E4
NMOC EMISSION RATE
ESTIMATE
Sechelt Landfill

Notes:

Relatively Inert: $k = 0.02 \text{ yr}^{-1}$, $Lo = 20 \text{ m}^3/\text{tonne}$
 Moderately Decomposable: $k = 0.06 \text{ yr}^{-1}$, $Lo = 120 \text{ m}^3/\text{tonne}$
 Decomposable: $k = 0.11 \text{ yr}^{-1}$, $Lo = 160 \text{ m}^3/\text{tonne}$



APPENDIX F
EMERGENCY RESPONSE AND CONTINGENCY PLAN

XCG File No.: 4-2111-01-89
July 4, 2023

**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: Mr. Marc Sole
Manager, Solid Waste Services



Trevor Mahoney, B.S.E.
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TABLE OF CONTENTS

1.	INTRODUCTION, PURPOSE AND, USE	1-1
2.	EMERGENCY RESPONSE PLAN	2-2
2.1	Emergency Response Personnel	2-2
2.1.1	Superintendent Responsibilities	2-2
2.2	Evacuation Procedures.....	2-3
2.3	Muster Points	2-3
3.	TYPES OF EMERGENCIES.....	3-1
3.1	Medical Emergencies.....	3-1
3.2	Minor Medical Injuries	3-1
3.2.1	Prevention	3-1
3.2.2	Response Plan	3-1
3.3	Serious Medical Injury.....	3-1
3.3.1	Prevention	3-1
3.3.2	Response Plan	3-2
3.4	Vehicle or Equipment Accidents	3-2
3.4.1	Prevention	3-2
3.4.2	Response Plan	3-2
4.	FIRES	4-1
4.1	Fire Prevention.....	4-1
4.2	General Fire Response Procedures	4-1
4.3	General Instructions	4-2
4.4	General Fire-Fighting Guidelines	4-2
4.5	Small Contained Fires.....	4-2
4.6	Uncontained Fires	4-3
4.7	Building Fires.....	4-3
4.7.1	Prevention	4-3
4.7.2	Response.....	4-3
4.8	Fires at the Working Face	4-3
4.8.1	Prevention	4-3
4.8.2	Response.....	4-3
4.9	Stored Material Fires.....	4-4
4.9.1	Prevention	4-4
4.9.2	Response.....	4-4
5.	SPILLS	5-1
5.1	On-Site Spills:	5-1
5.1.1	Prevention	5-1
5.1.2	Response Plan	5-1
6.	EXTREME WEATHER EVENTS	6-1
6.1	Extreme Weather	6-1
6.1.1	Preparedness.....	6-1
6.1.2	Response Plan	6-1
6.2	Natural Disasters	6-1
6.2.1	Preparedness.....	6-1



TABLE OF CONTENTS

6.3	Response Plan	6-1
7.	CONTINGENCY PLAN	7-1
7.1	Prohibited Wastes Delivered to or Discovered at the Site	7-1
7.1.1	Prevention	7-1
7.1.2	Response Plan	7-1
7.2	Hot Loads Delivered to the Site	7-1
7.2.1	Prevention	7-1
7.2.2	Response Plan	7-2
7.3	Elevated Parameters Detected in Groundwater Monitoring System	7-2
7.3.1	Prevention	7-2
7.3.2	Response Plan	7-2
7.4	Contamination of Surface Water	7-2
7.4.1	Prevention	7-2
7.4.2	Response Plan	7-2
7.5	Landfill Gas Exceedance	7-2
7.5.1	Prevention	7-2
7.5.2	Response Plan	7-3
7.6	Leachate Seepage through Final Cover System	7-3
7.6.1	Prevention	7-3
7.6.2	Response Plan	7-3
7.7	Excess Stormwater Flow into the Active Operating Area	7-3
7.7.1	Prevention	7-3
7.7.2	Response Plan	7-3
7.8	Breach of the Cover System	7-3
7.8.1	Prevention	7-3
7.8.2	Response Plan	7-3
7.9	Extreme Dust Emissions	7-4
7.9.1	Prevention	7-4
7.9.2	Response Plan	7-4
7.10	Detection of Strong Odors	7-4
7.10.1	Prevention	7-4
7.10.2	Response Plan	7-4
8.	CHECKLISTS	8-1
9.	REFERENCES	9-1



TABLES

Table F1	Minor Medical Injury Response Plan	end of text
Table F2	Serious Medical Injury Response Plan.....	end of text
Table F3	Vehicle or Equipment Accident Response Plan	end of text
Table F4	Low Risk Building Fire Response Plan.....	end of text
Table F5	High Risk Building Fire Response Plan.....	end of text
Table F6	Fire at the Working Face Response Plan	end of text
Table F7	Fire of Stored Materials Response Plan.....	end of text
Table F8	On-Site Spills Response Plan.....	end of text
Table F9	Extreme Weather Response Plan.....	end of text
Table F10	Prohibited Waste Delivered at the Landfill Response Plan.....	end of text
Table F11	Prohibited Waste Discovered to the Landfill Response Plan	end of text
Table F12	Hot Load Delivered to the Landfill Response Plan	end of text
Table F13	Groundwater Contamination Response Plan.....	end of text
Table F14	Surface Water Contamination Response Plan.....	end of text
Table F15	Landfill Gas Exceedance Response Plan.....	end of text
Table F16	Leachate Flow Greater than Expected Response Plan.....	end of text
Table F17	Excess Stormwater Flow to Active Area Response Plan.....	end of text
Table F18	Breach of the Cover System Response Plan	end of text
Table F19	Extreme Dust Emissions Response Plan.....	end of text
Table F20	Detection of Strong Odours Response Plan.....	end of text

FIGURE

Figure F1	Existing Site Conditions	end of text
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APPENDIX

Appendix F1	Ministerial Order No M. 329
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**1. INTRODUCTION, PURPOSE AND, USE**

XCG Consultants Ltd. (XCG) was retained by Sunshine Coast Regional District (SCRD) to prepare an Emergency Response and Contingency Plan (Plan) for the Sechelt Landfill (Site). This Plan has been prepared as an appendix to the Design, Operations and Closure Plan (DOCP).

This 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 associated with the Site. The key elements of the Plan include identification of:

1. The nature and severity of the emergencies;
2. The type of emergency response actions to be undertaken; and
3. The Emergency response personnel.

Emergency and contingency responses include the following:

- Medical emergencies;
- Fires;
- Spills;
- Extreme climate events; and
- Environmental and operational contingencies.

This Plan has been prepared for the sole use by the SCRCD and may not be used by any other person or entity without written authorization by XCG. Any use or reuse of this Plan, its findings, conclusions, and recommendations represented herein by users other than SCRCD, is at the sole risk of said users.



2. EMERGENCY RESPONSE PLAN

The SCR D 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 SCR D has an agreement with the Sechelt Fire Department (SFD) to provide emergency firefighting services at the Site (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 Site employees and contractor.

2.1 Emergency Response Personnel

The key to the success of the Plan is to assign a responsible person to take charge in case of an emergency. The Superintendent, Solid Waste Operations (Superintendent) is designated to have the primary responsibility to manage emergency situations at the Site. The Site Supervisor is designated as the alternate person responsible for managing emergency response.

The Superintendent 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 foreseeable emergency that may occur.

2.1.1 Superintendent Responsibilities

The Superintendent 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 Superintendent 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.

2.2 Evacuation Procedures

In the event that an area or structure at the landfill must be evacuated due to a fire, gaseous release, or other emergency, 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 Superintendent, 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 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.

2.3 Muster Points

Muster points are:

1. Primary Offsite: Dusty Road to the west of the Site Entrance (See Figure G1); or
2. Primary Onsite: North of the Public drop-off area; or
3. An alternate area designated by the Superintendent.

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 Superintendent will then proceed to the muster point.

The prime consideration for the Superintendent is to ensure that all employees and site visitors are safely evacuated. The Superintendent will:

- Only if safe to do so, check areas and buildings, including portable toilets, 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 Superintendent 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 Superintendent 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 Superintendent 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 Superintendent.



3. TYPES OF EMERGENCIES

3.1 Medical Emergencies

All injuries should be considered important and should be reported as a safety incident to the Superintendent.

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.

3.2 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.)

3.2.1 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.

3.2.2 Response Plan

The response plan to follow in the case of a minor medical emergency is presented in Table F1.

3.3 Serious Medical Injury

Serious medical injuries are injuries that require critical intervention (i.e. major or continuous bleeding, falls, head injury, fractures, etc.)

3.3.1 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.

3.3.2 Response Plan

The response plan to follow in the case of a serious medical emergency is presented in Table F2.

3.4 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 Superintendent 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.

3.4.1 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.

3.4.2 Response Plan

The response plan to follow in the case of a vehicle or equipment accident is presented in Table F3.



4. FIRES

4.1 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.

4.2 General Fire Response Procedures

Fires may occur at the following locations:

- Fires in the office buildings (Scale House, Waste Supervisors Hut, Maintenance Building and Office Trailer);
- Fires in onsite sea cans;
- 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 Superintendent.



4.3 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 Superintendent 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.

4.4 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.

4.5 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.

4.6 Uncontained Fires

- Do not attempt to fight the fire;
- Follow evacuation procedures; and
- Call 911.

4.7 Building Fires

4.7.1 Prevention

The following systems are in place in order to prevent building fires:

- Staff training and awareness; and
- Coordination with Fire Department.

4.7.2 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 House, Office Trailer, Waste Supervisors Hut and Maintenance Building) is presented in Table F4. 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, Propane Tank Area, and Paint and Special Waste Storage Area) in Table F5.

4.8 Fires at the Working Face

4.8.1 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.

4.8.2 Response

The response plan to follow in the case of a fire at the working face is presented in Table F6.



4.9 *Stored Material Fires*

4.9.1 *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.

4.9.2 *Response*

The response plan to follow in the case of a fire involving stored materials is presented in Table F7.



5. SPILLS

5.1 On-Site Spills:

5.1.1 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.

5.1.2 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 F1. The response plan to follow in the case of on-site spills is presented in Table F8. Granular absorbents as well as spill pads are stored on Site for use in case of a spill.

In the event of an off-site release, the Superintendent 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.



6. EXTREME WEATHER EVENTS

6.1 Extreme Weather

6.1.1 Preparedness

The following systems are in place in order to minimize impacts associated with extreme weather events:

- Monitor weather forecasts;
- Employee safety and response training and awareness; and
- Maintain on and off-site communications systems.

6.1.2 Response Plan

The response plan to follow in the case of extreme weather is presented in Table F9.

The Superintendent 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 SCR D website and social media.

6.2 Natural Disasters

6.2.1 Preparedness

The following systems are in place in order to minimize impacts associated with natural disasters such as forest fire, wind storm, flooding, earthquakes and rock slides:

- Emergency Response Plan contained herein;
- Employee safety training and awareness,
- Contact Superintendent;
- Work with local Sunshine Coast Emergency Program; and
- First Aid training.

6.3 Response Plan

In the event of a natural disaster that impacts the Site, the Superintendent will notify the Manager. The Manager will work with the SCR D CAO and the Sunshine Coast Emergency Program to coordinate the response.



7. 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:

- Protect the human health and life;
- Minimize impacts on the natural environment;
- 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.

7.1 Prohibited Wastes Delivered to or Discovered at the Site

7.1.1 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.

7.1.2 Response Plan

The response plan to follow in the case of prohibited wastes being delivered to the Site is presented in Table F10.

The response plan to follow in the case of prohibited wastes are discovered at the Site is presented in Table F11.

7.2 Hot Loads Delivered to the Site

7.2.1 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.

7.2.2 Response Plan

The response plan to follow in the case of a hot load delivered to the Site is presented in Table F12.

7.3 Elevated Parameters Detected in Groundwater Monitoring System

7.3.1 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.

7.3.2 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 F13.

7.4 Contamination of Surface Water

7.4.1 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.

7.4.2 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 F14.

7.5 Landfill Gas Exceedance

7.5.1 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.

**7.5.2 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 F15.

7.6 Leachate Seepage through Final Cover System**7.6.1 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.

7.6.2 Response Plan

The response plan to follow in the case of leachate seepage through the final cover system is presented in Table F16.

7.7 Excess Stormwater Flow into the Active Operating Area**7.7.1 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.

7.7.2 Response Plan

The response plan to follow in the case of excess stormwater flow into the active operating area is presented in Table F17.

7.8 Breach of the Cover System**7.8.1 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.

7.8.2 Response Plan

The response plan to follow in the case of a breach of the cover system is presented in Table F18.



7.9 Extreme Dust Emissions

7.9.1 Prevention

The following systems are in place in order to prevent extreme dust emissions:

- Use of calcium chloride to suppress 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.

7.9.2 Response Plan

The response plan to follow in the case of extreme dust emissions is presented in Table F19.

7.10 Detection of Strong Odors

7.10.1 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.

7.10.2 Response Plan

The response plan to follow in the case of the detection of strong odours is presented in Table F20.

**8. CHECKLISTS**

Checklists for various emergency situations as described above are provided as part of Tables F1 through F20.



9. 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

**Table F1 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	By Whom?	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 House and Office Trailer, 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	Superintendent	Site Staff and Occupational Health and Safety				

**Table F2 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	By Whom?	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	Superintendent 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 House and Office Trailer, AED and emergency supplies such as blankets, located in				
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	Superintendent	Site Personnel and Occupational Health and Safety				

Table F3 Response Plan - Vehicle or Equipment Accident

Action	Time Frame	By Whom?	Resources	Done?	Location	Date	Initial of Person who Completed Task
Report the accident to the Superintendent	Immediately	All employees	Incident Report Form, MIA Form				
If an injury is involved, call 911 and implement medical response actions	Immediately	Superintendent, Site Supervisor					
If damage is minor, have the vehicle driver report the accident to the RCMP. Take pictures prior to vehicle leaving.	Immediately	Superintendent, Site Supervisor	Incident Report Form, MIA Form				
If the damage is significant, call the RCMP and take pictures.	Immediately	Superintendent, Site Supervisor	Incident Report Form, MIA Form				
Secure the area for a follow-up investigation.	Immediately	Superintendent, 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.	Superintendent, Joint Health and Safety Committee, Human Resources					

Table F4 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 House, Office Trailer and Storage Sheds

Action	Time Frame	By Whom?	Resources	Done?	Location	Date	Initial of Person who Completed Task
Evacuate the Building	Immediately	All Staff					
Call 911	Immediately	Scale Attendant, Site Supervisor, Superintendent					
Secure the Area	Immediately	Superintendent, Site Supervisor, Scale Attendant, Designated Alternate					
Contact British Columbia Ministry of Environment	Immediately	Superintendent, Manager, Designated Alternate					
Contact the Manager, Solid Waste Services	Within the hour	Superintendent, Site Supervisor, Scale Attendant, Designated Alternate					

Table F5 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 Propane Tank Area and Paint and Special Waste Storage Area

Action	Time Frame	By Whom?	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, Superintendent					
Secure the area, and maintain an adequate buffer of the fire site	Immediately	Superintendent, Site Supervisor, Scale Attendant, Designated Alternate					
Contact British Columbia Ministry of Environment	Immediately	Superintendent, Manager, Designated Alternate					
Contact the Manager, Solid Waste Services	Within the hour	Superintendent, Site Supervisor, Scale Attendant, Designated Alternate					
Review the cause of the fire and prepare appropriate mitigative measures	Within 1 month	Superintendent, Site Supervisor, Site Contractor	Site employees, Fire Department				

Table F6 Resposne Plan - Fire at the Working Face

Action	Time Frame	By Whom?	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	Superintendent, 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, Superintendent	Fire Department, British Columbia Ministry of Environment				
Determine the nature and extent of the fire	Immediately	Superintendent, 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	Superintendent, Site Supervisor, Site Contractor	Fire Department, Equipment Operator				
Review the cause of the fire and prepare appropriate mitigative measures	Within 1 month	Superintendent, Site Supervisor, Site Contractor	Site employees, Fire Department				

Table F7 Response Plan - Fire of Stored Materials

Action	Time Frame	By Whom?	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	Superintendent, 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, Superintendent	Fire Department, British Columbia Ministry of Environment				
Determine the nature of the burning material and potential for emission of toxic fumes	Immediately	Superintendent, 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	Superintendent, 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	Superintendent, Site Supervisor, Site Contractor, Fire Department	Fire Department, Site Equipment				
Confirm the fire is extinguished	Immediately	Superintendent, Site Supervisor, Site Contractor	Fire Department, Equipment Operator				
Review the cause of the fire and prepare appropriate mitigative measures	Within 1 month	Superintendent, Site Supervisor, Site Contractor	Site employees, Fire Department				

Table F8 Response Plan - On-Site Spills

Action	Time Frame	By Whom?	Resources	Done?	Location	Date	Initial of Person who Completed Task
Contact British Columbia Ministry of Environment	Immediately	Superintendent, 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	Superintendent, 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	Superintendent, Site Supervisor, Site Contractor	Environmental consultant				
Investigate corrective measures	Within 24 hours	Superintendent, Site Supervisor, Site Contractor	Environmental consultant				
Implement corrective measures	Within 24 hours	Superintendent, Site Supervisor, Site Contractor	Environmental consultant				
Review operating procedures and revise, if appropriate	Within 2 weeks	Superintendent	Environmental consultant				

Table F9 Response Plan - Extreme Weather

Action	Time Frame	By Whom?	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 F10 Response Plan - Prohibited Waste Delivered to the Landfill

Action	Time Frame	By Whom?	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, Superintendent	Transport Canada, Transport of Dangerous Goods Regulation				
Inform the waste generator of the infraction	Within 1 hour	Site Supervisor, Scale Attendant, Superintendent					
Document the nature of the incident and actions taken	Within 1 hour	Superintendent, Site Supervisor, Scale Attendant	Daily Activity Log Book				
Review waste acceptance procedures and implement necessary mitigative measures	Within 1 month	Superintendent, Site Supervisor, Scale Attendant					

Table F11 Response Plan - Prohibited Waste Discovered at the Landfill

Action	Time Frame	By Whom?	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, Superintendent	Scale records and staff observations				
If identified, contact the hauler and waste generator to review the options	Within 1 to 2 weeks	Site Supervisor, Superintendent					

Table F12 Response Plan - Hot Load Delivered to the Landfill

Action	Time Frame	By Whom?	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, Superintendent, 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 F13 Response Plan - Groundwater Contamination

Action	Time Frame	By Whom?	Resources	Done?	Location	Date	Initial of Person who Completed Task
Contact British Columbia Ministry of Environment	Immediately	Superintendent, Site Supervisor	British Columbia Ministry of Environment				
Re-sample to verify or validate exceedances.	Within 1 month	Environmental Technician, Superintendent	Environmental consultant and laboratory				
Assessment of the nature and risk of the problem	Within 2 months	Superintendent, Environmental Technician, Site Supervisor	Environmental consultant				
Identify the appropriate corrective actions and implement	Within 1 month	Superintendent, Environmental Technician, Site Supervisor	Environmental consultant				
Implement corrective measures	Within 2 months	Superintendent, Site Supervisor	Environmental consultant				

Table F14 Response Plan - Surface Water Contamination

Including any off-Site discharge from the Contact Water Pond

Action	Time Frame	By Whom?	Resources	Done?	Location	Date	Initial of Person who Completed Task
Contact British Columbia of Environment	Immediately	Superintendent , 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, Superintendent	Environmental consultant, laboratory				
Assessment of the nature and risk of the problem	Within 2 months	Superintendent , Environmental Technician, Site Supervisor	Environmental consultant				
Identify the appropriate corrective actions and implement	Within 1 month	Superintendent , Environmental Technician, Site Supervisor	Environmental consultant				
Review the surface water management plan and update and revise if necessary	Within 2 months	Superintendent , Site Supervisor	Environmental consultant				

Table F15 Response Plan - Landfill Gas Exceedance

Action	Time Frame	By Whom?	Resources	Done?	Location	Date	Initial of Person who Completed Task
Contact British Columbia Ministry of Environment	Immediately	Superintendent, Site Supervisor	British Columbia Ministry of Environment				
Re-sample to verify or validate exceedances.	Within 2 days	Environmental Technician, Superintendent	Environmental consultant				
Assessment of the nature and risk of the problem	Within 2 months	Superintendent, Environmental Technician, Site Supervisor	Environmental consultant				
Identify the appropriate corrective actions and implement	Within 1 month	Superintendent, Environmental Technician, Site Supervisor	Environmental consultant				
Implement corrective measures	Determined following the assessment of the problem	Superintendent, Site Supervisor, Site Contractor	Environmental consultant				

Table F16 Response Plan - Leachate Seepage through Final Cover System

Action	Time Frame	By Whom?	Resources	Done?	Location	Date	Initial of Person who Completed Task
Contact British Columbia Ministry of Environment	Immediately	Superintendent, 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	Superintendent, Site Supervisor, Site Contractor					
Investigate the cause of the seep	Within 2 days	Superintendent, Site Supervisor, Site Contractor	Environmental consultant				
Investigate corrective measures	Within 1 week	Superintendent, Site Supervisor	Environmental consultant				
Implement corrective measures	Within 2 weeks	Superintendent, Site Supervisor, Site Contractor	Environmental consultant				
Review operating procedures and revise if appropriate	Within 2 months	Superintendent, Site Supervisor	Environmental consultant				

Table F17 Response Plan - Excess Storm Water Flow into the Active Area

Action	Time Frame	By Whom?	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, Superintendent	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	Superintendent, Site Supervisor, Site Contractor	Environmental consultant				
Implement corrective measures	Within 2 weeks	Superintendent, Site Supervisor, Site Contractor	Environmental consultant				

Table F18 Response Plan - Breach of the Cover System

Action	Time Frame	By Whom?	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	Superintendent, Site Supervisor, Site Contractor	Environmental consultant				
Reconstruct the breached area	Within 1 to 2 months	Superintendent, Site Supervisor, Site Contractor	Environmental consultant				

Table F19 Response Plan - Extreme Dust Emissions

Action	Time Frame	By Whom?	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 Wast 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		Superintendent , Site Supervisor					

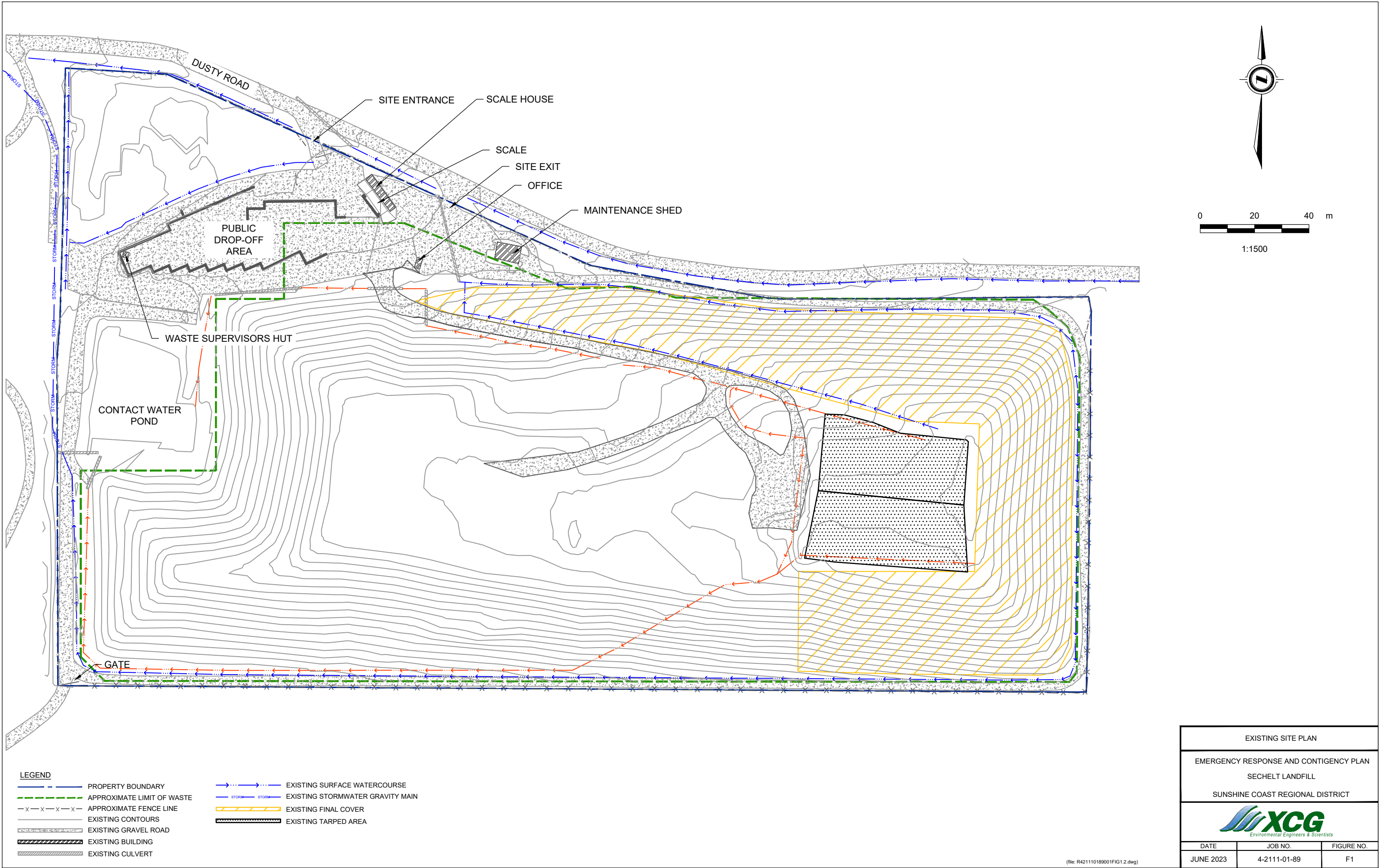
Table F20 Response Plan - Detection of Strong Odours

Action	Time Frame	By Whom?	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	Superintendent, Site Supervisor	Environmental consultant				



FIGURE

FIGURE





APPENDIX F1
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

- 1 Definitions
- 2 Reportable spills
- 3 Reportable spills of natural gas
- 4 Initial report
- 5 Updates to minister
- 6 End-of-spill report
- 7 Lessons-learned report
- 8 Emergency response completion date
- 9 Application to oil and gas permit holders

SCHEDULE

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 G
LONG-TERM CAPITAL PLAN

July 4, 2023

XCG File No. 4-2111-01-89

Mr. Marc Sole
Manager, Solid Waste Services
Sunshine Coast Regional District
1975 Field Road
Sechelt, British Columbia
V0N 3A1

Re: Long-term Capital Plan, Sechelt Landfill

Dear Mr. Sole:

XCG Consulting Limited (XCG) is pleased to present this letter outlining the long-term capital plan (the Plan) for the development of the Sechelt Landfill (the Site). 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 Plan references the scope of work and development sequence outlined in the “Design, Operations and Closure Plan,” dated June 30, 2023, prepared by XCG. The estimated costs provided in this Plan are based on conceptual designs, the existing Site conditions, current Site performance. All costs and rates provided in the Plan are in 2023 dollars.

The 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 “J” to “R”. It is noted that the 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 development 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 summarized in Table 1 indicates that the development sequence will provide a total of approximately 120,000 cubic metres over a site life of approximately 6.3 years.

Table 2 provides a summary of the costs for each of the landfilling development stages and associated infrastructure projects. Based upon the estimated capital costs of \$7,175,000 and the estimated remaining waste capacity of approximately 120,000 cubic metres, the calculated capital cost per cubic metre over the remaining life of the landfill is \$59.78 in 2023 dollars.

An annual capital budget for the years 2023 through 2030 is provided in Table 3. Detailed capital budgets for each of the landfilling stages and infrastructure projects are provided in Tables 4 and 5.



The estimated post-closure annual costs, including Site maintenance and monitoring costs and are summarized in Table 6. Table 7 provides a summary of the estimated closure and post-closure costs for the Site. The net present value for the estimated closure and post-closure costs for the landfill is \$14,872.876. The landfill liability as of December 2016 was \$13,060,952.

Table 8 provides estimated 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 reaching the design capacity, as discussed in the DOCP. A capital cost of \$6,528,572 in 2023 dollars was estimated for the contingency closure plan.

This Plan has been prepared for the sole use by the SCRD and may not be used by any other person or entity without written authorization by XCG. Any use or reuse of this Plan, its findings, conclusions, and recommendations represented herein by users other than SCRD, is at the sole risk of said users.

Should you have any questions or require additional information, please do not hesitate to contact the undersigned.

Yours very truly,

XCG CONSULTING LIMITED

A handwritten signature in black ink, appearing to read 'Trevor Mahoney', written over a horizontal line.

Trevor Mahoney, B.S.E.
Project Manager

Thomas Kolodziej, B.A.Sc., P.Eng.
Senior Project Manager

TABLES

Table 1 Landfilling Development Sequences

Development Stage	Air Space (m ³)	Cumulative Air Space (m ³)	Waste Capacity (tonnes)	Cumulative Waste Capacity (tonnes)	Life (months)	Cumulative Life (years)
Preparation for Biocover Pilot	5,750	5,750	3,795	3,795	4	0.3
Stage J	9,500	15,250	6,270	10,065	6	0.8
Site Modifications	0	15,250	0	10,065	0	0.8
Stage K	7,500	22,750	4,950	15,015	5	1.2
Stage L	12,000	34,750	7,920	22,935	8	1.8
Stage M	11,500	46,250	7,590	30,525	7	2.4
Stage N	18,000	64,250	11,880	42,405	11	3.4
Stage O	11,500	75,750	7,590	49,995	7	4.0
Stage P	17,000	92,750	11,220	61,215	11	4.9
Stage Q	8,000	100,750	5,280	66,495	5	5.3
Stage R	18,000	118,750	11,880	78,375	11	6.3
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 K	\$ 3,017,340
Final Closure	\$ 4,155,718
Total (Excluding GST)	\$ 7,173,058

Table 3 Annual Development Capital Costs

Year / Stage	2023	2024	2025	2026	2027	2028	2029	2030	Totals
Progressive Closure during Stage K		\$3,017,340	\$0	\$0	\$0	\$0	\$0	\$0	\$3,017,340
Final Closure		\$0	\$0	\$0	\$0	\$0	\$0	\$4,155,718	\$4,155,718
Total	\$0	\$3,017,340	\$0	\$0	\$0	\$0	\$0	\$4,155,718	\$7,173,058

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%)				\$291,530
Operations	Temporary Haul Road - supply, place, and compact	L.M.	65	\$222	\$14,430
Closure	Ditch Realignment - fill in interior ditch, realign exterior ditch to pond, erosion control	L.M.	40	\$95	\$3,800
	Remove culvert by pond, construct inlet to pond with erosion control	L.S.	1	\$3,176	\$3,176
	Remove culvert on lower portion of the haul road ditch	L.M.	15	\$95	\$1,425
	Final Cover - district supplied native soils and topsoil, supply, place, compact, grade, seed	m ²	23,262	\$83	\$1,930,746
Subtotal					\$2,235,067
Engineering (15%)					\$335,260
Contingency (20%)					\$447,013
Total (Excluding GST)					\$3,017,340

Table 5 Stage R- Final Closure

Item	Description	Unit	Approx. Quantity	Unit Price	Total Price
Administration and Execution Requirements	Bonds, Insurance, Mobilization, Demobilization, Temporary Controls, and Closeout (15%)				\$401,519
Closure	Final Cover - district supplied native soils and topsoil, haul, place, compact, grade, and seed	m ²	31,680	\$83	\$2,629,440
	Culvert - Removal	L.M.	45	\$64	\$2,880
	Pond Overflow - construct primary emergency overflow and connect to existing stormwater gravity drain, elevate existing overflow for use as secondary overflow	L.S.	1	\$6,351	\$6,351
	Regrade Haul Road	L.M.	180	\$64	\$11,520
	Ditching - including erosion control	L.M.	280	\$95	\$26,600
Subtotal					\$3,078,310
Engineering (15%)					\$461,746
Contingency (20%)					\$615,662
Total (Excluding GST)					\$4,155,718



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 K	\$3,017,340	2024
Final Closure	\$4,155,718	2030
Post-Closure Costs	\$45,750	2030-2130

Reference Figures	
General Inflation ^a	2.21%
Discount Rate ^b	1.47%
Real Discounted Interest Rate	-0.72%

Net Present Value	
NPV - Capital	\$7,565,554
NPV - Post-Closure	\$7,307,322
NPV - Total	\$14,872,876

Landfill Liability	
Total Landfill Volume (m ³) ^c	985,000
Volume Used as of June 2023 (m ³) ^c	865,000
Total Volume Available as of June 2023 (m ³)	120,000
Landfill Liability as of December 2016	\$13,060,952

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 June 10, 2023.

c - Volume estimated from historic waste tonnages and an apparent density of 0.65 tonnes per m³.

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%)				\$655,041
Closure	Ditch Realignment - fill in interior ditch, realign exterior ditch to pond, erosion control	L.M.	40	\$95	\$3,800
	Remove culvert by pond, construct inlet to pond with erosion control	L.S.	1	\$3,176	\$3,176
	Remove culvert on lower portion of the haul road ditch	L.M.	15	\$95	\$1,425
	Final Cover - district supplied native soils and topsoil, haul, place, compact, grade, and seed	m ²	51,942	\$83	\$4,311,186
	Culvert - Removal	L.M.	45	\$64	\$2,880
	Pond Overflow - construct primary emergency overflow and connect to existing stormwater gravity drain, elevate existing overflow for use as secondary overflow	L.S.	1	\$6,351	\$6,351
	Regrade Haul Road	L.M.	180	\$64	\$11,520
	Ditching - including erosion control	L.M.	280	\$95	\$26,600
Subtotal					\$5,021,979
Engineering (10%)					\$502,198
Contingency (20%)					\$1,004,396
Total (Excluding GST)					\$6,528,572