

**WEST COAST LANDFILL  
DESIGN, OPERATIONS AND CLOSURE REPORT**

**Submitted To:** British Columbia Ministry of Environment  
**Prepared By:** McGill & Associates Engineering Ltd. (File #1755-2011)  
On behalf of the Alberni-Clayoquot Regional District  
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## Executive Summary

The West Coast Landfill (WCL) is operated by the Alberni-Clayoquot Regional District (ACRD) under Operational Certificate Number MR-05634, issued in 2005. The landfill is located approximately 9 km northwest of the Tofino-Ucluelet junction. The areas that dispose of waste at the landfill include the District of Tofino, District of Ucluelet, Parks Canada, ACRD Electoral Area C (Long Beach) and First Nations Communities Toquaht, Ucluelet, Ahousaht, Tla-o-qui-aht and Hesquiaht.

This report was prepared to meet the requirements of Section 2.4 of the Operational Certificate and the criteria listed in the *Landfill Criteria for Municipal Solid Waste* published by the British Columbia Ministry of Environment in 1993.

The WCL opened in 1980, after a Solid Waste Study was completed to identify and evaluate potential landfill sites. The site was selected for its location, remoteness from development, anticipated life, low potential for groundwater or surface water pollution and economic feasibility.

The WCL property is approximately 28.4 hectares in area. A scale building and weigh scale are located at the landfill entrance. Tipping bins and stockpile areas are available for public use while commercial vehicles dump refuse at the active face. The estimated footprint area of the current landfilled area is approximately 6.2 hectares, and located near the centre of the property. The 50 m landfill buffer has been reduced to 15 m on the east and south sides to allow for extending the life of the landfill.

The properties surrounding the landfill are currently undeveloped forested land. The north, east and west surrounding properties are owned by forestry companies while the neighbouring property to the south is owned by Parks Canada. A 20 metre strip separates the south landfill boundary from the Parks Canada boundary. The nearest residential development is the Tla-o-qui-aht First Nation Esowista Reserve, located greater than 7,400 m northwest. The Long Beach Airport is located approximately 6 km northwest of the WCL.

The WCL site is underlain by a thin layer of peat material over a thick clay layer. A borehole drilling program confirmed a silty clay to approximately 2 m depth over at least 12 m of marine clay. The hydraulic conductivity is estimated between  $4.1 \times 10^{-10}$  and  $7.8 \times 10^{-11}$  m/s with a vertical seepage velocity less than 2 cm/year. As the surface gradients are estimated to be less than 5%, groundwater is not considered a significant pathway for leachate migration.

The nearest surface water body is a small tributary to Sandhill Creek located within the southwest corner property line. This tributary enters Sandhill Creek and subsequently empties into Wickaninnish Bay.



A seismic review indicates that there would not be any risk of a foundation failure or decrease in leachate containment during an earthquake. The WCL property is not located in a floodplain area or in an identified tsunami flood zone.

The landfill operates as both a natural control and an engineered landfill. The natural clay base acts as a liner while the engineered leachate collection system collects and treats leachate generated onsite. Leachate is collected in surface ditches from the perimeter of the fill area and directed to a leachate storage lagoon. The leachate is then pumped through a forcemain to a spray irrigation system in the northern portion of the property and treated using a natural wetland type treatment. Stormwater collection ditches are constructed adjacent to the leachate collection ditches to redirect stormwater away from the leachate collection system. Leachate flows are not measured, however a water balance was completed to estimate leachate flows under different flow scenarios.

As the WCL does not receive greater than 10,000 tonnes of solid waste annually or have a volume of solid waste greater than 100,000 tonnes, a landfill gas assessment has not yet been completed. It is estimated that a Landfill Gas Generation Assessment Report will be required in 2012.

The filling plan consists of a series of cells that will be filled sequentially over time. Cells A and B will fill the northern part of the existing landfill footprint to an elevation of approximately 108 m (about 10 m above the estimated base) and temporarily capped. Cell C includes expanding the current footprint to the east, to fill the area east and south of the current fill area. This will involve land clearing and reconstruction of the leachate and surface water collection ditches. Cell D will include filling the southern boundary up to an elevation of 108 m, the same as Cells A through C. The final cell, Cell E, will be constructed on top of Cells A through D and will raise the top of the landfill to a final elevation of 120 m. The existing leachate collection ditches along the west and south edges will remain and act as the limit of the fill area. All cells will be constructed using side slopes of 3 horizontal to 1 vertical, with the final surface sloped toward the surface water collection ditches. The final footprint area is estimated to be 9.1 ha, with a total volume of solid waste at closure expected to be approximately 1,100,000 m<sup>3</sup>.

The WCL is currently operated by Berry & Vale Contracting Ltd. and is open to the public six days a week. Tipping fees are regulated by ACRD Bylaw R1010-1. Solid waste is landfilled and storage areas are available for recycling of plastics, cardboard and metals. The active fill area is covered daily with either granular material or large metal covers. The use of cover prevents the attraction of vectors and wildlife and prevents the spread of litter. Suitable cover material is not available onsite and must be brought in from a local gravel pit.

A bi-monthly environmental monitoring program was implemented in 1996 to evaluate water quality at and around the site. The sampling program consists of a series of surface water sites that are tested for the presence of leachate. Sample results are compared to the *British Columbia*



*approved Water Quality Guidelines* for the protection of freshwater aquatic life. The latest report indicates slight leachate impacts in the receiving water body but no obvious long term increasing trends.

A weigh scale was installed at the WCL in 1999. Historic annual weights have been estimated to range from 2,400 tonnes to 5,500 tonnes, with an estimated 4,560 tonnes being landfilled in 2010. As of December 2010, there is an estimated 98,500 tonnes of solid waste in place at the WCL.

It is estimated that there is approximately 275,000 m<sup>3</sup> of solid waste currently landfilled at the WCL, based on survey data from January 4, 2011, and an estimated 840,000 m<sup>3</sup> of available volume remaining. Historic records indicate that a filling density of about 0.49 tonnes/m<sup>3</sup> is considered appropriate for future filling projections.

As the WCL reaches its maximum capacity, it will be decommissioned and closed. A final impermeable landfill cap will be constructed over the landfill surface to minimize rainfall infiltration, minimize gas migration, control odours and prevent access by vectors and other wildlife. A surface water collection system will be constructed to prevent clean runoff from entering the leachate collection system. Based on the current filling plan and projected annual tonnages, the landfill has an estimated 82 years remaining, indicating closure around the year 2093.

Following landfill closure, post-closure activities such as water quality monitoring, landfill gas monitoring (if required), and regular inspection and maintenance activities are expected to continue for a minimum of 25 years.

Using current construction practices and prices, a closure and post-closure cost estimate was prepared. It is estimated that \$5,600,000 will be needed at closure to account for the closure and post-closure activities. As there is approximately \$200,000 currently in the WCL closure fund, it is estimated that \$70,000 per year, for the remaining 80 years should be added to the fund to provide financial security for closing the WCL. The closure plan and annual closure fund allocation should be reviewed regularly to reflect current construction practices and costs.

The 2007 Solid Waste Management Plan indicated that the future of waste disposal at the WCL was going to be reviewed. It raised the prospect that the WCL might be closed and converted to a transfer station, with landfilling at the Alberni Valley Landfill. A study to review the transfer station concept has not been started, as the possibility of increased disposal at the AVL has not been confirmed. The ACRD must review the impacts with local residents, community groups, First Nations communities and government agencies before proceeding.



## TABLE OF CONTENTS

<b>1. INTRODUCTION.....</b>	<b>1</b>
1.1 Objective.....	1
1.2 List of Reports.....	2
1.3 Background.....	2
1.4 Report Structure.....	3
<b>2 EXISTING SITE &amp; INFRASTRUCTURE.....</b>	<b>3</b>
2.1 General Site Layout.....	3
2.2 Property Boundary.....	4
2.3 Surrounding Land Use.....	5
2.4 Geology, Hydrogeology & Unstable Areas.....	6
2.5 Surface Water.....	7
2.6 Floodplain.....	8
<b>3 LANDFILL DESIGN.....</b>	<b>8</b>
3.1 Design Approach.....	8
3.2 Leachate Collection System.....	8
3.3 Leachate Generation.....	10
3.4 Contingency Measures.....	11
3.5 Landfill Gas Management System.....	11
3.6 Filling Plan.....	12
<b>4 CURRENT LANDFILL OPERATIONS.....</b>	<b>14</b>
4.1 General.....	14
4.2 Fill Area.....	15
4.3 Fire Protection.....	16
4.4 Cover Material.....	16
4.5 Environmental Monitoring.....	16
4.6 Annual Reporting.....	17
<b>5 WASTE CHARACTERIZATION &amp; QUANTIFICATION.....</b>	<b>17</b>
5.1 Waste Characteristics.....	17
5.2 Waste Quantification.....	19
5.3 Existing Landfill Volumes.....	20
<b>6 PERFORMANCE CRITERIA.....</b>	<b>20</b>
6.1 Groundwater and Surface Water Quality.....	21
6.2 Leachate Generation.....	21
6.3 Landfill Gas Management.....	22
6.4 Public Health, Safety and Nuisance.....	22
<b>7 CLOSURE PLANS.....</b>	<b>23</b>
7.1 Closure Design.....	23
7.2 Volume and Estimated Date of Closure.....	24
7.3 Closure Notification.....	24
7.4 Legal Obligations.....	24



<b>8</b>	<b>POST-CLOSURE PLAN</b> .....	<b>25</b>
8.1	Water Quality Monitoring.....	25
8.2	Landfill Gas Management.....	25
8.3	Inspection and Maintenance.....	25
8.4	Buildings/Structures.....	26
<b>9</b>	<b>FINANCIAL SECURITY</b> .....	<b>26</b>
<b>10</b>	<b>REVIEW OF SOLID WASTE MANAGEMENT PLAN RECOMMENDATIONS</b> .....	<b>29</b>
<b>11</b>	<b>LIMITATIONS</b> .....	<b>31</b>

## LIST OF FIGURES

- Figure 1: Site Location Plan
- Figure 2: General Site Plan
- Figure 3: Landfill Buffers & Surrounding Land Use Plan
- Figure 4: Leachate Collection System
- Figure 5: Proposed Filling Plan – Cells A through D
- Figure 6: Proposed Filling Plan – Cell E
- Figure 7: Water Quality Monitoring Locations
- Figure 8: Landfill Cover Detail

## LIST OF APPENDICES

- Appendix A – Operational Certificate MR-05634
- Appendix B – List of Reports
- Appendix C – West Coast Landfill Legal Plans
- Appendix D – Plan of Tsunami Inundation Zone, Pacific Rim National Park Reserve, Long Beach Unit
- Appendix E – Alberni-Clayoquot Regional District Bylaw R1010-1
- Appendix F – Estimated Historic Landfill Weights
- Appendix G – Closure & Post-Closure Cost Estimate



## 1. INTRODUCTION

The WCL is located approximately 9 km northwest of the Tofino-Ucluelet junction, on the east side of the highway. The landfill currently operates under Operational Certificate Number MR-05634, issued by the Ministry of Environment on April 12, 2005. A copy of the operational certificate is included in Appendix A.

The Alberni-Clayoquot Regional District (ACRD) operates the West Coast Landfill (WCL) to dispose municipal solid waste from several communities on the West Coast of Vancouver Island. The known areas disposing of waste at the WCL include:

- District of Tofino
- District of Ucluelet
- Parks Canada
- ACRD Electoral Area C – Long Beach
- First Nations Communities
  - Toquaht
  - Ucluelet
  - Ahousaht
  - Tla-o-qui-aht
  - Hesquiaht

While the landfill is under the jurisdiction of the ACRD, daily landfill operations are currently contracted out to Berry & Vale Contracting Ltd.

### 1.1 Objective

The objective of this report is to provide site development, operating, leachate management, closure and post-closure plans required to meet Section 2.4 of Operational Certificate MR-05634. This report was developed based on the criteria specified by the *Landfill Criteria for Municipal Solid Waste*, published by the Ministry of Environment (MoE) in June 1993, to address:

- Performance Criteria;
- Siting Criteria;
- Design Criteria;
- Operational Criteria; and,
- Closure and Post-Closure Criteria.



## 1.2 List of Reports

Several reports have been prepared for the WCL since the start of landfilling in 1980. These reports include discussion of water and leachate monitoring, site development, geotechnical conditions and leachate system design. These reports have been used as references in the preparation of this report. A list of the reports available for the WCL are provided in Appendix B.

## 1.3 Background

In 1975, Associated Engineering Services Ltd. completed a Solid Waste Study for the West Coast Region to identify options for solid waste management for the west communities of the ACRD. The study reviewed the existing services, disposal areas and service area characteristics. Both disposal by sanitary landfill and incineration were considered. Nine sites were considered and evaluated based on public health and pollution control standards, operational procedures, landfill equipment required, climatological problems, drainage, future use of the land, cover material availability, access roads, location with respect to hauling distances, potential for surface or groundwater pollution and public acceptability. After reviewing the sites, the current WCL site was selected due to:

- Its location – central and outside of the Park;
- Its remoteness from any present or planned development;
- Its anticipated useful life – in excess of 50 years;
- Less potential for ground or surface water pollution becoming a problem; and,
- More economically feasible than a regionally operated incinerator.

The WCL opened in 1980 and operated under Ministry of Environment Permit PR-5634, first issued on November 29, 1979. It was authorized to discharge refuse from municipal sources located in Tofino, Ucluelet, Pacific Rim Park and adjacent unorganized areas.

According to populations listed in the solid waste management report prepared in 2007, it is estimated that the WCL services a population in the order of 4,700 full time residents. Tourism is a main industry within the WCL service area, therefore the population increases significantly in the summer months. While the exact population increase is unknown, in 2005, there was reported to be more than 778,000 visitors to the Long Beach unit of Pacific Rim National Park Reserve. The solid waste management plan also estimated that approximately 13% of the waste is from residential sources, and the other 87% is from commercial, industrial and institutional sources.

Berry and Vale Contracting currently operate the WCL under contract to ACRD. Berry and Vale Contracting were awarded the contract on July 1, 2011 for a five year term.



## 1.4 Report Structure

The report has been divided into the following seven major sections:

- Existing Site and Infrastructure (Section 2);
- Landfill Design (Section 3);
- Current Landfill Operations (Section 4);
- Waste Characterization and Quantification (Section 5);
- Performance Criteria (Section 6);
- Closure Plans (Section 7);
- Post Closure Plans (Section 8); and,
- Financial Security (Section 9).

## 2 EXISTING SITE & INFRASTRUCTURE

The WCL is located approximately 9 km northwest of the Tofino-Ucluelet junction, on the east side of the highway. The site is located at an elevation of approximately 40 to 50 m and includes an area of approximately 28.4 hectares. The property is legally described as Lot A, District Lot 1399, Clayoquot District, Plan No. VIP68534. A copy of the legal plan has been attached in Appendix C. The site is accessed by a gravel road owned by Parks Canada. The ACRD holds a statutory right of way over a small section of land between the Parks Canada road and the landfill property to provide landfill access. The statutory right of way is part of District Lot 1398, shown on Plan No. VIP 68535, and is currently owned by International Forest Products Ltd. A copy of the land title and statutory right of way are also included in Appendix C. A site location plan is attached as Figure 1.

### 2.1 General Site Layout

The entrance to the WCL is located at the southeast corner of the property. Through the entrance gate is the scale shack and one 21.3 m (70 ft) long weigh scale. The main road travels northwest where there are designated drop off areas for recycling, batteries, tires and white goods. Further along the main road are solid waste transfer bins available for public solid waste disposal.

A plan showing the general site layout is attached as Figure 2.

The existing landfilled area is located near the center of the property. The current footprint covers an area estimated to be 6.2 ha. The estimated base elevation of the landfill is approximately 97.5 m while the top of the filled surface ranges in elevation from approximately 100 m to approximately 109 m, based on a local survey datum (not referenced to geodetic).



A leachate collection ditch follows the landfill footprint on the northwest, west, south and east boundaries. Leachate collection ditches drain to the southwest corner of the property flowing into a leachate treatment and balancing pond. From the pond, leachate is pumped to the northern area of the property where it is then released through a spray irrigation system, and allowed to flow overland towards the west, where it is treated using a wetland approach. A small ridge intersects the northeast corner of the property in a northwest-southeast direction, causing a drainage divide. Further information on the leachate collection system is discussed in Section 3.2.

The remainder of the landfill property is undeveloped, with most of it still forested. Several cut lines have been cleared through the forested areas, to allow for inspection, maintenance and monitoring.

## 2.2 Property Boundary

The property boundary is shown on the site plan attached as Figure 2. An electric fence follows the landfill property boundary. The fence line has been cleared of vegetation to allow proper inspection and maintenance.

The minimum buffer from the landfill boundary to the current estimated landfill footprint is listed in the table below.

Table 1: Distance from Landfill to Property Line

<b>Boundary</b>	<b>Distance from Current Landfill Footprint (m)</b>
North	230
East	90
South	40
West	120

In May 2004, McGill & Associates Engineering Ltd. submitted a report entitled *West Coast Landfill, Leachate Collection, Treatment and Future Development* where the leachate treatment system was proposed and questions from Ministry of Environment and Parks Canada were addressed. The standard buffer zone for landfill setbacks is 50 m, however a relaxation of this buffer down to 15 m on the east and south boundaries was requested. The reduction was requested as:

- The reduction in buffer will extend the life of the landfill, thereby environmental impacts to other areas of the ACRD;
- There are economic savings in that the lifetime of the landfill is extended and that tipping fees will not have to be increased to cover costs of disposal elsewhere; and,



- The site is remote, with a 38 m distance from the toe of the landfill to the Parks Canada boundary to the south and a natural tree barrier has been left alongside the public use road along the east boundary.

The operational certificate indicates that the buffer on these two boundaries has been reduced to allow for additional expansion and for the installation of the leachate collection and treatment system.

### 2.3 Surrounding Land Use

The property surrounding the WCL is currently undeveloped, forested land. The surrounding property legal descriptions are shown on Figure 3.

The north and west boundaries are adjacent to District Lot 1399, owned by Weyerhaeuser and currently zoned A4 Forest Service Area. This zoning allows for natural resource development and extraction and has a setback requirement of 21.5 m.

Land to the east of the WCL is District Lot 1398 and is owned by International Forest Products Ltd. This land is also zoned A4 Forest Service Area and has a 21.5 m setback. The ACRD holds a statutory right of way over a portion of this property allowing access to the WCL entrance.

South of the WCL is District Lot 398 and southeast of the landfill is District Lot 403. Both of these properties are owned by Parks Canada and zoned P2 Park and Public Use district. This zoning is for public use for recreation and has a 20 m front yard setback.

While there are various Parks Canada trails throughout the area, the nearest development is Green Point Campground located approximately 2,600 m west of the WCL. The nearest residential development is the Tla-o-qui-aht First Nation Esowista Reserve, located greater than 7,400 m northwest of the WCL.

The BC Water Resources Atlas was used to identify registered water wells near the WCL. The nearest registered well was located approximately 2,900 m west-northwest, however is not considered operational as the estimated well yield was 0 gpm.

As there is no development within 300 m of the WCL, the site location meets the minimum 300 m buffer distance, with the exception of a public park. The south property boundary borders Parks Canada land, however there is a 20 m wide dedicated road allowance that will provide some separation. At present, the toe of the landfill is approximately 60 m from the Parks Canada property line. In addition, regular water monitoring is conducted to evaluate the quality of runoff leaving the WCL property.

The Long Beach Airport is located approximately 6 km northwest of the WCL. While the distance from the WCL to the Long Beach Airport does not meet the minimum 8 km criteria, the



potential for birds causing hazard to aircraft is considered low as daily cover is applied to control scavenging birds.

## 2.4 Geology, Hydrogeology & Unstable Areas

Several investigations have been conducted at the WCL to explore the site geology. The following section summarizes the findings of the reports.

The WCL is located on the Estevan Coastal Plain that is characterized as flat lying, poorly drained with high annual precipitation. The site slopes gently to the southwest. Mapping indicates that the site is underlain by silt and clay marine sediments over bedrock. Nearby historic well logs indicate that the silt and clay are in the order of 30 to 50 m deep. Marine sediments around the landfill are typically overlain by a layer of weathered clay and peaty soil, up to 30 cm thick. A geotechnical investigation comprised of eleven testpits was completed in 2000 and confirmed a thin layer of organic soil throughout the surface of the site. A thin layer of fibrous peat was observed in wet areas near the southern portion of the site. Some testpits encountered a brown clayey silt ranging from 0.3 m to 1.0 m thick. In other areas, a mottled clay was found below the organic layer and ranged in depth from 0.6 m to 1.0 m. All testpits encountered blue clay in the lower portion of the testpit, and was proven to depths between 2 and 3 m.

Based on the colour of the clay, the seasonal low water table is about 0.6 to 1.0 m below ground, while the winter water table rises to ground surface.

Preliminary reports indicated that the clay and silt deposits underlying the site are expected to have very low hydraulic conductivities in the order of  $10^{-9}$  m/s. As the shallow surface gradients are less than 5%, it was estimated that groundwater flow rates (seepage velocities) will be approximately 4.5 mm/year and therefore not considered a significant pathway for leachate migration. Some groundwater flow may occur in the peaty soil and weathered clay overlying the marine sediments, but would be closely related to surface runoff flow. Both groundwater and surface water at the landfill area are interpreted to flow to the southwest, towards a creek beyond the western property line.

In order to confirm that the underlying site met the natural control landfill criteria, a drilling program consisting of three boreholes was completed. The stratigraphy was consistent between the three holes, consisting of between 1.7 and 2.1 m of mottled, silty clay over soft to firm, plastic, blue, marine clay to the borehole depths of about 12.2 m. Therefore indicating marine clay thicknesses of greater than 10 m. Monitoring wells were installed in the boreholes to allow for water level measurement and sampling. The static groundwater levels were estimated to be within the mottled soil horizon and the hydraulic conductivity of the clay is estimated between  $4.1 \times 10^{-10}$  and  $7.8 \times 10^{-11}$  m/s. Vertical seepage velocities were estimated to be less than 2 cm/year.



The WCL Is located in a large, gently sloping basin, and is not located within 200 m from any potentially unstable areas. Therefore there are no significant slopes towards which ground movements could occur. It is situated in an area at risk from Cascadia subduction events, with peak ground acceleration of 0.51g for a seismic event that has a 2% probability of exceedance in a 50 year period. The marine clay sediments below the site are very firm, plastic sediments that are not susceptible to liquefaction. Based on the thickness and the plastic nature of the clay, it is expected that it would deform to some extent without fracturing. Therefore, there would not be any risk of a foundation failure or decrease in leachate containment during an earthquake.

As there is a thick layer of surficial sediments above the bedrock, the presence of faults is not known. While there may be faults present below the site, the likelihood of significant deformation in the faults over the next 10,000 years is remote. Should it occur, the plastic marine sediments would serve as a plastic raft. Also, with 3:1 side slope construction of the landfill, horizontal waste movement during an earthquake would be very small and easily remedied.

## 2.5 Surface Water

A drainage divide has been identified near the northeast portion of the site, where surface water from the majority of the landfill drains to the southwest and a small portion of the site drains towards the northeast.

Site drainage to the southwest enters a tributary to Sandhill Creek, located within the southwest property line. While the extent of the tributary creek has not been surveyed, the creek is located approximately 140 m from the landfilled area, greater than 80 m from the leachate lagoon overflow. The tributary to Sandhill Creek drains south to Sandhill Creek, and subsequently into Wickaninnish Bay. The tributary to Sandhill Creek is considered the receiving water body for the WCL.

A small natural drainage course is located on the site near the northeast property boundary. It is located on the northeast side of the identified drainage divide, and drains northeast, off of the property. The drainage course likely drains north and joins a tributary to Kootowis Creek. As there has not been any landfilling activities on this side of the drainage divide, it is not expected to have any leachate impacts. This drainage course is sampled as part of the monitoring program and used as the background sample site.

As only a shallow layer of organic soil is located above the low permeability clay layer, it is expected that the majority of runoff from the site will be surface flow, or flow within the shallow organic soil layer. Therefore surface flow is considered the primary pathway for leachate migration and thus the water quality monitoring program collects only surface water samples.



## 2.6 Floodplain

The nearest adjacent water course to the WCL is a tributary to Sandhill Creek that nears the southwest landfill boundary. There are no floodplain maps available for Sandhill Creek. As the tributary is located down a steep bank from the landfill, it is not expected that the tributary creek to Sandhill Creek will flood onto the WCL property.

The west coast of Vancouver Island is susceptible to tsunamis and tsunami flood zones. The Tofino Emergency Preparedness Website was used to retrieve a plan showing the *Tsunami Inundation Zone and Evacuation Routes for the Pacific Rim National Park Reserve, Long Beach Unit*. The plan indicates that the WCL and the neighbouring tributary to Sandhill Creek are outside of the tsunami inundation zone. The plan also shows that the evacuation route for the WCL area is south, to the Tofino-Ucluelet Highway junction. A copy of the plan is attached in Appendix D.

## 3 LANDFILL DESIGN

The WCL operates as a combination of both a natural control landfill and an engineered landfill.

### 3.1 Design Approach

The *Landfill Criteria for Municipal Solid Waste* indicates that a natural control landfill must have at least a 2 m thick liner of low permeability soil with a hydraulic conductivity of  $10^{-6}$  cm/s ( $10^{-8}$  m/s) or less and the bottom most solid waste cell is to be 1.2 m above the seasonally high water table. An engineered landfill must have at least a 1 m thick compacted soil liner (or geosynthetic liner) with a hydraulic conductivity of  $10^{-7}$  cm/s ( $10^{-9}$  m/s) or less and designed leachate collection systems.

The WCL utilizes the natural low permeability ( $10^{-10}$  m/s) of the underlying marine clay to contain surface water within the site. Geotechnical investigations have confirmed that the clay layer is greater than 10 m thick, and is thought to be closer to 30 to 50 m thick.

The seasonal water table is located near the soil surface, and therefore does not provide 1.2 m between the water table and solid waste cells. Previous reports indicate that a granular drainage layer is deemed unnecessary for the site as it would not improve the efficiency of the leachate collection system and would reduce the attenuation of storm flows that may be provided by temporary storage of water in the waste. Several engineered controls have been put in place to collect and direct the leachate for treatment.

### 3.2 Leachate Collection System

In order to prevent leachate from leaving the WCL property, a leachate collection, treatment and disposal system was constructed in 2004 to meet the *Landfill Criteria for Municipal Solid Waste*. The objective of the leachate collection system is to see that water at or beyond the



landfill boundary meets the Ministry of Environment *Approved and Working Criteria for Water Quality*.

In 2000, a natural wetland leachate treatment system was proposed. The proposed system was comprised of a perimeter ditch collection system, equalization storage lagoon and irrigation dispersal area. A preliminary design report was prepared and submitted to both the Ministry of Environment, Lands and Parks and Parks Canada for review. A report submitted in May 2004 addressed the issues and questions raised as part of the review.

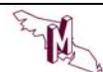
The leachate system was approved and constructed in 2005. A summary of the main leachate collection system components include:

- A 500 m long leachate collection ditch along the east and south edge of the landfill to collect leachate and direct it to the leachate pond;
- A drainage ditch to collect any clean surface water runoff from the east side of the landfill and direct it away from the leachate collection system;
- A 400 m long leachate collection ditch along the north and west edges of the landfilled area to collect leachate and direct it to the leachate pond;
- A 5,000 m<sup>3</sup> clay lined pond to store leachate and provide equalization storage for storm events, complete with emergency overflow;
- A pump station and 400 m of 150 mm diameter forcemain to pump leachate from the storage pond to the treatment dispersal area; and,
- A 150 m long perforated drain pipe spray irrigation system for leachate dispersal.

The leachate treatment used at the WCL is a natural wetland type treatment. Water quality sampling prior to the construction of the leachate collection system indicated that not only dilution, but other factors such as adsorption, ion exchange, oxidation, precipitation and biological uptake were occurring as it passed through the soils and vegetation. The treatment system was designed to use the existing natural terrain (significant land area with combination of trees, shrubs and peaty soils) and a combination of overland flow, rapid infiltration and subsurface flow to lower leachate concentrations to acceptable limits.

A stormwater collection ditch runs parallel to the leachate collection ditch on the east side of the landfilled area. This ditch intercepts clean surface water and directs it to a natural drainage path, so as to prevent it from entering the landfilled area and creating additional leachate.

Future work on the leachate collection system will include investigating a potential seepage pathway from the west leachate collection ditch. Changes in the current filling operation, together with increased compaction levels expected over the next two years are expected to



result in a reduction and possible elimination of the seepage course. This will be closely monitored over the next two years to determine its impact.

A diagram of the main leachate collection and treatment system components is attached as Figure 4.

### 3.3 Leachate Generation

A water balance was conducted by Piteau Associates Ltd. in 2004 to estimate the leachate flows that will be generated at the WCL. The water balance looked at three stages of landfill development that included different stages of capping and future development to the east, as well as average annual, average December and average summer precipitation. It also considered several different durations for the 1:10 year storm.

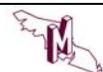
Based on the analysis at different development stages, the following flow and application estimates were made, based on 1.2 ha available for irrigation:

- Average annual flows varied from 4.8 to 6.1 L/s (40 mm/day);
- Average December flows varied from 9.4 to 11.8 L/s (75 mm/day); and
- Average summer quantities were approximately 0.5 L/s (3 mm/day).

The 10 year storm flows ranged from 70 to 86 L/s for a 24 hour storm to about 160 L/s for a 6 hour storm while the 100 year, 2 hour storm estimated flows as high as 300 L/s. Based on the flows, a combination of detention storage and irrigation was investigated. It was determined that a maximum irrigation rate of 25 L/s and a 5,000 m<sup>3</sup> storage lagoon were recommended for the leachate management system.

When the volume of stormwater exceeds the combined capacity of the system, water will overflow from the lagoon. The decant water is expected to be highly dilute, and is estimated to be less than 10% of the original leachate strength. Based on the storm analysis, this overflow may occur during average annual conditions for the 10 year, 10 day duration storm when the landfill footprint has expanded to the east. For the winter storms, decant flows up to 13 L/s may occur once the east expansion area is developed.

As areas of the WCL become properly capped, the surface of the landfill will become relatively impermeable and reduce the amount of rainfall entering the landfill, and thus the amount of leachate generated. Upon final closure, it is expected that runoff from the surface of the landfill will be of sufficient quality that it can enter the local surface water system, resulting in leachate flows lower than current flows.



### 3.4 Contingency Measures

As part of the landfill design, several contingency measures have been identified as solutions, should the performance criteria indicate that there are leachate impacts beyond the boundary of the landfill. Contingency measures may include:

- Excavating a sump to intercept flows destined for surface water bodies, and pumping to the leachate collection system if necessary; and,
- Constructing a permanent clay berm to block shallow groundwater and surface flow.

There are clay sources available in the area and the landfill operators have the machinery available onsite for any emergency construction needed.

The bi-monthly water quality sampling program is intended to evaluate the condition of the leachate and surface water at and surrounding the landfill, with the objective of identifying increased concentrations before they reach the maximum water quality guidelines and contingency measures are needed.

### 3.5 Landfill Gas Management System

Effective January 1, 2009, the MoE released the *Landfill Gas Management Regulation*. This regulation is focused on reducing greenhouse gas emissions from landfills and identifying potential landfill gas recovery opportunities. The new regulation indicates that for landfills with volumes greater than 100,000 tonnes, a landfill gas generation assessment report must be submitted.

The new regulation utilizes a different assessment methodology than previous regulations. It evaluates the need for a landfill gas collection system based on the amount of methane generated each year. Once the annual amount of methane generated exceeds 1,000 tonnes, a landfill gas management design plan must be developed.

As of December 2010, the estimated volume of solid waste at the WCL has not yet reached 100,000 tonnes. As discussed in Section 5.2, the WCL is nearing 100,000 tonnes of solid waste and will likely reach this volume during 2011. Therefore, according to the *Landfill Gas Management Regulation*, a Landfill Gas Generation Assessment Report for the WCL must be submitted to the Ministry of Environment by March 1, 2012.

Once the annual methane production exceeds 1,000 tonnes, a landfill gas design plan will be prepared and a collection system will be installed.



### 3.6 Filling Plan

For the first ten years of operation, the WCL operated using a trench and backfill method of filling. Around 1990, operations switched to a cell filling method due to problems with poor surface drainage resulting from working with the clay material.

The landfill area is filled and covered in a series of cells. Solid waste is compacted and covered to achieve a filling density of at least 600 kg/m<sup>3</sup>. Fire cells are constructed using a minimum of 150 mm thick fire resistant material, with maximum dimension of 27.4 m by 27.4 m by 3 m deep. Finished side slopes of 3 horizontal to 1 vertical are required to maximize filling area while maintaining structural slope stability.

Based on the current landfill area, a future filling plan has been developed. The objective is to bring the central, north and east areas of the landfill up to the same elevation. It will include sloping the finished surface towards the eastern perimeter collection ditches at a slope of at least 2%. It will also include covering the surface with an intermediate cover material that is expected to reduce infiltration into the solid waste below. In addition, existing side slopes that are steeper than 3 horizontal to 1 vertical will attempt to be remediated to achieve proper slopes and cover and where possible 3:1 slopes. The objective will be to adequately cover the existing landfilled area to minimize the amount of rainfall infiltrating into the landfill and therefore minimize the amount of leachate generated.

Cell A currently ranges in elevation, with a maximum elevation of approximately 109.5 m. This area has slopes that are steeper than 3 horizontal to 1 vertical and does not have proper intermediate cover. As good quality cover material is dropped off at the site, the top and sides of Cell A will be graded and have proper cover material. The intent will be to provide a proper intermediate cover layer over Cell A while regular filling operations continue in other areas.

A copy of the proposed filling plan showing Cells A through D is shown on attached Figure 5.

Current filling operations are within Cell B. It will use the present landfill footprint and will continue filling at 3:1 slopes up to an elevation of approximately 108 m (based on a local survey datum). There is an estimated 59,000 m<sup>3</sup> of fill volume available in Cell B.

Prior to the completion of filling in Cell B, some site work will be needed before filling can proceed to Cell C. Cell C is located on the eastern portion of the property and has been approved for future expansion. Proceeding to this area will allow the current transfer station area to be maintained without having to be moved from its current location. Filling Cell C will involve expanding the current landfill footprint by approximately 3.2 ha. The area must be cleared and graded prior to any filling. The current leachate collection and stormwater collection ditches must be rerouted to the eastern and southern edge of the proposed Cell C to allow any leachate generated to be intercepted and directed to the leachate collection system.



The northern limit of Cell C will be the drainage divide. Cell C is designed to be filled to an elevation of 108 m. There is an estimated 161,000 m<sup>3</sup> of volume available in Cell C.

Filling will then continue in Cell D. Once the lower portions of the area are filled, the existing transfer bin area must be relocated to allow additional filling in Cell D. There is an estimated 136,000 m<sup>3</sup> of volume available in Cell D.

Following the completion of Cells A through D, Cell E will be constructed above the existing cells. It will fill from an elevation of 108 m up to a final elevation of 120 m (based on the local survey datum). The estimated volume of Cell E is 483,000 m<sup>3</sup>. The fill area of Cell E is attached on Figure 6.

Based on the cells and fill criteria identified above, the following table summarizes the fill volume in each cell.

Table 2: Estimated Volume of Landfill Cells

Cell	Estimated Volume (m <sup>3</sup> )
A	1,000
B	59,000
C	161,000
D	136,000
E	483,000
<b>Total</b>	<b>840,000</b>

As of January 4, 2011 there is an estimated 840,000 m<sup>3</sup> of volume remaining at the WCL until closure.

The filling plan utilizes the existing leachate collection and treatment system and will continue to use the existing system at closure. While there is substantially more land available on the property to expand the landfill footprint from that of the current filling plan, significant capital would be required to design and construct a leachate collection and treatment system for the increased area.

The construction of access roads within the landfill will be designed to service the active cell, with consideration given to future cell development, and access to the finished landfill face. The intent of road planning is to minimize road construction costs and the amount of usable volume allocated to roads. Landfill access roads will be designed to have a maximum grade of 7%, in order to provide access for larger commercial trucks.

The access road along the south boundary will be maintained to provide permanent access to the equalization lagoon and pump station. Access will be maintained along the fence line to allow regular inspection and maintenance of the electric fence.



Based on the design presented above, the WCL will have a final footprint area of approximately 9.1 ha. With a finished elevation of approximately 120 m, there will be a total volume of approximately 1,100,000 m<sup>3</sup> at the WCL at closure of the current approved landfill area. A significant area will remain unfilled. With changes in leachate treatment technology over the next 50 to 100 years this area is expected to become a viable landfill site extending the WCL landfill site a further 100 to 200 years into the future.

## 4 CURRENT LANDFILL OPERATIONS

The following sections outline the routine operations and activities at the WCL.

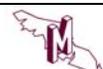
### 4.1 General

The landfill is operated by staff from Berry and Vale Contracting Ltd. and is open to the public six days a week. Signage is located at the entrance to inform users of the owner, operator, contact numbers, landfill hours, tipping fees, accepted waste and banned materials. The designated landfill operating hours are Monday to Saturday from 10:00 am to 4:00 pm.

The landfill is closed on Statutory Holidays. During working hours, at least one landfill employee is present in the scale shack at all times. After hours, the single entrance gate is locked.

The scale shack is located inside the landfill entrance to meet all incoming traffic. For large quantities, the vehicle is weighed before and after tipping and then charged according to the type and weight of waste disposed. Tipping fees at the WCL are regulated by Bylaw R1010-1. Current tipping fees are:

- Domestic Waste (145 kg or greater) - \$95.00/tonne (\$8.00 minimum)
- Domestic Waste (145 kg or less) \$2.00 each garbage bag or can (\$8.00 maximum)
- \$2.00 for each tire or \$170 per tonne, whichever is greater
- \$100.00 for each wrecked auto
- \$200.00 for each wrecked truck or bus
- \$10.00 each for stoves, washers, dryers, dishwashers, hot water tanks
- \$85.00 per tonne for metal
- Fridges and freezers - \$20.00 each
- Construction/Demolition Waste - \$120.00/tonne
- Stumps, land clearing debris - \$120.00/tonne



Fees for additional controlled waste items are included on Bylaw R1010-1 included in Appendix E.

The WCL does not charge for disposal of recyclable materials. Recycling bins are provided in a designated area near the landfill entrance. Designated areas for the drop off of white goods, bulky metallic objects, tires and batteries are also provided. All the drop off areas are located within the center of the landfill, inside the perimeter leachate collection ditches. Waste oil is not accepted and asbestos is no longer accepted at the WCL.

When users have only small quantities of waste, the waste is emptied into the tipping bins. One tipping bin is provided for mixed solid waste while a second bin is provided for waste metal. Large commercial vehicles are sent to the active landfill face for waste disposal. When the bins at the tipping area become full, they are trucked to the landfill face and emptied by WCL staff. Solid waste is compacted using a Rex TrashMaster 345 using four or five passes. As only commercial users are allowed onto the working face, the opportunity for scavenging is minimized.

A Risk Control Survey was completed for the WCL in July 2011 as part of the Municipal Insurance Association program. After a review of the site, the following four recommendations were made:

- Install a fire extinguisher by the main booth (scale shed);
- Install traffic signage directing the public around the area, that will also keep them from accessing restricted areas;
- Provide a guard rail or barrier by the metal and regular garbage drop offs to reduce a possible falling hazard; and,
- Implement delineation lines around the drop off areas to protect the public from possible vehicle/pedestrian collisions.

In the event of a power outage, a 5000 watt generator is connected to the scale building to provide backup power and allow the landfill to remain operational.

#### **4.2 Fill Area**

The active filling area is located near the center of the landfill, within Cell B. At the end of each day, large metal covers are placed over the active face. The use of the metal covers reduces the need for daily cover material therefore makes the landfill operations more economic and also maximizes the volume of solid waste being placed in the landfill. As the areas become filled, the waste is compacted and a granular fill material is placed over the waste. Both the large metal covers and the fill material act as temporary cover to prevent attraction of vectors and other wildlife. The temporary cover also prevents wind from blowing refuse and spreading



litter. The electric bear control fence was constructed in 1999 to prevent bears and other wildlife from entering the landfill, as required by the Operational Certificate MR-5634.

Two water tanks are available to help with providing dust control at the site as needed. As there are no residential or commercial activities directly surrounding the landfill, dust control is not a major concern at the WCL.

### **4.3 Fire Protection**

The water tanks provide initial fire protection on site. The landfill operator is also required to have a portable pump unit onsite, with at least one competent employee to operate the system. As of 2011, proper fire cells are being constructed. Prior to 2011, the frequency and adequacy of the fire cells is unknown. It is possible that some hazardous waste material (including some organic content) may have been used for cover and fire cell construction.

The ACRD plans on having discussions with the Ucluelet Volunteer Fire Brigade, the Tofino Volunteer Fire Department, Parks Canada and BC Forest for including the WCL in their service areas. The BC Forest Service will currently provide firefighting assistance to upwind areas of the WCL only.

### **4.4 Cover Material**

Due to the nature of the local geology, there is no suitable cover material available at the WCL. All daily cover material is brought in from a gravel pit at the Tofino /Ucluelet highway junction and stockpiled onsite.

In past years, some contaminated soil was used as cover. The material had some organic content and was brought in from a soil remediation project at one of the First Nations reserves. The material has since been deemed unsuitable and is no longer used as a final cover material or for fire cell construction. As a significant quantity of the material remains stockpiled onsite, it is being used for intermediate cover, between fire cells.

### **4.5 Environmental Monitoring**

A bi-monthly environmental monitoring program is conducted at the WCL. The water quality monitoring program began in 1996 with a total of seven surface water sites. Following construction of the leachate collection and treatment system in 2004, the sampling locations were revised and expanded to ten surface water sample sites. In 2005, an additional two sites were added to the sampling program. The selected sites are intended to characterize the leachate quality, measure impacts to Sandhill Creek and to document background chemistry.

Three groundwater monitoring wells were installed in 2002 and were sampled once in 2003 and once in 2006. The water levels and field parameters were measured bi-monthly from 2003 to 2009. Figure 7 attached shows the current and previous sample locations.



The samples are collected by ACRD staff and the results of the monitoring program reviewed and reported yearly by Piteau Associates Engineering Ltd. The water quality analysis varies from each of the sample locations, the common analysis include:

- Field Measurements:
  - Temperature
  - pH
  - Conductance
  - Colour
- Lab Analyses:
  - Physical parameters (pH, conductance, TDS, total hardness)
  - Anions (alkalinity, chloride, sulphate)
  - Nutrients (ammonia, nitrate, total phosphate)
  - Total or Dissolved Metals, with some sites only aluminum, iron and manganese.

Select sites are also sampled for Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) and the leachate storage lagoon is also sampled for Volatile Organic Carbons (VOCs).

Further discussion on the results of the monitoring program is included in Section 6.1 and additional detail on the current water quality monitoring program and results can be found in *2010 Monitoring – West Coast Landfill – Alberni-Clayoquot Regional District*, prepared by Piteau Associates Engineering Ltd., dated July 28, 2011.

Landfill gas is not yet a concern at the WCL. Once the landfill reaches a total of 100,000 tonnes of solid waste, a Landfill Gas Generation Assessment will be completed to evaluate the amount of landfill gas generated at the WCL. Should the landfill currently generate small quantities of landfill gas, it is not expected to pose any major risk to anyone at the site or surrounding properties due to migration.

#### **4.6 Annual Reporting**

The *Landfill Criteria for Municipal Solid Waste* indicates that an annual report must be prepared and submitted to MoE. As specified in Operational Certificate MR-5634, the annual report is required to be submitted by June 1<sup>st</sup> of the following year.

### **5 WASTE CHARACTERIZATION & QUANTIFICATION**

#### **5.1 Waste Characteristics**

WCL staff characterize the incoming solid waste into several categories. Based on the type of waste, it is either placed into the landfill or removed by an outside recycling company. The general solid waste categories and their destinations are shown in the following table.



Table 3: Destination of Incoming Landfill Material

Waste Category	Destination
Mixed Solid Waste	Landfilled
Construction/Demolition Waste	Landfilled
Gypsum/Gyproc	Landfilled
Fridges & Freezers	Stockpiled and removed
Washers, Dryers & Stoves	Stockpiled and removed
Tires	Stockpiled and removed
Recycled Materials (Cans, Glass, Newspaper, Cardboard & Plastic)	Removed by outside company for recycling
Outgoing Steel	Removed by outside company for recycling
Asbestos	No longer accepted
Stumps + Land Clearing	Landfilled

Asbestos is no longer accepted at the WCL and is redirected to the Alberni Valley Landfill where it is accepted under permit only.

A review of the types of wastes accepted at the WCL is currently being conducted by the ACRD.

The composition of solid waste at the WCL has not been formally measured, however the SWMP prepared by Gartner Lee Limited in 2007 provides an estimate of the solid waste composition for the West Coast. The composition is based on that from Whistler, British Columbia as their characteristics are considered similar to the West Coast in that recycling services are depot based, there are no disposal bans in place, there is a strong influence of tourism and there has been significant construction activity in the past 5 - 10 years. Their estimated waste composition is shown in the following table.

Table 4: Estimated Waste Composition

Category	Estimated Percentage of Total Waste
Compostables	28%
Construction/Demo	21%
Paper	16%
Miscellaneous	13%
Plastic	11%
Metal	7%
Electronics	2%
Glass	1%
Household Hazardous	1%



This composition estimate was made before curbside recycling was implemented on the West Coast. It is expected that the amount of recyclable materials entering the landfill has changed since the recycling program implementation.

Further discussion and analysis of the composition of solid waste at the WCL will be included in the Landfill Gas Generation Assessment Report, when it is required.

## 5.2 Waste Quantification

Prior to the weigh scale installation in 1999, solid waste at the WCL was not measured. Several reports estimated the annual quantities, and these numbers have been used to estimate the historic quantities. After 1999, the annual quantities have been measured. The historic quantities were compiled by the ACRD and have been used to estimate the current quantity of waste at the WCL. The estimated annual weights range from 2,400 tonnes to almost 5,500 tonnes. These annual tonnages and total tonnage is attached in Appendix F.

A breakdown of the waste for 2009 and 2010 has been provided by the ACRD and is provided in Table 5.

Table 5: Measured Weight of Solid Waste Entering WCL (tonnes)

Type of Waste	2009	2010
Commercial Waste	2,999	3,114
Residential Waste	553	618
Covered Solid Waste	111	127
Construction/Demolition Waste	863	688
Gypsum	8	14
Animal Carcasses	2.7	4.5
Corrugated Cardboard	0.9	-
Wrecked Auto	11	-
Fridges and Freezers (each)	116	89
No Charge Segregated Materials	6,004	-
Steel	36	43
Washers, Dryers, Stoves (each)	220	164
Tires (each)	42	57
Recycling	83	82



Of the materials entering the landfill, it is estimated that approximately 4,540 was actually landfilled in 2009 and approximately 4,560 was actually landfilled in 2010.

As of December 2010, there is an estimated 98,500 tonnes of solid waste in place at the WCL.

### 5.3 Existing Landfill Volumes

In 1980, landfilling began at the WCL. There is no available topographic survey data to indicate the original base of the landfill. Therefore, the base of the landfill has been estimated based on the surrounding elevations at the base of the landfill toe, at an elevation of approximately 97.5 m (based on a local survey datum).

Based on the estimated original surface and the most recent topographic survey data, completed on January 4, 2011, there is approximately 275,000 m<sup>3</sup> of solid waste in the WCL. The top of the WCL fill area is not at a constant elevation, but varies significantly over the landfill footprint.

Topographic survey data is compared to the weigh scale records in order to estimate the filling rate, or density. When comparing the data from June 14, 2010 to January 4, 2011, the volume increased by approximately 13,195 m<sup>3</sup> and the solid waste received was approximately 2,681 tonnes. Therefore, a filling density of about 0.20 tonnes/m<sup>3</sup> was achieved. This density is considerably lower than that of the previous period (May 23, 2009 to June 14, 2010) where a density of approximately 0.49 tonnes/m<sup>3</sup> was achieved. The lower density is attributed to a high fill volume resulting from extra filling and cover material placement associated with the anticipated transfer of site operations from one contractor to another. A filling density of 0.49 tonnes/m<sup>3</sup> is considered appropriate for future filling projections. It should be noted that this density does not represent the actual density of the landfill, as cover material has not been included in the calculation.

## 6 PERFORMANCE CRITERIA

In 2007, Gartner Lee Limited was retained to prepare a Solid Waste Management Plan (SWMP) for the ACRD. Based on an evaluation of current public and political direction, the following plan objectives were developed:

- Reduce the amount of waste requiring disposal;
- Increase the level of recycling activity throughout the regional district; and,
- Ensure that any residual waste is disposed of in a manner that protects environmental and social well-being.

The objectives are in line with those of the *Landfill Criteria for Municipal Solid Waste* in that they promote the reduction of solid waste and thus the reduction in the production of leachate and landfill gas. The ACRD has begun implementation of the recommendations developed in the



SWMP. The following sections provide discussion on the performance criteria used to meet the objectives above.

## 6.1 Groundwater and Surface Water Quality

A bi-monthly water quality monitoring program is conducted to evaluate water quality locations around the landfill property. The program is contracted to Piteau Associates Engineering Ltd. while the field sampling program is conducted by trained ACRD staff.

The analytical results from each location are compared to the *British Columbia Approved Water Quality Guidelines* and a *Compendium of Working Water Quality Guidelines for British Columbia* for the protection of freshwater aquatic life.

Prior to the construction of the leachate collection system, leachate flowed west and then south along primary pathways located along a series of cut lines. Some leachate impacts were observed near the southwest corner of the landfill, adjacent to the Sandhill Creek tributary and at one location near the south property line. Once the leachate collection system was commissioned, the system has routed surface leachate flows into the collection ditches.

The latest monitoring report, from the 2010 year, indicates slight leachate impacts but no obvious long time increasing trends. Leachate concentrations are found to vary seasonally. Only very slight leachate impacts were observed in the receiving water monitoring site. The parameters that exceeded the guidelines were iron, manganese and aluminum, however, both iron and aluminum chronically exceed the guidelines in the background sampling sites. There were two manganese exceedances in 2010 and they are not considered characteristic for this site. The exceedances are considered anomalous results and not likely the result of leachate. Sampling data for a second location on the Sandhill Creek tributary (near Highway 4) did not show any indication of leachate impacts.

The annual water quality report reviews the results of the bi-monthly sampling program and provides an update on water quality compared to the required guidelines.

## 6.2 Leachate Generation

Leachate from the landfilled area is collected in the perimeter leachate collection ditches and transported to the leachate storage lagoon in the southwest corner of the property. The leachate is then pumped through a forcemain where it is then dispersed through a perforated pipe for irrigation.

The volume of leachate entering the storage pond and being pumped for treatment is not currently measured, and therefore actual quantities of leachate generated and treated are unknown.



The size of the leachate storage pond is approximately 5,000 m<sup>3</sup>. The current pumps were designed with a pumping capacity of about 12.5 l/s. A pond overflow is provided for when the volume resulting from heavy rainfall events exceed the capacity of the pumps.

As would be expected, the amount of leachate generated is significantly higher in the wet winter months than in the dry summer months. This is confirmed by several surface water sampling locations being dry during the summer. It should also be noted that while the amount of leachate generated in the winter is larger, the concentration or strength of the leachate is less as there is more rainwater and therefore more dilution.

An estimate of the leachate generation rates was completed as part of the water balance submitted by Piteau Associates Engineering Ltd. in 2004. A summary of the estimated flows is discussed in Section 3.3.

### **6.3 Landfill Gas Management**

The Operational Certificate (MR-5634) requires that a landfill gas generation assessment must be conducted once 100,000 tonnes of waste have been discharged at the landfill, after which the potential for landfill gas generation must be re-assessed every five years. Based on data provided by the Alberni Clayoquot Regional District, there is an estimated 98,500 tonnes of waste in the WCL, therefore, a landfill gas generation assessment has not yet been required.

Since issuing the Operational Certificate, a new landfill gas regulation has been developed. Effective January 1, 2009, the MoE released the *Landfill Gas Management Regulation*. This regulation supersedes the previous regulation and is focused on reducing greenhouse gas emissions from landfills and identifying potential landfill gas recovery opportunities. The new regulation indicates that a landfill gas generation assessment report is required once the quantity of solid waste reaches 100,000 tonnes. Should the assessment indicate that methane generation rates exceed 1,000 tonnes per year at the WCL, a landfill gas management facility must be designed and subsequently constructed.

The WCL has not yet reached 100,000 tonnes, however at current filling rates, it is anticipated to reach 100,000 tonnes in 2011. At that time, a landfill gas generation assessment must be completed. Therefore, it is estimated that a landfill gas assessment will need to be completed and submitted to the Ministry of Environment before March 31, 2012.

### **6.4 Public Health, Safety and Nuisance**

The WCL is located in a rural area, with public access via a gravel road from Highway 4. An electric bear fence surrounds the landfill property, with an electric chain link fence gate at the entrance. The landfill gate is kept closed during working hours, and opened when vehicles need to enter or exit the property. The objective of having the gate closed during operating hours is to prevent wildlife, namely bears, from gaining access to the site. Landfill staff are present at the scale shed at the WCL entrance during operating hours and are aware of users entering the



landfill property. After operating hours, the gate is closed and locked, deterring public entry on to the site.

At some landfills, odour concerns are often an issue due to the mixed composition of the solid waste. Due to the rural location of the WCL, the fact that the surrounding properties are undeveloped and regular placement of daily and intermediate cover activities, odours are not considered a concern at the WCL.

## 7 CLOSURE PLANS

Once the landfill reaches its maximum capacity, it will be decommissioned according to the closure plan. The closure plan dictates the procedures and activities that must be implemented to close the landfill according to the MoE *Landfill Criteria for Municipal Solid Waste*.

### 7.1 Closure Design

Future operations are anticipated to follow the current operations plan with construction of slopes at 3:1 to a maximum elevation of approximately 120 m, covering a land area of 9.1 ha. At closure, a landfill cap will be constructed with the objectives of:

- Minimizing rainfall infiltration into the landfill, therefore reducing the amount of leachate generated;
- Minimizing gas migration out of the landfill and towards gas collection facilities, if required;
- Controlling any odours generated by the landfill; and,
- Preventing access to the solid waste from vectors and other wildlife.

The final cap will cover the entire landfilled area and re-direct surface water away from the landfill. In addition to the landfill cap, a surface water drainage plan must also be developed.

The surface water drainage plan will be separate from the leachate collection system to reduce the volume of contaminated water needing treatment. At closure the leachate collection ditches will continue to collect leachate and direct it to the leachate storage pond. The surface water collection system will collect clean surface water and direct it into natural drainage paths. The proposed landfill at closure is shown in attached Figure 6.

In order to divert surface water, the landfill cap must be impermeable to reduce infiltration into the landfill. The proposed landfill cap is as follows:

- Topsoil layer – approximately 0.3 m thick topsoil layer to promote vegetation growth;



- Protective Layer – approximately 0.6 m thick layer of low permeability soil to act as a protective layer against both erosion and desiccation cracks;
- Drainage Layer – approximately 0.15 m thick coarse sand and gravel layer to promote drainage towards the landfill boundaries;
- Barrier Layer – impermeable synthetic geomembrane liner to prevent water infiltration into the landfill; and,
- Grading Layer – approximately 0.6 to 0.9 m thick coarse layer to grade landfill surface and provide stability.

A section through the proposed cap is shown in Figure 8. While the landfill cap is to be placed over the entire landfill surface, it is likely that some openings may be required to facilitate a landfill gas extraction system or water quality monitoring. While a landfill gas extraction system is not yet required for the landfill, one may be required in the future. The future assessment, design and construction of a landfill gas extraction system will follow the MoE *Landfill Gas Management Regulation*, effective January 1, 2009.

## 7.2 Volume and Estimated Date of Closure

Based on the design criteria presented above, the remaining landfill capacity at the WCL is estimated to be 840,000 m<sup>3</sup>. Based on a current estimated volume of 275,000 m<sup>3</sup>, there will be approximately 1,100,000 m<sup>3</sup> of solid waste at the WCL at closure.

The average annual solid waste tonnages for the last five years is about 5,000 tonnes. Using the average weight, remaining volume and the estimated filling density of 0.49 tonnes/m<sup>3</sup>, there is an estimated 82 remaining years of operating life at the WCL. Therefore, the estimated date of closure is around the year 2093.

## 7.3 Closure Notification

It is planned that closure notification will start approximately one year prior to anticipated closure. At this time appropriate signage will be placed at the landfill entrance to warn users of the upcoming closure and to notify them of new disposal locations. Approximately 3 months prior to closure, an advertising program will be initiated to notify local residents and businesses of the upcoming closure and alternative locations. Forms of advertising will include ads in the local paper and on local municipal websites.

## 7.4 Legal Obligations

Upon landfill closure, a covenant will be registered on the property indicating that the property was used as a municipal solid waste landfill, thereby meeting the requirements of the *Land Title Act*.



## 8 POST-CLOSURE PLAN

Upon closure of the WCL, water quality monitoring, landfill gas collection, site maintenance and site inspection activities will continue to be required.

### 8.1 Water Quality Monitoring

As required by the *Landfill Criteria for Municipal Solid Waste*, the water quality monitoring program will continue once the WCL has been closed. The water quality monitoring program is expected to be similar to the current program and will likely continue for at least 15 years following closure. The program will involve bi-monthly surface water and leachate monitoring at and surrounding the landfill. The water quality results will continue to be compared to the *Approved and Working Criteria for Water Quality*, published by the BC MoE. The results will be reviewed and reported yearly. The report will evaluate the effectiveness of the landfill cap and surface water drainage system and address any identified water quality issues.

After about 15 years, it is anticipated that the water quality at the landfill will stabilize and the water quality monitoring frequency can be reduced to semi-annually. After 25 years, the results will be reviewed and if there is sufficient evidence that shows that the landfill has not had significant impact on the surrounding environment, the water quality monitoring program will be completed.

### 8.2 Landfill Gas Management

A landfill gas management system may be required to be constructed prior to closure. As a collection system is not yet required and therefore not yet designed, the details of required operation, maintenance and monitoring is unknown.

Should a system be required, it is anticipated that landfill gas collection will continue after closure. A remote SCADA system will be utilized and maintenance staff will be contacted for emergencies. An inspection and monitoring program, will likely have to be established to evaluate the landfill gas collection system. The results of the collection system monitoring program will determine how long the system operates for. For cost estimating purposes, it has been assumed that monitoring will be required for a minimum of 25 years.

### 8.3 Inspection and Maintenance

After closure, a regular inspection and maintenance program must be initiated to maintain the integrity of the landfill. Inspections must include evaluation of the:

- landfill cap by noting any significant erosion, cracking, settlement or seepage;
- electric fence for structural integrity and performance;
- landfill cap for evidence of wildlife or rodent impacts; and,



- leachate collection system components for containment.

The inspection reports should identify if maintenance activities are required, such as vegetation clearing around the electric fence. Inspections are assumed to be monthly for the first year, and quarterly for the years following.

#### **8.4 Buildings/Structures**

No structures will be constructed on the finished landfill surface as there is high potential for differential settlement and landfill gas intrusion. It is understood that a small structure or shed may be required to facilitate a landfill gas collection system, and if required, will be designed and constructed with MoE approval. Past the 25 year post-closure date, it is unlikely that any structures will be constructed on the property as a covenant will be registered on the property notifying future users it was formerly operated as a landfill. At present, the WCL and surrounding area is rural and unlikely to have interest in development activities.

### **9 FINANCIAL SECURITY**

The ACRD is responsible for establishing a closure fund to cover costs associated with landfill closure and post-closure activities. Closure activities include properly capping the finished landfill face and post-closure activities include continued monitoring, inspection and maintenance. The estimated costs are tabulated in Table 6.



Table 6: Estimated Closure & Post-Closure Costs

Item	Estimated Cost
<b>Closure:</b>	
<ul style="list-style-type: none"> <li>• Landfill Cap &amp; Associated Closure Construction                             <ul style="list-style-type: none"> <li><i>Grading Layer – 0.6m sand and gravel</i> \$837,000</li> <li><i>Barrier Layer – geosynthetic membrane liner</i> \$744,000</li> <li><i>Drainage Layer – 0.15m sand and gravel</i> \$279,000</li> <li><i>Protective Layer – 0.6m low permeability soil</i> \$1,395,000</li> <li><i>Topsoil Layer – 0.3m topsoil</i> \$558,000</li> <li><i>Vegetation</i> \$23,250</li> </ul> </li> <li>• Legal Fees \$30,000</li> </ul>	
Subtotal Closure Costs =	\$3,866,250
Contingency (10%) =	\$386,625
<b>Total Closure Costs =</b>	<b>\$4,253,000</b>
<b>Post-Closure:</b>	
<ul style="list-style-type: none"> <li>• Water (surface water and leachate) Quality Monitoring:                             <ul style="list-style-type: none"> <li><i>Bi-monthly Monitoring for 15 years (\$35,000/year)</i> \$525,000</li> <li><i>Semi-Annual Monitoring for following 10 years (\$10,000/year)</i> \$100,000</li> </ul> </li> <li>• Landfill Gas Operations and Monitoring for 25 years (\$15,000 per year) \$375,000</li> <li>• Roads Maintenance (\$400/year) \$10,000</li> <li>• Surface Water Control System Inspection &amp; Maintenance (\$1,600/year) \$40,000</li> <li>• Leachate Collection System Inspection &amp; Maintenance (\$400/year) \$10,000</li> <li>• Landfill Cap Inspection &amp; Maintenance (\$400/year) \$10,000</li> <li>• Utilities (hydro for electric fence &amp; gas collection system, \$5,000/year) \$125,000</li> <li>• Miscellaneous Rehabilitation Costs (\$1,000/year) \$25,000</li> </ul>	
Subtotal Post-Closure Costs =	\$1,220,000
Contingency (10%) =	\$122,000
<b>Total Post-Closure Costs =</b>	<b>\$1,342,000</b>
<b>Total Closure &amp; Post-Closure Costs =</b>	<b>\$5,600,000</b>

A more detailed breakdown of quantities and unit costs for the landfill cap construction has been included in Appendix G. All costs are based on current dollars and do not include escalation. In the preparation of this estimate, several assumptions have been made. The above cost estimate assumes that:

- The unit costs are based on current construction values



- All construction materials are expected to be from offsite sources and estimated costs include transportation and placement
- Costs do not include the purchase or design of a new landfill site or the construction of an onsite transfer station
- No remediation work will be required at closure
- A landfill gas collection system will be implemented and will only require minor operations, maintenance and monitoring post-closure
- All water quality monitoring sample locations be constructed prior to closure
- All post-closure inspections and maintenance will be provided by ACRD staff
- Access roads will be constructed prior to closure as part of regular operation
- Major drainage paths and surface water controls will be implemented prior to closure
- Engineering design fees will be included in the operations budget in the years prior to closure

All of the above costs should be considered preliminary as it is difficult to predict costs for greater than 80 years into the future. It should be expected that actual costs will vary significantly and they should be updated regularly to reflect current technology, construction practices and prices.

In order to allow the ACRD to save an appropriate financial security to cover closure and post-closure costs, annual contributions should be made to the WCL Closure Fund. The following table summarizes the estimated costs, amount of current closure fund and recommended annual closure fund allocation.

Table 7: Summary of WCL Closure Fund Status

<b>Item</b>	<b>Estimated Cost</b>
Total Closure & Post Closure Costs	\$5,600,000
Current Closure & Post-Closure Fund	\$200,000
Required for Financial Security	\$5,400,000
Annual Allocation (based on 80 years)	\$70,000

It is recommended that \$70,000 be added to the WCL Closure Fund each year, based on 80 years until closure. This should be reviewed at regular intervals to evaluate if it is sufficient.



## 10 REVIEW OF SOLID WASTE MANAGEMENT PLAN RECOMMENDATIONS

In 2007, a Solid Waste Management Plan (SWMP) was completed by Gartner Lee Limited for the ACRD. It reviewed the status of solid waste management within the ACRD, the regional facilities and provided recommendations. The report made several recommendations for items to be completed at the WCL in the upcoming years.

During the time of the SWMP preparation, the WCL was considered out of compliance with the MoE operational certificate due to leachate quality at the property boundary having had occurrences of water quality above the criteria and with not submitting the design, operations and closure plan. With the current water quality data and submission and approval of this design, operations and closure report, the WCL will meet these two criteria.

In addition, the report provided a list of tasks that must be completed and these included:

- Assessing the leachate collection and treatment system to establish work required to reduce off-site impacts; and,
- Completing an assessment to evaluate long term costs of operating the WCL compared with costs of transferring solid waste to the Alberni Valley Landfill (AVL).

Should the WCL be the preferred option and continue to operate, the report recommended:

- Upgrades to the leachate collection system;
- Preparing an operations and closure plan;
- Operating the WCL in accordance with the *BC Landfill Criteria for Municipal Solid Waste* and the *Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills*; and,
- Providing adequate training for operations personnel.

Since the completion of the SWMP report, the leachate collection system has received maintenance such as clearing of the leachate collection ditches and maintenance work on the leachate pumps. An electromagnetic survey of the west leachate collector ditch indicated an area where leachate may be escaping and this area is going to be further investigated. Water quality sampling of the receiving surface water site has shown some leachate impacts, however they have not exceeded the criteria for the last 2 years, with the exception of those naturally occurring (as seen by background sample concentrations). Therefore, at this time, no major upgrades or infrastructure work is considered to be required on the leachate collection system.

An evaluation of the costs of operating the WCL compared with transferring solid waste to the AVL has not yet been completed. Prior to spending funds to complete the study, the ACRD needs approval that transferring the solid waste to the AVL is a viable option. While the AVL currently has capacity to accept the additional waste, the impacts of the increased waste disposal must be reviewed with local residents, community groups, First Nations communities



and government agencies. Upon preliminary consultation with these groups, the ACRD will decide whether or not to proceed with an assessment of costs for considering early closure of the WCL and construction of a transfer station.

For this design, operations and closure report it has been assumed that the WCL will not be closed and converted to a transfer station. Should an assessment be conducted to consider switching to a transfer station, the study must address:

- Capital costs associated with transfer station construction;
- Maintenance and operation costs of transfer station;
- Operational costs of trucking and disposal at AVL;
- Capital costs associated with early closure of the WCL;
- Operations costs for post closure monitoring of water quality and leachate collection system; and,
- Operations costs for post-closure inspection and necessary maintenance.

The current WCL operator has completed the Manager of Landfill Operations training with the Solid Waste Association of North America. Current WCL site personnel have been trained with landfill operations with the site superintendent having over 12 years of experience working at landfills. All landfill staff also have basic first aid training.

Once this design, operations and closure report has been approved, the WCL will be operating in compliance with the *BC Landfill Criteria for Municipal Solid Waste* and the *Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills*.



## 11 LIMITATIONS

This document was prepared by McGill & Associates Engineering Ltd. for the Ministry of Environment, on behalf of the Alberni-Clayoquot Regional District. Its material, recommendations and conclusions represent the best material available to McGill & Associates Engineering Ltd. at the time of the report preparation. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. McGill & Associates Engineering Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Yours truly,

for **McGill & Associates Engineering Ltd.**

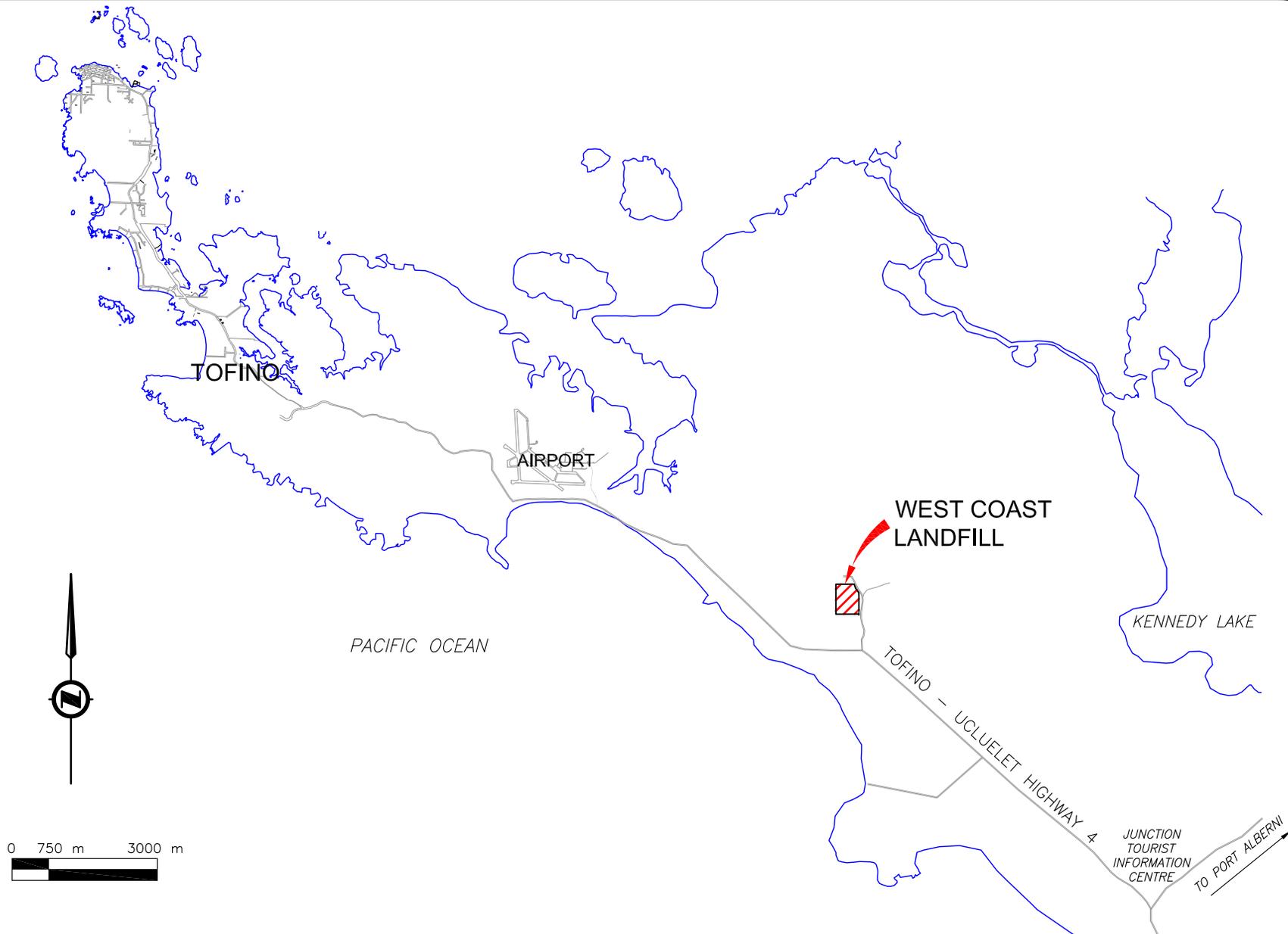
**Sarah Waldriff, P.Eng.**

**Alan McGill, P. Eng.  
Principal**



## FIGURES





JANUARY 2012

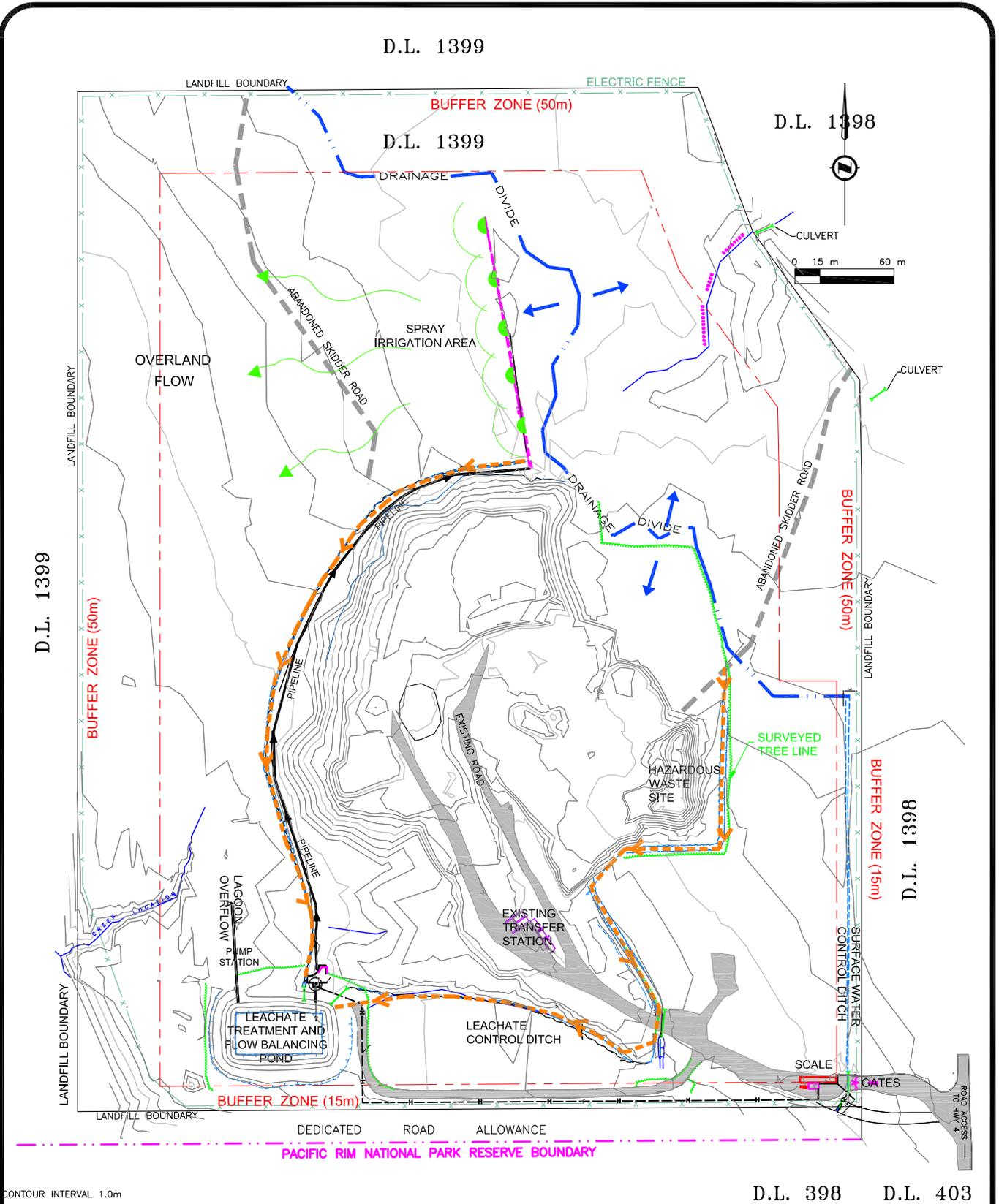
ALBERNI CLAYOQUOT REGIONAL DISTRICT  
WEST COAST LANDFILL - DESIGN OPERATIONS & CLOSURE REPORT

SITE LOCATION PLAN

FIGURE 1



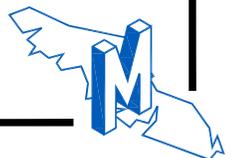
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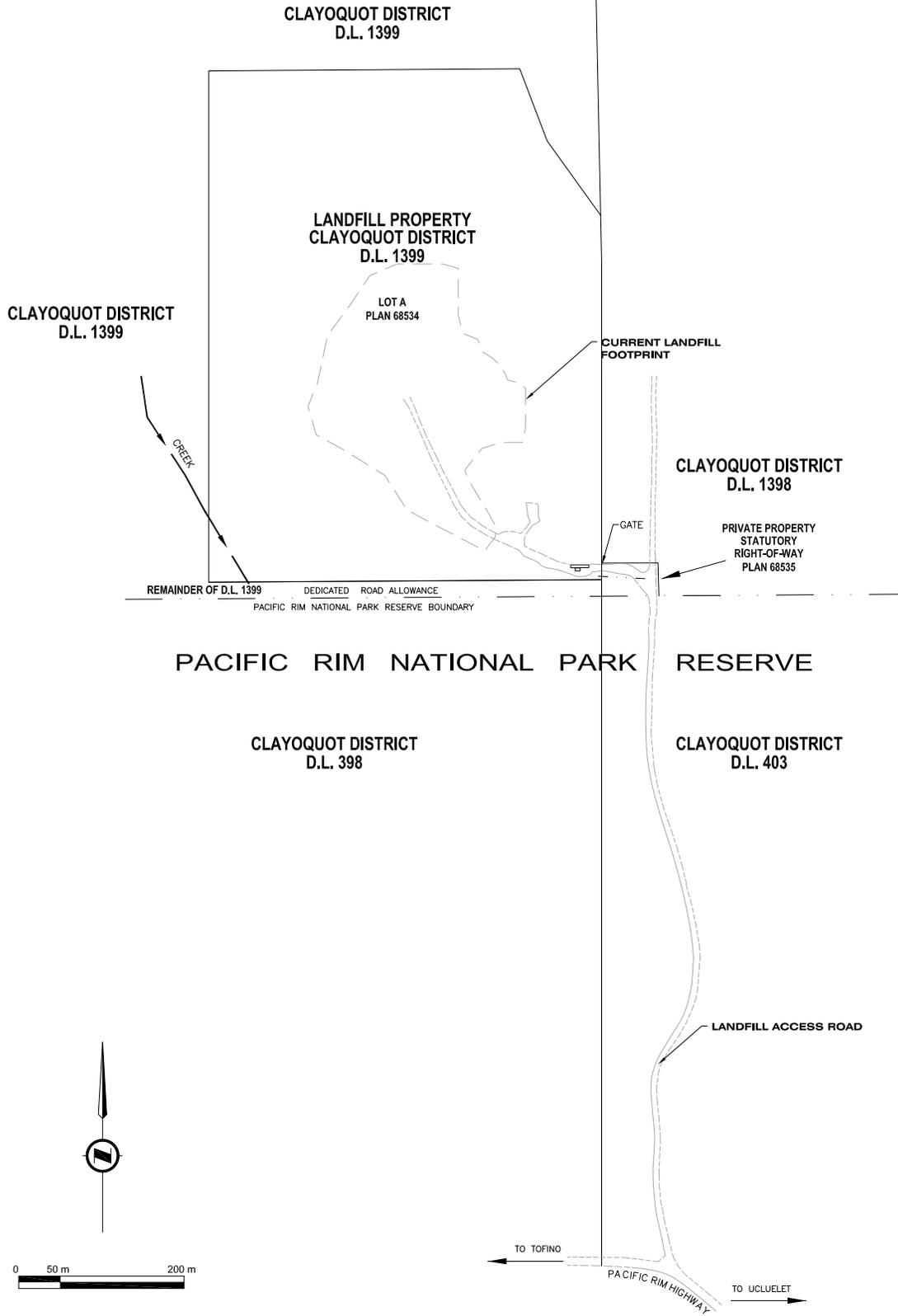
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ALBERNI CLAYOQUOT REGIONAL DISTRICT  
 WEST COAST LANDFILL  
 DESIGN OPERATIONS & CLOSURE REPORT  
 SITE PLAN

FIGURE 2



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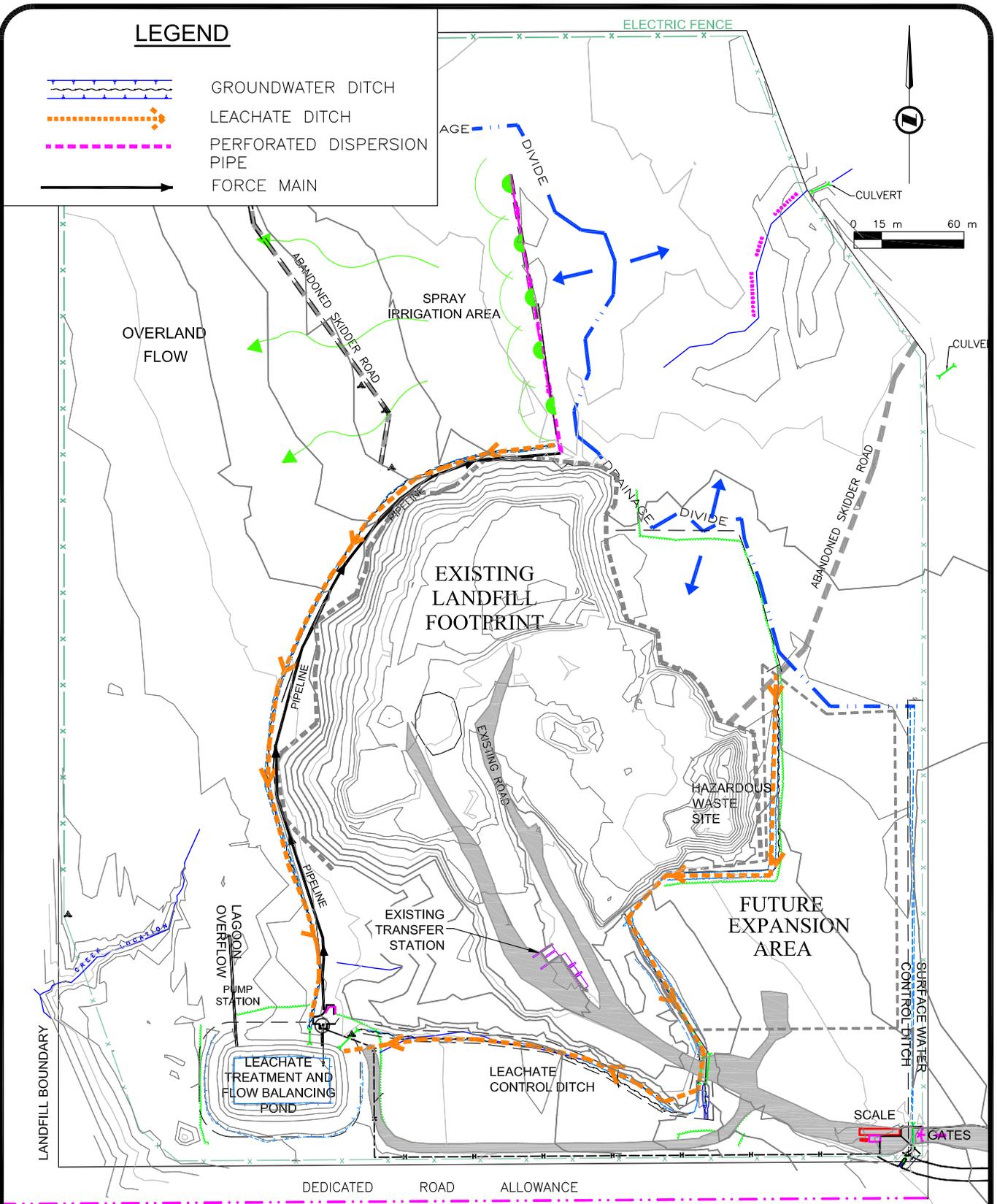


ALBERNI CLAYOQUOT REGIONAL DISTRICT  
WEST COAST LANDFILL  
DESIGN OPERATIONS & CLOSURE REPORT  
LANDFILL BUFFERS & SURROUNDING LAND USE PLAN

FIGURE 3

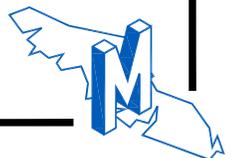


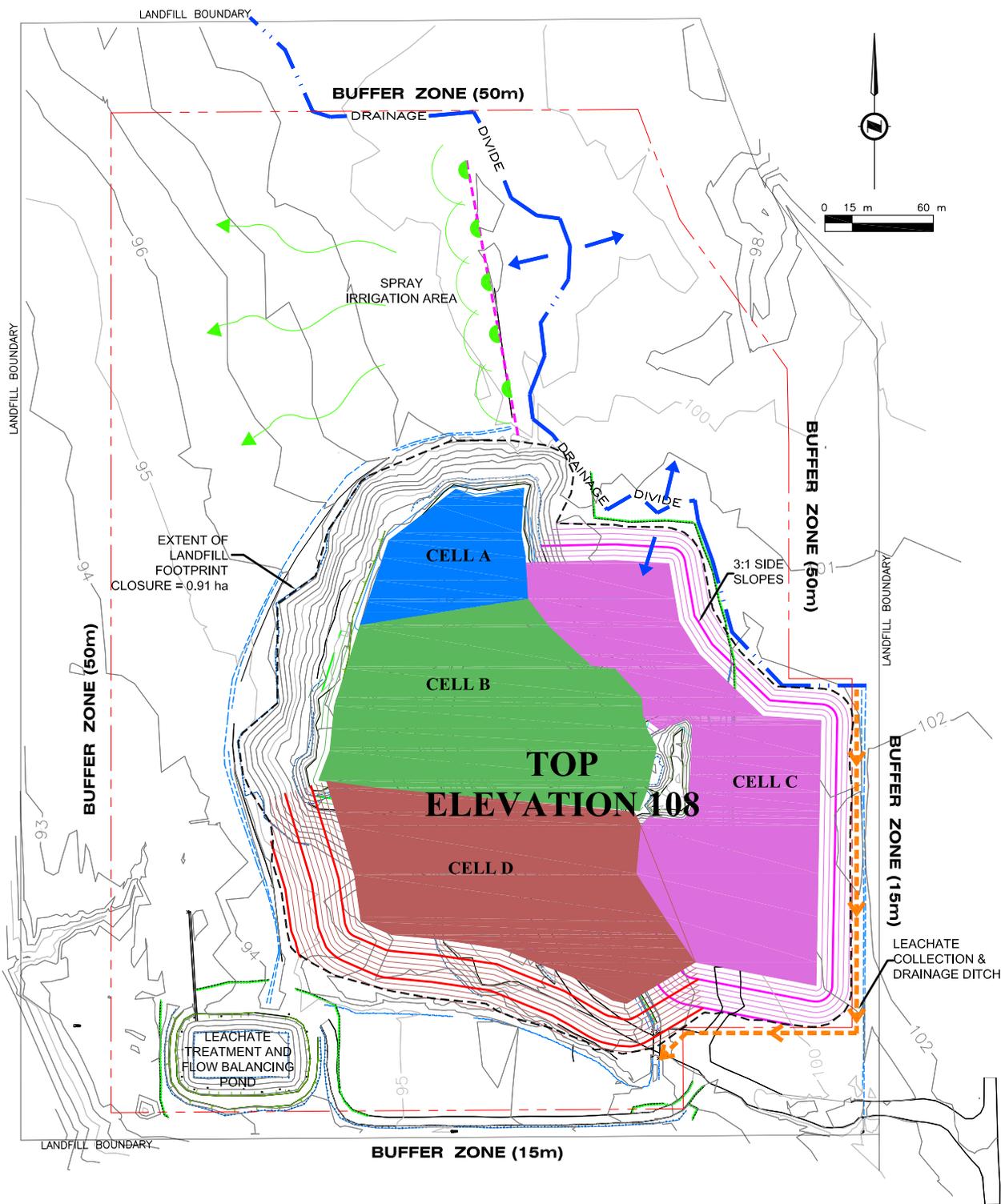
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ALBERNI CLAYOQUOT REGIONAL DISTRICT  
 WEST COAST LANDFILL  
 DESIGN OPERATIONS & CLOSURE REPORT  
 LEACHATE COLLECTION SYSTEM

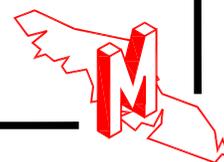
FIGURE 4

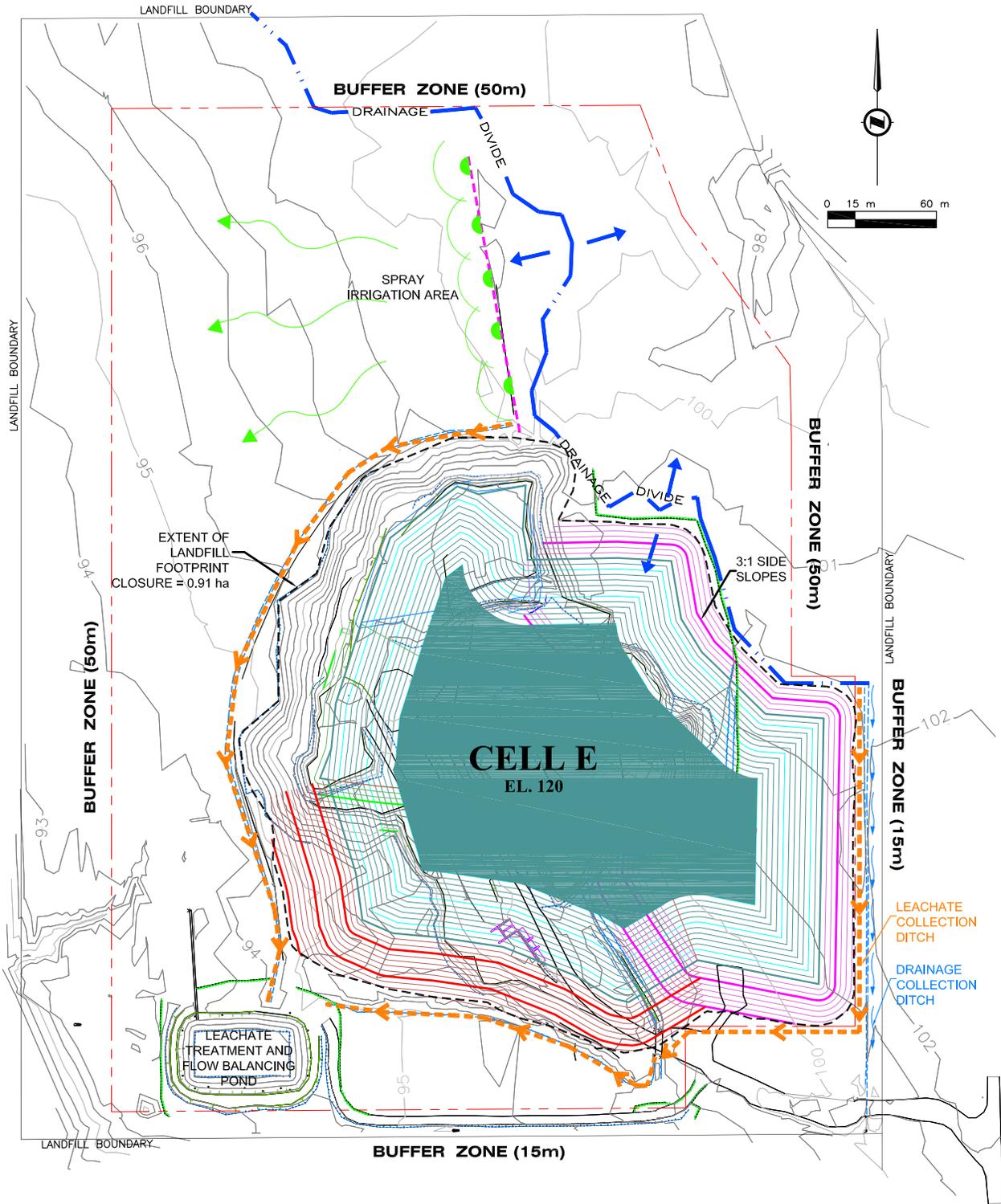




ALBERNI CLAYOQUOT REGIONAL DISTRICT  
WEST COAST LANDFILL  
DESIGN OPERATIONS & CLOSURE REPORT  
PROPOSED FILLING PLAN - CELLS A TO D

FIGURE 5



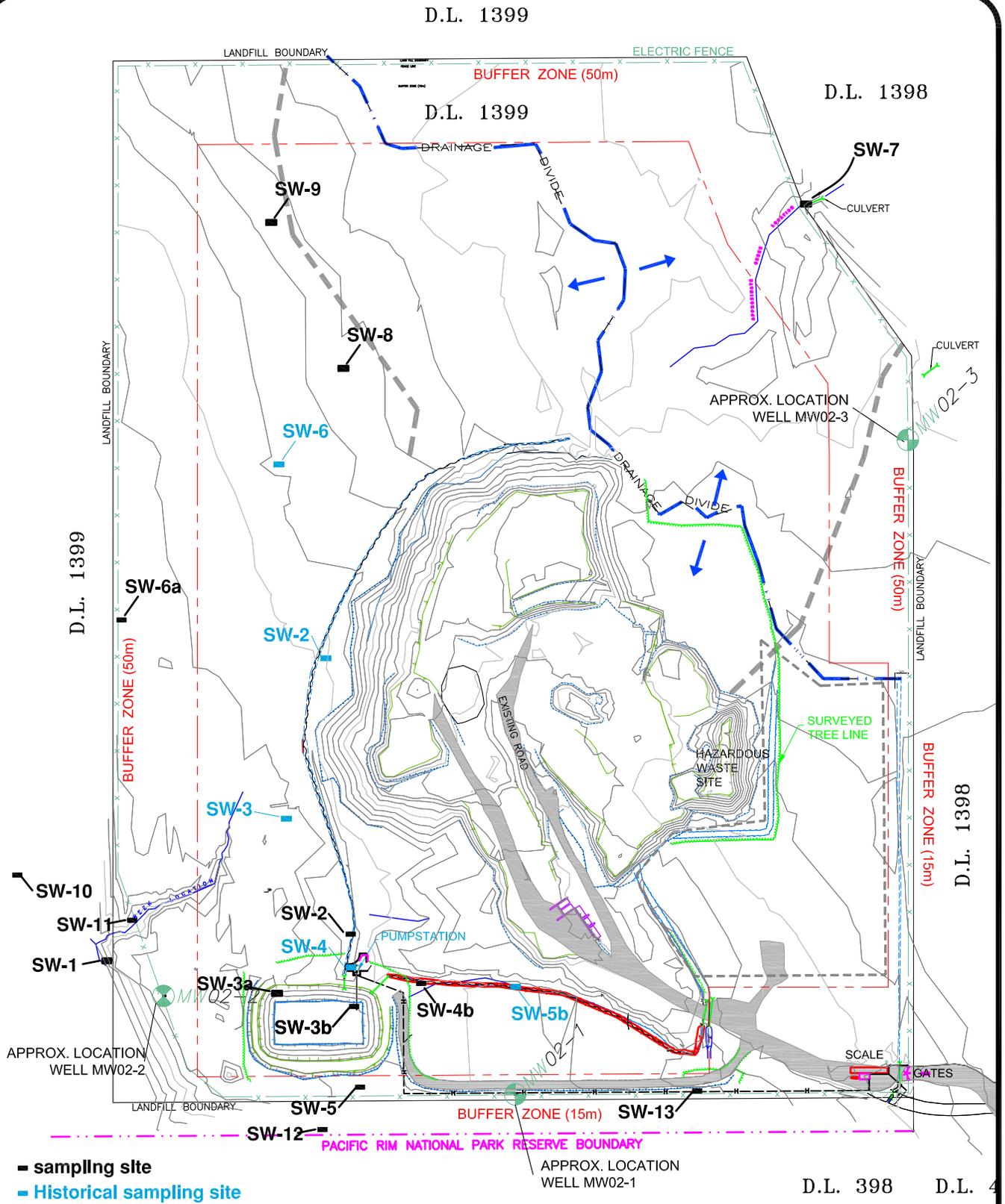


ALBERNI CLAYOQUOT REGIONAL DISTRICT  
WEST COAST LANDFILL  
DESIGN OPERATIONS & CLOSURE REPORT  
PROPOSED FILLING PLAN - CELL E

FIGURE 6



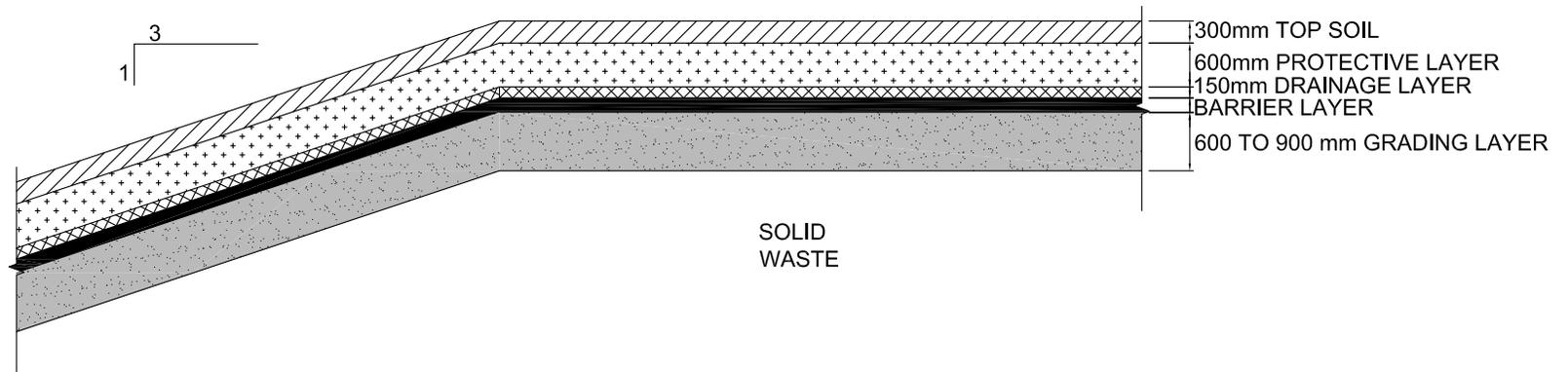
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ALBERNI CLAYOQUOT REGIONAL DISTRICT  
WEST COAST LANDFILL  
DESIGN OPERATIONS & CLOSURE REPORT  
WATER QUALITY MONITORING LOCATIONS

FIGURE 7





JANUARY 2012

ALBERNI CLAYOQUOT REGIONAL DISTRICT

FIGURE 8

WEST COAST LANDFILL - DESIGN, OPERATIONS & CLOSURE REPORT

LANDFILL COVER DETAIL



**APPENDIX A**  
**OPERATIONAL CERTIFICATE MR-05634**





MINISTRY OF WATER, LAND  
AND AIR PROTECTION

Vancouver Island Region  
Environmental Protection  
2080-A Labieux Road  
Nanaimo, British Columbia  
V9T 6J9  
Telephone: (250) 751-3100  
Fax: (250) 751-3103

**OPERATIONAL CERTIFICATE**  
MR-05634

*Under the Provisions of the Environmental Management Act*

**Regional District of Alberni-Clayoquot**  
**3008 Fifth Avenue**  
**Port Alberni, British Columbia**  
**V9Y 2E3**

is authorized to manage recyclable material and waste from the Regional District of Alberni-Clayoquot and environs at the West Coast landfill located between Ucluelet and Tofino, British Columbia, subject to the conditions listed below. Contravention of any of these conditions is a violation of the *Environmental Management Act* and may result in prosecution.

**1. MANAGEMENT OF WASTE AND RECYCLABLE MATERIAL**

**1.1. Sanitary Landfill**

- 1.1.1. This subsection applies to the discharge of waste to a sanitary landfill.
- 1.1.2. Waste may be discharged to the sanitary landfill shown on attached Site Plan A.
- 1.1.3. The characteristics of the discharge must be municipal solid waste as defined under the *Environmental Management Act* and other wastes as approved in writing by the Director.
- 1.1.4. The authorized works are a sanitary landfill, and related appurtenances approximately located as shown on attached Site Plan A.
- 1.1.5. The authorized works must be complete and in operation on and from the date of this operational certificate.

**1.2. Leachate**

- 1.2.1. This subsection applies to the management and disposal of leachate from the landfill.

Date Issued:  
Date Amended:  
(most recent)  
Page: 1 of 4

APR 12 2005

R. Alexander  
for Director, *Environmental Management Act*

OPERATIONAL CERTIFICATE: MR-05634

- 1.2.2. The characteristics of the leachate at the property boundary must not exceed concentrations set in the *British Columbia Approved Water Quality Guidelines (Criteria)* and *A Compendium of Working Water Quality Guidelines for British Columbia*. Where natural background water quality concentrations exceed the aforementioned guidelines, characteristics of the leachate must not exceed background concentrations.
- 1.2.3. The authorized works are a leachate collection and conveyance system, leachate treatment works, discharge distribution pipe, and related appurtenances approximately located as shown on Site Plan A.
- 1.2.4. The authorized works must be complete and in operation on or before September 30, 2005.

### **1.3. Location of authorized facilities**

The location of the facilities for the management of waste and recyclable material to which this operational certificate is applicable is Lot A, Plan VIP 68534 and Plan VIP 38600, District Lot 1399, Clayoquot Land District.

## **2. GENERAL REQUIREMENTS**

### **2.1. Entrance facilities**

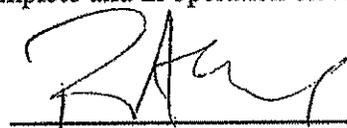
- 2.1.1. The authorized facilities are signs, weigh scales, recyclable material and waste drop-off and storage facilities and related appurtenances approximately located as shown on attached Site Plan A.
- 2.1.2. The authorized facilities must be complete and in operation on and from the date of this operational certificate.

### **2.2. Bear-Proof Facilities**

- 2.2.1. Bears must not access putrescible waste at the landfill facility. All putrescible waste that arrives at the landfill facility must be immediately contained within a bear-proof bin or an area enclosed by a bear-proof electric fence. Grass, leaves, weeds, branches and woodwaste are exempt from bear-proofing requirements.
- 2.2.2. A bear-proof electric fence must be installed around the landfill.
- 2.2.3. The bear-proof fence must be designed, constructed, operated and maintained to prevent bears from penetrating the fence.
- 2.2.4. The bear-proof electric fence must be complete and in operation on and from the date of this operational certificate.

Date Issued:  
Date Amended:  
(most recent)  
Page: 2 of 4

APR 12 2005



R. Alexander  
for Director, *Environmental Management Act*

OPERATIONAL CERTIFICATE: MR-05634

### **2.3. Qualified Professionals**

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

### **2.4. Plans**

- 2.4.1. Site development, operating, leachate management, closure and post closure plans must be submitted to the Regional Manager, Environmental Protection, by December 31, 2005.
- 2.4.2. The plans must address, but not be limited to, each of the subsections in the *Landfill Criteria for Municipal Solid Waste* including performance, siting, design, operational and closure and post-closure criteria.
- 2.4.3. The facilities must be developed, operated and closed in accordance with the plans.

### **2.5. Landfill Gas**

- 2.5.1. When 100,000 tonnes of waste have been discharged at the landfill, an assessment of the potential for landfill gas generation must be submitted to the Regional Manager, Environmental Protection.
- 2.5.2. The landfill gas assessment must address, but is not limited to, subsections 4.2 and 6.4 of the *Landfill Criteria for Municipal Solid Waste* and section 6 of the *Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills*.
- 2.5.3. The potential for landfill gas generation is to be re-assessed at least once every 5 years after the initial assessment.

### **2.6. Seismic and Fault Activity**

A report that assesses the risk from seismic and fault activity must be submitted to the Regional Manager, Environmental Protection, by December 31, 2005.

### **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, additional leachate and landfill gas management facilities. The Director may also amend the requirements of any of the information required by this operational certificate including plans, programs, assessments and reports.

Date Issued: APR 12 2005  
Date Amended:  
(most recent)  
Page: 3 of 4



R. Alexander  
for Director, *Environmental Management Act*

### **3. MONITORING AND REPORTING**

#### **3.1. Monitoring Program**

- 3.1.1. A monitoring program must be developed to identify any impacts to the environment and public health from the landfill.
- 3.1.2. The monitoring program must address, but not be limited to, subsections 4.1, 4.2 and 7.15 of the *Landfill Criteria for Municipal Solid Waste* and the *Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills*.
- 3.1.3. Monitoring must be conducted in accordance with the monitoring program.

#### **3.2. Annual Operating and Monitoring Report**

- 3.2.1. An annual operating and monitoring report for the preceding 12 month period from January 1 to December 31 must be submitted to the Regional Manager, Environmental Protection, by June 1 of each year.
- 3.2.2. The report must include:
- An executive summary;
  - Tonnage of each type of waste discharged to the landfill for the year;
  - Remaining site life and capacity;
  - Review of the preceding year of operation, plans for the next year and any new information or proposed changes relating to the facilities and plans;
  - Comparison of the monitoring data with the performance criteria in section 4 of the *Landfill Criteria for Municipal Solid Waste* and the *Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills*, interpretation of the monitoring data, identification and interpretation of irregularities and trends, recommendations, and any proposed changes to the monitoring program.

### **4. SITE CLOSURE**

#### **4.1. Closure and Post-Closure Fund**

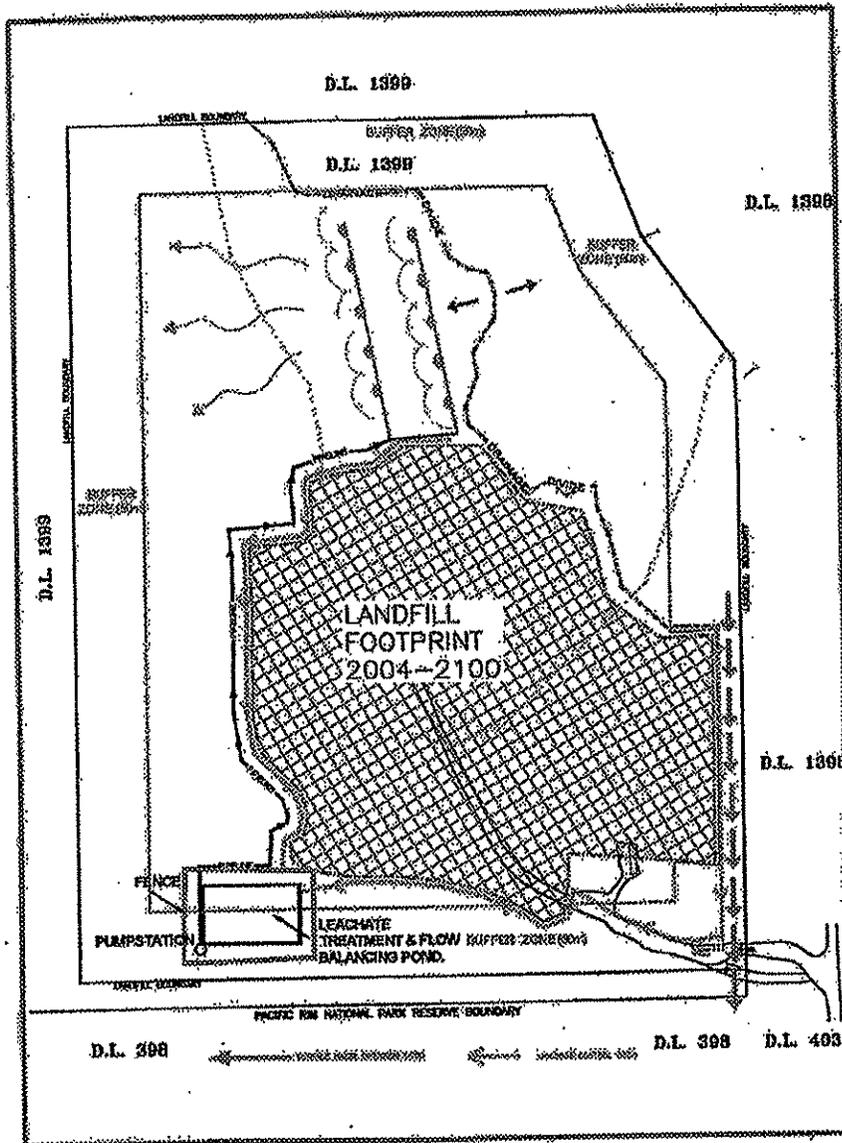
A closure and post-closure fund must be built up over time. The closure and post-closure fund must ultimately meet or exceed the estimated closure and post-closure costs plus a reasonable contingency for any remediation that may be required.

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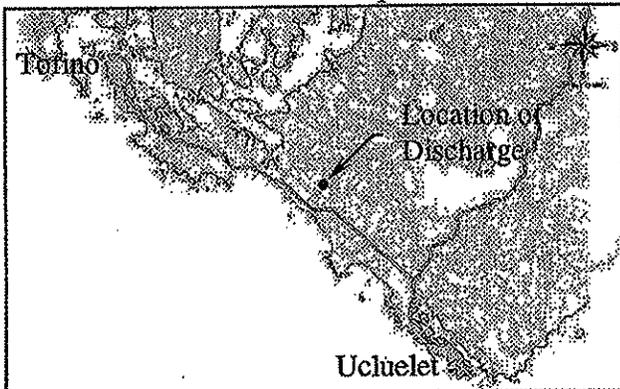


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### SITE PLAN A



Location Map



Scale: NTS

OPERATIONAL CERTIFICATE: MR-05634

Date: APR 12 2005

R. Alexander  
for Director, *Environmental Management Act*

**APPENDIX B**  
**LIST OF REPORTS**



## LIST OF REPORTS

- Associated Engineering Services Ltd. "*Solid Waste Study, West Coast Region*". Report prepared for the Regional District of Alberni-Clayoquot, January 16, 1975.
- Stanley Associates Engineering Ltd. "*Solid Waste Management, Tofino-Ucluelet Area*". Report prepared for the Regional District of Alberni-Clayoquot, May 1990.
- Cameron Advisory Services Ltd. "*Solid Waste Management Plan - Stage 1 Report*". Report prepared for the Alberni-Clayoquot Regional District, August 1994.
- Cameron Advisory Services Ltd. "*Solid Waste Management Plan - Stage 2 Final Report*". Report prepared for the Alberni-Clayoquot Regional District, November 1995.
- Cameron Advisory Services Ltd. "*Solid Waste Management Plan*". Report prepared for the Alberni-Clayoquot Regional District, August 1996.
- Piteau Associates Engineering Ltd. "*1999/2000 Monitoring - West Coast Landfill, Alberni-Clayoquot Regional District*". Report prepared for McGill & Associates Engineering Ltd., January 23, 2001. (Piteau File #1576)
- Cameron Advisory Services Ltd., "*Report on Natural Wetland Leachate Treatment at the West Coast Landfill*". Report prepared and submitted with McGill & Associates Engineering Ltd. Letter to Ministry of Environment, October 12, 2000.
- Piteau Associates Engineering Ltd., "*Geotechnical Investigation - West Coast Landfill, Tofino, B.C.*" Report prepared for McGill & Associates Engineering Ltd., October 13, 2000. (Piteau File #1576)
- Piteau Associates Engineering Ltd., "*Response to MOELP Letters of March 14 and May 14, 2011, West Coast Landfill*" Report prepared for McGill & Associates Engineering Ltd., July 15, 2001. (Piteau File #1576)
- Piteau Associates Engineering Ltd., 2000/2001. "*Water Quality Monitoring Program*" to Fall 2001 - West Coast Landfill, Tofino, B.C. Report prepared for the Alberni-Clayoquot Regional District, January 2, 2002.
- Piteau Associates Engineering Ltd. "*Results of Drilling Investigation for West Coast Landfill, Regional District of Alberni-Clayoquot, Tofino, B.C.*" Report prepared for the McGill & Associates Engineering Ltd., November 5, 2002. (Piteau File #1576)

- Piteau Associates Engineering Ltd., “2003 Monitoring - West Coast Landfill – Alberni-Clayoquot Regional District” Report prepared for McGill & Associates Engineering Ltd., January 2, 2004. (Piteau File #1576)
- Piteau Associates Engineering Ltd., “Water Balance for West Coast Landfill, Regional District of Alberni-Clayoquot, Tofino, BC”. Report prepared for McGill & Associates Engineering Ltd., April 28, 2004. (Piteau File #1576)
- Piteau Associates Engineering Ltd. “Evaluation of West Coast Landfill Site and Operation, Relative to the Landfill Criteria for Municipal Solid Waste”. Prepared for McGill & Associates Engineering Ltd., April 29, 2004. (Piteau File #1576)
- McGill & Associates Engineering Ltd. “West Coast Landfill, Tofino, BC – Leachate Collection, Treatment and Future Development”. Prepared for Ministry of Water, Land and Air Protection, May 2004. (McGill File # 1755)
- Piteau Associates Engineering Ltd. “2004 Monitoring – West Coast Landfill – Alberni-Clayoquot Regional District”. Prepared for McGill & Associates Engineering Ltd., December 15, 2004. (Piteau File #1576)
- Piteau Associates Engineering Ltd. “2005 Monitoring – West Coast Landfill – Alberni-Clayoquot Regional District”. Prepared for McGill & Associates Ltd., January 30, 2006 (draft). (Piteau File #1576)
- Piteau Associates Engineering Ltd., “2006 Monitoring – West Coast Landfill – Alberni-Clayoquot Regional District” Report prepared for Alberni-Clayoquot Regional District, February 19, 2007. (Piteau File #1576)
- Gartner Lee Limited. “Solid Waste Management Plan”. Report prepared for the Alberni Clayoquot Regional District, November 2007. (Gartner File #GLL 60717)
- Piteau Associates Engineering Ltd., “2007 Monitoring – West Coast Landfill – Alberni-Clayoquot Regional District” Report prepared for the Alberni-Clayoquot Regional District, April 30, 2008. (Piteau File #1576)
- Piteau Associates Engineering Ltd. “2008 Monitoring – West Coast Landfill – Alberni-Clayoquot Regional District” Prepared for the Alberni-Clayoquot Regional District, May 13, 2009. (Piteau File #1576)
- Piteau Associates Engineering Ltd. “2009 Monitoring – West Coast Landfill – Alberni-Clayoquot Regional District” Prepared for the Alberni-Clayoquot Regional District, May 28, 2010. (Piteau File #1576)

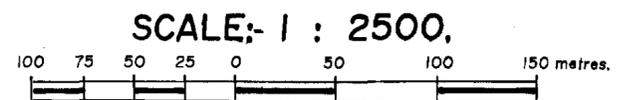
- McGill & Associates Engineering Ltd. *“West Coast Landfill, 2008 Operations and Monitoring Report”* Prepared for the British Columbia Ministry of Environment, December 2010. (McGill File #1602-2010)
- Piteau Associates Engineering Ltd. *“2009 Leachate Excursion Investigation, West Coast Landfill, Tofino, BC”*. Prepared for the McGill & Associates Engineering Ltd., February 2, 2010.
- Risk Management Services Inc. *“Risk Control Survey, Alberni-Clayoquot Regional District”* Prepared for the Alberni-Clayoquot Regional District, July 20, 2011.
- Piteau Associates Engineering Ltd. *“2010 Monitoring – West Coast Landfill – Alberni-Clayoquot Regional District”* Prepared for the Alberni-Clayoquot Regional District, July 28, 2011. (Piteau File #1576)

**APPENDIX C**  
**WEST COAST LANDFILL LEGAL PLANS**



# REFERENCE PLAN OF PART OF DISTRICT LOT 1399, CLAYOQUOT DISTRICT (PURSUANT TO SECTION 99 (1)(h) OF THE LAND TITLE ACT).

## PLAN NO.-VIP-68534



B.C.G.S. 92F.002

EN10672  
jk

Deposited in the Land Title Office  
at Victoria, B.C.  
this 5 day of FEB, 1998  
Bauman  
Registrar.

- LEGEND:-**
- OP - denotes wooden post found.
  - RP - denotes reference post placed.
  - - denotes Standard Iron Post found.
  - - denotes Standard Iron Post placed.
  - ⊙ - denotes Standard Capped Post found.
  - ⊗ - denotes Standard Capped Post placed.

All distances are in metres & decimals thereof.  
Bearings are astronomic and are derived from the plan &  
the field notes for D.L. 1399, Clayoquot District.

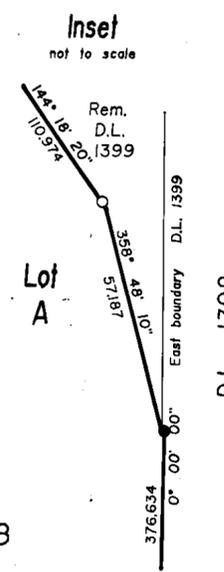
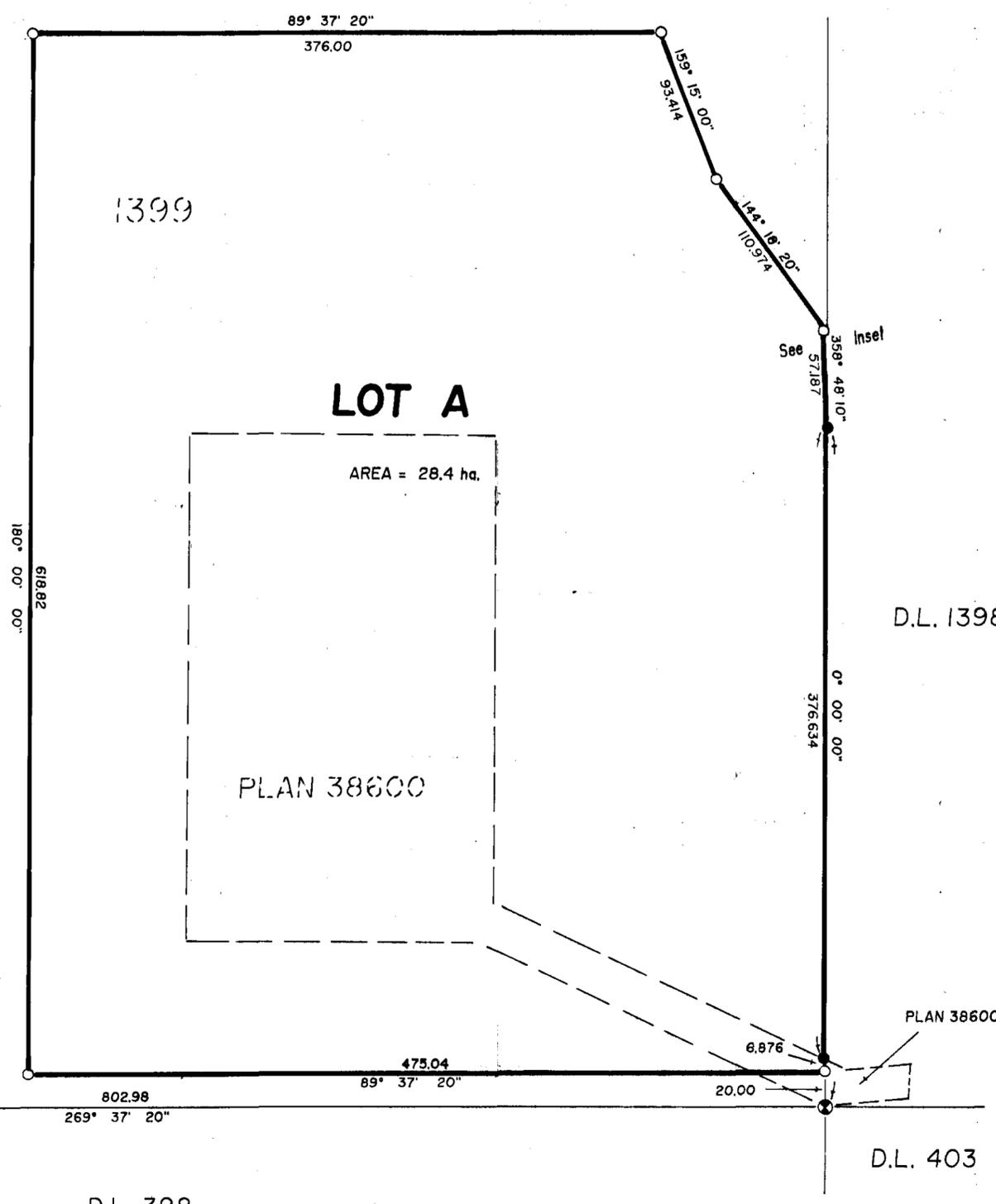


MacMILLAN BLOEDEL LIMITED Reg. no. A-47301  
owner  
[Signature]  
authorized signatory N. Bruce Kulla

[Signature]  
authorized signatory Christine E. Mynett

[Signature]  
Witness Roxana Sychuk

[Signature]  
Administrative Assistant  
witness occupation  
925 W. Georgia St., Vancouver, BC  
witness address V6C 3L2



BT's Fd.  
0.5m hem 92°, 4.97m (mkd. BT 25)  
0.3m hem 329°, 4.31m (stump)

BT's  
0.4m hem. 210° (mag.) 4.06m  
0.6m ced. 285°, 10.5m

OP - RP

ACRES & POLLOCK  
B.C. LAND SURVEYORS  
PORT ALBERNI  
PHONE - (250) 723 5412  
FILE - 7771

I, David Michael Pollock, a British Columbia  
Land Surveyor, of Port Alberni, in British Columbia,  
certify that I was present at and personally  
superintended the survey represented by this plan,  
and that the survey and plan are correct.

The survey was completed on the 19th day of  
MARCH, 1998.

[Signature]  
B.C.L.S.



**PLAN OF STATUTORY RIGHT-OF-WAY OVER PART OF DISTRICT LOT 1398, CLAYOQUOT DISTRICT. (PURSUANT TO SECTION 99 (1)(e) OF THE LAND TITLE ACT).**

**PLAN NO. VIP 68535**

SCALE:- 1 : 500.

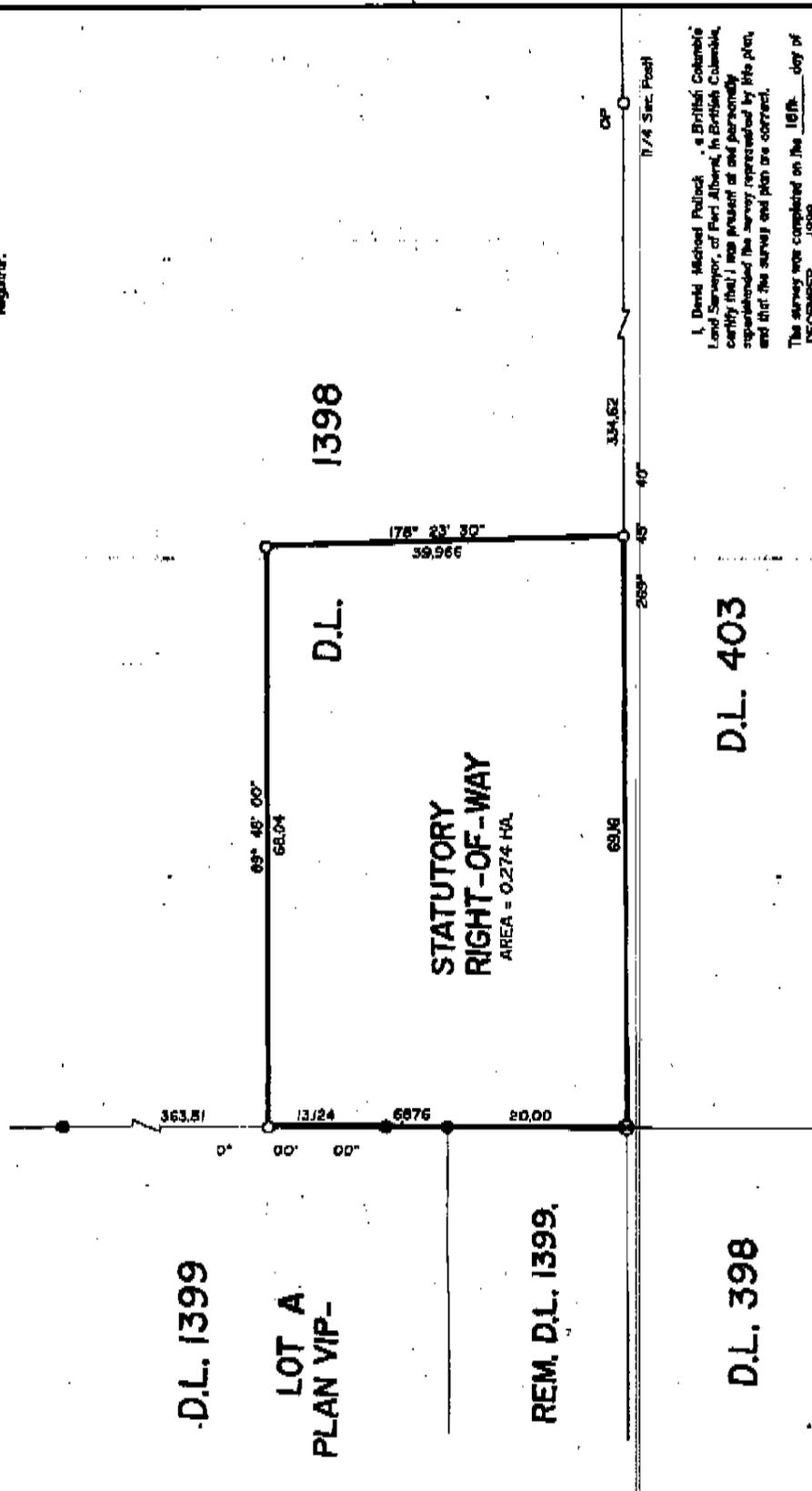


B.C.G.S. 92F.002

**LEGEND:-**

- denotes Standard Iron Post found.
- denotes Standard Iron Post placed.
- ⊙ denotes Standard Copied Post found.
- ⊙ denotes uncoloured post found.

All distances are in metres & bearings true. Bearings are astronomic and are derived from Plan VIP.



Deposited in the Land Title Office, of Victoria, B.C.

This 5 day of FEB 1999

*[Signature]*  
Registrar.

I, David Michael Pollock, a British Columbia Land Surveyor, of Port Alberni, in British Columbia, certify that I was present at and personally supervised the survey represented by this plan, and that the survey and plan are correct.

The survey was completed on the 18th day of DECEMBER, 1998.

*[Signature]*  
B.C.L.S.

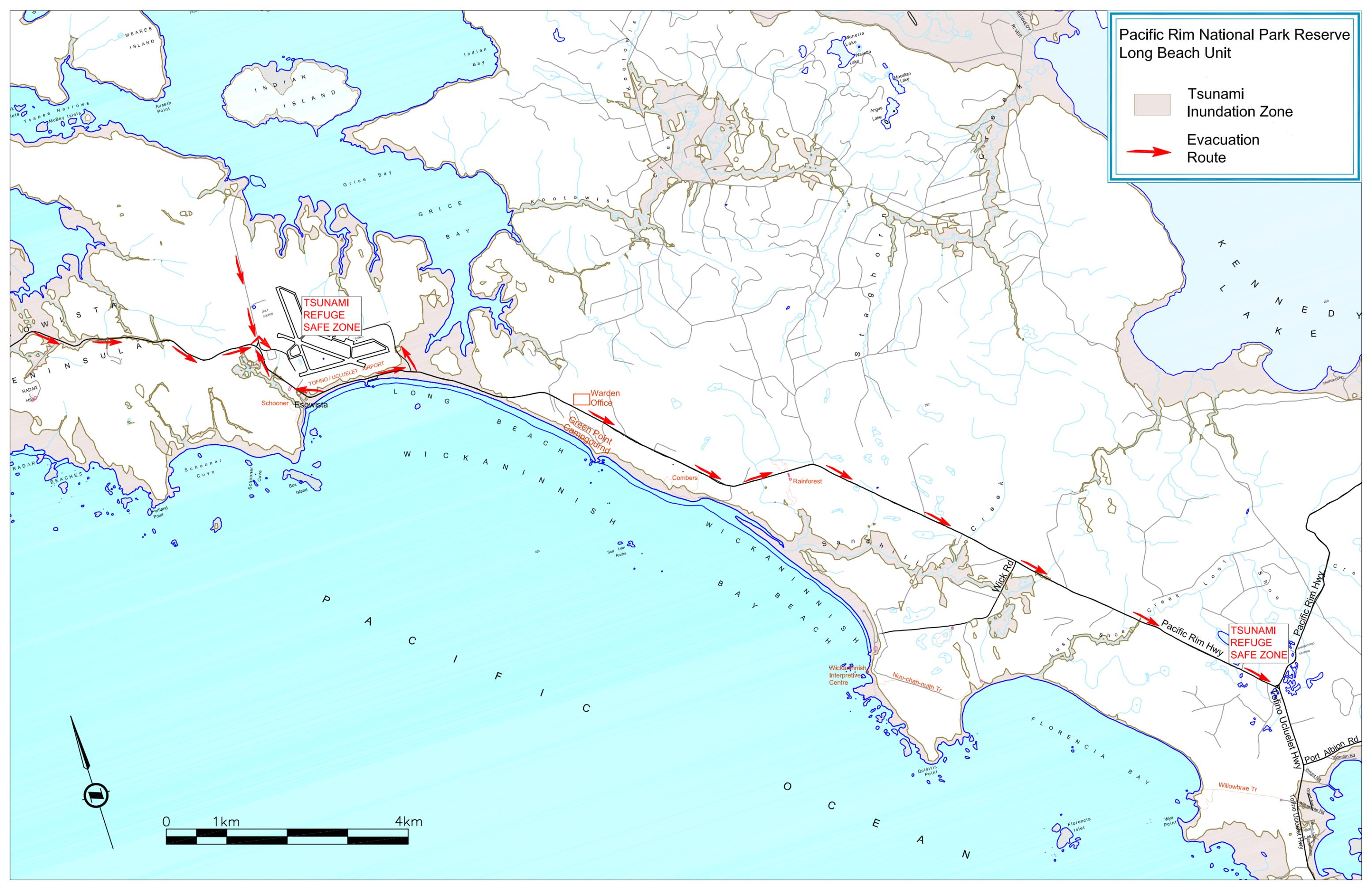
ACRES & POLLOCK  
B.C. LAND SURVEYORS  
PORT ALBERNI  
PHONE - (250) 723 5412  
FILE - 7771

## **APPENDIX D**

### **TSUNAMI INUNDATION ZONE AND EVACUATION ROUTES FOR THE PACIFIC NATIONAL PARK RESERVE, LONG BEACH UNIT**

**Pacific Rim National Park Reserve  
Long Beach Unit**

-  Tsunami Inundation Zone
-  Evacuation Route



## **APPENDIX E**

### **ALBERNI-CLAYOQUOT REGIONAL DISTRICT BYLAW R1010-1**



**REGIONAL DISTRICT OF ALBERNI-CLAYOQUOT**

**BYLAW NO. R1010-1**

A Bylaw to Amend Tipping Fees for  
the West Coast Landfill

**WHEREAS** by Supplementary Letters Patent, dated August 10th, 1973 as amended, the Regional District of Alberni-Clayoquot was granted the function of Garbage Disposal under Division XIV of its Letters Patent;

**AND WHEREAS** the Regional District of Alberni-Clayoquot is empowered to establish a scale of charges payable for depositing refuse at a disposal site;

**AND WHEREAS** the Regional Board of the Regional District of Alberni-Clayoquot has established regulations and a scale of charges for the West Coast Landfill;

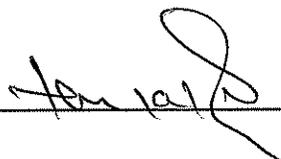
**AND WHEREAS** the Regional Board of the Regional District of Alberni-Clayoquot wishes to amend the tipping fees for the West Coast Landfill;

**NOW THEREFORE**, the Board of the Regional District of Alberni-Clayoquot in open meeting assembled enacts as follows:

1. Bylaw R1010, cited as "West Coast Landfill Tipping Fee and Regulation Bylaw No. R1010, 1999" is hereby amended by replacing Schedule "A" with Schedule "A" attached to and forming part of this bylaw.
2. This bylaw comes into effect on September 1, 2008.
3. This bylaw may be cited as the "West Coast Landfill Tipping Fee Amendment Bylaw No. R1010-1, 2008"

Read a first time this	23 <sup>rd</sup>	day of July, 2008
Read a second time this	23 <sup>rd</sup>	day of July, 2008
Read a third time this	23 <sup>rd</sup>	day of July, 2008
ADOPTED this	23 <sup>rd</sup>	day of July, 2008

  
\_\_\_\_\_  
Secretary-Treasurer

  
\_\_\_\_\_  
Chairperson

**REGIONAL DISTRICT OF ALBERNI-CLAYOQUOT**

**SCHEDULE "A" to BYLAW NO. R1010-1**

**CHARGES**

1. The charge for depositing covered solid waste at the disposal ground is:
  - a. Loads 145 kg or greater \$95.00 per tonne (\$8.00 minimum)
  - b. Loads under 145 kg - \$2.00 each garbage bag or can (\$8.00 maximum)
  - c. \$2.00 for each tire or \$170 per tonne, whichever is greater
  - d. \$100.00 for each wrecked auto
  - e. \$200.00 for each wrecked truck, bus or recreational vehicle
  - f. \$10.00 each for stoves, washers, dryers, dishwashers, hot water tanks
  - g. \$85.00 per tonne for metal
2. In the event that the scales provided are not operational, weight shall be estimated by the scale clerk at the landfill.
3. The fee to be charged for all loads of solid waste which arrives at the landfill site uncovered shall be double the normal fee for loads of covered solid waste.
4. There shall be no charge for recyclable materials, including but not limited to paper, boxboard, Corrugated Cardboard, compostable materials and other materials as determined by the Regional District but excludes any material contaminated by food or oil and any material that is a Controlled Waste.
5. All charges payable under this Bylaw shall be paid prior to the deposit of the solid waste for which the charge is made unless it is necessary to weigh the vehicle depositing solid waste loaded and empty to determine the weight of solid waste, in which case the charge shall be paid immediately after weighing the vehicle empty.
6. The person paying a charge shall obtain a receipt for such payment and shall produce such receipt for inspection on request of a person employed for that purpose at a disposal site as a condition of depositing solid waste at a disposal site.
7. Notwithstanding anything to the contrary in this Bylaw, persons depositing solid waste at a disposal site on a regular basis may apply to the Regional District for credit and if credit is granted to that person, then payment of the charge imposed under Section 1 shall be made and the credit extended on condition that:
  - a. Payment in full shall be received by the Regional District within thirty days of the last day of the month for which an invoice has been submitted. The Regional District will invoice monthly for material delivered during the proceeding month. The invoice amount will be based on the total quantity of the refuse delivered during the month, and the posted disposal rates in effect at the time of delivery.

- b. Late payments will be subject to an interest charge of 2% per month (effective annual interest of 24%)
- c. The Regional District reserves the right to cancel, upon five days' notice, the credit offered herein for late payment, non-payment or other justified cause.

8. Controlled Waste

The charges, as measured by weight on the scales, for the depositing of Controlled Waste at the disposal site are:

- a. Construction/Demolition Waste - \$120.00 per tonne; if the Demolition Waste is crushed to pieces 7 cubic centimetres or smaller the charge is \$95.00 per tonne;
- b. Stumps, land clearing debris - \$120.00 per tonne;
- c. Waste oil (commercial) - \$0.50 per litre;
- d. Material containing traces of contaminated soils:
  - i. \$10.00 per tonne provided that the Ministry of Environment has approved of disposal of the contaminated soil, without treatment, at the Alberni Valley Landfill or;
  - ii. \$70.00 per tonne plus the Regional District's estimated out-of-pocket treatment costs, provided that the Ministry of Environment has approved of the treatment and disposal of the contaminated soil at the Alberni Valley Landfill.
- e. Material containing pumpings from domestic septic tanks - \$120.00 per tonne;
- f. Material containing catch basin and manhole material - \$120.00 per tonne;
- g. Waste asbestos - \$250.00 per tonne (\$120.00 minimum);
- h. Fish, shrimp shells, animal carcasses - \$170.00 per tonne (\$95.00 minimum), provided that there will be no charge for animal carcasses removed from public roadways by a public body or their contractor;
- i. Fridges and freezers - \$20.00 each;
- j. Batteries - no charge if separated and placed in hazardous waste container;
- k. Steel Cable - \$500.00 per tonne;
- l. Biomedical waste - \$132.00 per tonne;
- m. Loads containing Gypsum - \$120.00 per tonne;
- n. Loads containing Corrugated Cardboard - \$130.00 per tonne;
- o. Loads containing fish feed totes - \$400.00 per tonne (\$120.00 minimum).

## **APPENDIX F**

### **ESTIMATED HISTORIC LANDFILL WEIGHTS**



**Estimated Historic Annual Weights for West Coast Landfill**

<b>Year</b>	<b>Annual Weight (tonnes)</b>	<b>Cumulative Weight (tonnes)</b>
1980	2,400	2,400
1981	2,400	4,800
1982	2,400	7,200
1983	2,400	9,600
1984	2,400	12,000
1985	2,400	14,400
1986	2,400	16,800
1987	2,400	19,200
1988	2,400	21,600
1989	2,400	24,000
1990	2,520	26,500
1991	2,520	29,000
1992	2,520	31,500
1993	2,520	34,000
1994	2,520	36,500
1995	2,650	39,200
1996	2,650	41,900
1997	2,650	44,600
1998	2,650	47,300
1999	2,650	50,000
2000	3,536	53,500
2001	3,106	56,600
2002	3,678	60,300
2003	4,390	64,700
2004	4,348	69,000
2005	4,752	73,800
2006	4,686	78,500
2007	5,390	83,900
2008	5,456	89,400
2009	4,540	93,900
2010	4,560	98,500

**Notes:**

1. Weights from 1999 and earlier are estimates as scale data was not available.
2. Weights from 2000 to present were provided by the ACRD.



**APPENDIX G**  
**CLOSURE & POST-CLOSURE COST ESTIMATE**



West Coast Landfill - Estimated Closure & Post Closure Costs

**Closure Costs**

Item	Unit	Quantity	Unit Cost	Total
Landfill Cap & Associated Closure Construction				
Grading Layer - 0.6m sand and gravel	m <sup>3</sup>	55,800	\$15	\$837,000
Barrier Layer - geosynthetic membrane liner	m <sup>2</sup>	93,000	\$8	\$744,000
Drainage Layer - 0.15m sand and gravel	m <sup>3</sup>	13,950	\$20	\$279,000
Protective Layer - 0.6m low permeability soil	m <sup>3</sup>	55,800	\$25	\$1,395,000
Topsoil layer - 0.3m topsoil	m <sup>3</sup>	27,900	\$20	\$558,000
Vegetation	m <sup>2</sup>	93,000	\$0.25	\$23,250
Legal Fees	L.S.	1	\$30,000	\$30,000

Subtotal = \$3,866,250

Contingency (10%) = \$386,625

**Total = \$4,253,000**

**Annual Post-Closure Costs**

	# Years	Cost/year	Total
Water Quality Monitoring and Reporting			
Bi-monthly Monitoring	15	\$35,000	\$525,000
Semi-Annual Monitoring	10	\$10,000	\$100,000
Landfill Gas Collection System Monitoring and Reporting	25	\$15,000	\$375,000
Roads Maintenance	25	\$400	\$10,000
Surface Water Control System Inspection & Maintenance	25	\$1,600	\$40,000
Leachate Collection System Inspection & Maintenance	25	\$400	\$10,000
Landfill Cap Inspection & Maintenance	25	\$400	\$10,000
Utilities (hydro power for electric fence & gas collection system)	25	\$5,000	\$125,000
Miscellaneous Rehabilitation Costs	25	\$1,000	\$25,000

Subtotal = \$1,220,000

Contingency (10%) = \$122,000

**Total = \$1,342,000**

**Total Closure & Post-Closure = \$5,600,000**

Existing Closure & Post Closure Fund (2010) = \$200,000

Amount Needed for Financial Security = \$5,400,000

**Annual Allocation for 80 Years = \$67,500**