TECHNICAL MEMORANDUM

MORRISON HERSHFIELD

DATE:	September 20, 2013	PROJECT No.:	5130323 00
TO:	Russ Smith, Anke Bergner, Capital Regional District.		
CC:			
FROM:	Todd Baker, P.Eng.	E-MAIL:	tbaker@morrisonhershfield.com
RE:	**The 5th R: RESIDUAL WASTE MANAGEMENT MEMO**		

1. Introduction

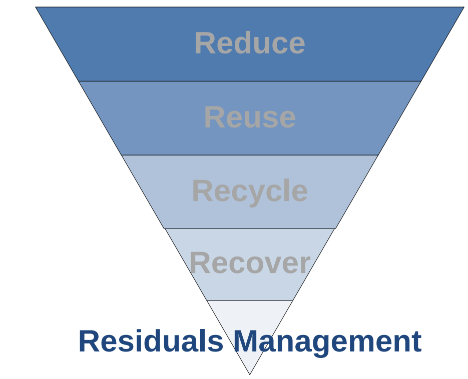


Figure 1 Waste Management Hierarchy

The Public and Technical Advisory Committee (PTAC) has discussed the first four Rs of the waste management hierarchy (reduce, reuse, recycle/composting and resource recovery). The 5th R refers to residuals management. Residuals management is the final treatment or disposal of waste that cannot be used or managed through any of the other 4 Rs. Residuals management in the Capital Region involves disposal through landfilling at two specific sites . The CRD owns and operates the Hartland Landfill in Saanich and the second is a landfill owned and operated by Tervita known as the Highwest Waste Management Facility (HWMF) that accepts construction and demolition (C & D) waste.

It is estimated that at the current rate of filling, and based on the original filling plans, the landfill has another 36 years of life remaining. It is in the CRD's best interest to maximize landfill capacity since it is potentially costly and time consuming to site a new landfill in British Columbia. There is also significant uncertainty associated with the siting process - the likelihood of being able to site a new landfill in specific areas of the province is low. The Hartland Landfill is a significant asset and must be utilized to the greatest extent possible. Options need to be considered for preserving and extending landfill life, optimizing operations, recovering energy, generating revenue, for the landfill's end-use and for integrating with other strategies. To this end, it is the CRD's vision to extend the life of the landfill to 2100 and beyond. Updated landfill capacity and filling rate estimates were prepared and used as a basis for this memo.

This memo summarizes the factors that impact landfill's future, methods for increasing capacity, methods for conserving landfill space and options for adding years to the landfill's life.

This memo is organized as follows:

- Introduction
- Residuals management overview
- Current situation (under the existing plan)
- Residuals management options
- Summary and conclusion

As with the Resource Recovery memo, the information in this memo is for consideration by the PTAC. It is intended to generate discussion both at the meeting and online (before and after the meeting). The contents of the memo will be presented at the meeting. The presentation will be followed by group breakout discussion sessions. PTAC members are requested to review this memo and to provide input on the general direction and options.

2. Residuals Management Overview

Residuals management is the final treatment or disposal of waste that cannot be used or managed through any of the other 4 Rs. Landfilling is the most common method of residuals management although conversion technologies such as combustion can be employed in combination with landfilling to preserve landfill space. Residuals management (also termed disposal) is considered the least desirable means of managing wastes. The 4th and 5th Rs overlap since resources can be recovered at the landfill, for example by using landfill gas for generation of electricity.

2.1 Landfills as Assets

An existing landfill is an asset that should be operated in a manner that is not only environmentally sound but preserves airspace and extends landfill life. Most regional districts throughout British Columbia utilize one or more landfills for waste disposal. Regional districts that have been faced with limited landfill airspace capacity have taken measures to increase their capacity at existing landfills. An option being employed by the Cowichan Valley Regional District involves exporting waste to a landfill in Washington State. Faced with very limited permitted capacity at both of its regional landfills, the Comox Valley Regional District reviewed regional disposal options including exporting waste to Washington State. The Comox Valley Regional District concluded that expansion of existing landfills would be the most secure and cost effective alternative. Based on a similar review of disposal alternatives, the Regional District of Nanaimo constructed an engineered retaining wall to increase capacity at the Nanaimo Regional Landfill.

2.2 Residuals Management

Methods for managing residuals are limited to landfilling and in some cases conversion technologies such as combustion. The following sections provide general information on landfilling as a residuals management technology, best practices for preserving and extending landfill life and the integration of landfilling with other technologies.

Landfill Disposal

Landfilling involves the controlled placement and management of wastes on or within surficial soils of the earth. Figure 2 on the following page shows a schematic cross section of the Hartland Landfill. The figure illustrates the overall development of a the landfill and the environmental controls infrastructure in place.

Modern landfills are highly engineered facilities that employ liner systems, cover systems, landfill gas management systems, leachate collection / treatment systems and surface water management works as environmental controls. Typical landfill operations require that waste be covered with adequate cover material daily, therefore the availability of locally available soil or aggregate is important for cost effective operations. In the case of the Hartland Landfill, rock is obtained from a quarry adjacent to the active part of the landfill. The rock is crushed and used to cover the waste on an on-going basis.

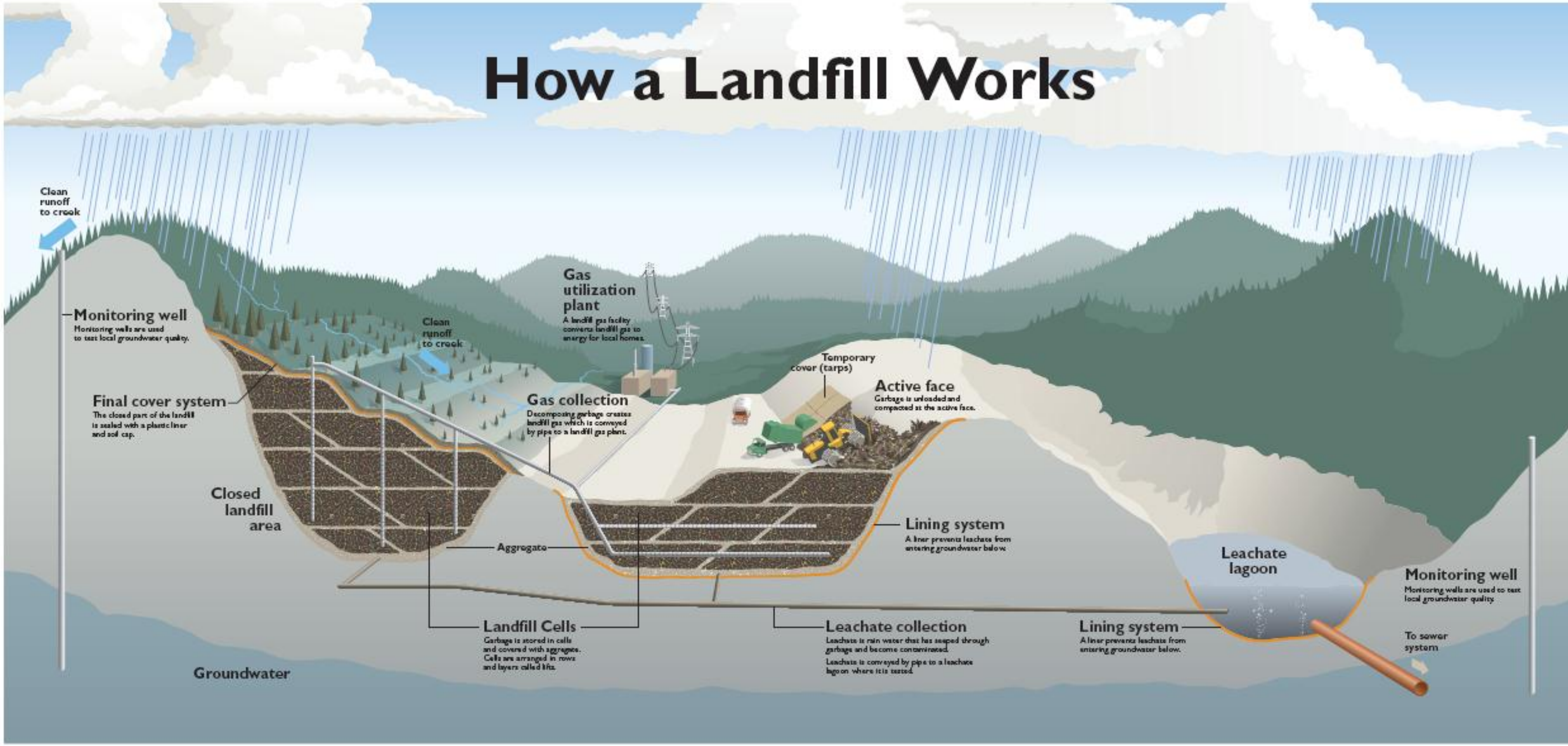


Figure 2 – Hartland Landfill Cross Section Schematic

Landfill Gas (LFG)

Landfill gas (LFG) contains approximately 50% carbon dioxide and 50% methane gas. The methane gas is generated through decomposition of organic material under anaerobic conditions. As a greenhouse gas, methane is 21 times more potent than carbon dioxide. Landfill gas is also hazardous. It is explosive between methane concentrations of 5 and 15% by volume and landfill gas can displace oxygen in confined spaces (i.e. it is an asphyxiate). Landfill gas may be used to generate electricity and heat. It can also be converted to different forms of natural gas and piped to existing gas distribution networks.

Leachate

Leachate is a contaminated liquid that contains a number of dissolved and suspended chemicals. Leachate is produced from water in the form of precipitation and surface run-on coming into contact with the waste. Leachate typically percolates through the waste and may travel into the underlying soils in the absence of a liner and leachate collection system. If breakouts occur it may migrate off-site on the surface as contaminated storm-water. Leachate is managed at landfills by installing engineered systems for leachate extraction / treatment or by natural attenuation at sites without engineered liner systems. When landfill cells are operated as bioreactor cells, leachate can be recirculated back into the waste as a means of stabilizing the waste, generating landfill gas quickly and as a means of managing leachate.

2.3 Best Practices for Preserving and Extending Landfill Life

Landfill airspace is defined as the volume available within a designated area for waste, daily / intermediate cover and final cover and is highly valued. It is also defined as the capacity of the landfill. Methods for preserving airspace include reducing the amount of waste requiring disposal, minimizing the amount of cover materials used, and compaction of waste within the landfill. Methods of increasing airspace include both vertical and horizontal landfill expansion. In some cases where space for horizontal expansion is limited, engineering retaining walls can be used to increase airspace vertically.

The airspace has an economic value and there are different methods for determining this value. It is important to create sufficient airspace to accommodate the long term needs of the community serviced by the landfill. There are best practices for operating landfills in order to use airspace effectively and efficiently. The available airspace and the rate of consuming airspace determine the lifespan of the landfill. Methods for extending the life of the landfill include increasing airspace and reducing the consumption rate of the airspace.

Landfill Airspace

Not considering the operational aspects of a landfill, the available landfill airspace, including potential for expansion is a function of several factors:

- Landfill geometric constraints (e.g. side-slopes, height, etc., based on design)
- Footprint size
- Potential soil or rock excavation volume

Typically the landfill geometry is constrained by regulatory requirements, technical constraints (e.g. seismic stability) and sometimes other constraints such as a height restrictions based on potential aesthetic impacts to surrounding properties.

The landfill footprint size is the land area available for placement of waste and cover. It is determined by the site constraints (e.g. property size, buffer zones) and the overall landfill design. Area required for other infrastructure such as leachate treatment and public drop-off facilities must be considered in the overall design of the site. Factors such as potential ecological and social impacts may dictate the footprint size and shape, as well as the landfill geometry (e.g. height restriction).

When siting a new landfill it is important to find a location that is not significantly constrained beneath the ground surface. The groundwater table or bedrock can limit the amount of soil or rock that can be recovered for use as cover and also limit the available airspace created by the excavation. It is common to design a landfill such that the soil or rock required as cover within and on the landfill is created by excavation of future landfills cells.

A combination of landfill geometry and footprint size and potential airspace created through excavation of future cells determines the available airspace. Methods for increasing airspace based on these factors consist of changing the landfill geometry, changing the footprint size and excavating base soil or rock for new landfill cells. The landfill geometry can be changed by extending the landfill vertically (vertical expansion or changing other factors that limit airspace such as the sideslope angle). Vertical expansion can consist of adding airspace to the top of the landfill or a combination of lateral and vertical expansion that adds airspace to the side and top of the landfill. It is also possible to gain airspace by constructing an engineered retaining wall near the edge of the landfill against which waste is placed. This requires less land area than a typical lateral expansion, however cost and technical constraints are key considerations. Options for increasing the airspace can simply involve revising the conceptual plans and the filling strategy for the site.

Landfill airspace can also be created by mining wastes that still have recovery or recycling value. This is discussed in a subsequent section of the memo.

Landfill Airspace Consumption

Consumption and preservation of landfill airspace are functions of several factors:

- Waste disposal rate
- Types of waste disposed
- Compaction effort of wastes
- Volume and type of cover material
- Settlement

The waste disposal rate is defined as the amount of waste, either by volume (m^3) or weight (tonnes), that is disposed each year. The disposal rate is a function of the amount of waste generated and the programs available for diverting specific materials (e.g. curbside recycling collection, composting) prior to landfilling.

Different types of waste take up more or less space in a landfill. Bulky wastes which do not compact well within the landfill take up more space than less bulky wastes which are easily compacted. Examples of bulky wastes include furniture, demolition waste and mattresses. Examples of less bulky wastes are light plastics and textiles.

After wastes are placed in the active area of the landfill they are compacted using specialized landfill compaction equipment. Landfill owners attempt to optimize the compaction effort by using the most appropriate equipment for the site, running the machine over the waste a set number of times (e.g. 3-5 passes over the waste) and by ensuring the angle of the active area of the waste is set appropriately.

Soil or rock cover is required on a regular basis to control nuisances, vectors (e.g. birds), litter, fire potential and odour. The frequency of cover is determined by the regulations and the design / operation of the landfill. Landfill owners typically attempt to minimize the amount of cover used in the landfill as it consumes valuable landfill airspace, space that could be utilized for waste. Alternate daily covers (ADCs) such as tarps or steel plates can be used to cover waste at the end of each day and are removed the following day. Soil or rock cover is applied regularly but less often.

Within the landfill the waste settles over time. This is related to the types of waste within the landfill, time and the height of the landfill. As more waste is placed on top of the landfill, the weight of the waste compresses the lower wastes resulting in settlement and the creation of additional airspace. Over time the rate of settlement decreases as wastes stabilize and compress.

Landfill airspace can be preserved by considering and making changes that impact the factors identified above. Changes to the waste disposal rate and types of waste disposed can be made through improving waste reduction / diversion efforts. Improving the compaction effort will also preserve airspace, although at well run and established landfills the compaction effort is typically close to optimal. Further reductions in the amount of cover used in the landfill can be achieved, although, similar to the compaction effort, well run landfills are already close to optimal on cover soil usage. It is not common to attempt to alter the amount of settlement in a landfill as this is typically a by-product of other aspects of landfill operation and design. However, sometimes the rate of settlement is altered intentionally by operating the landfill as a bioreactor landfill. Bioreactor landfills are discussed in a subsequent section of the memo.

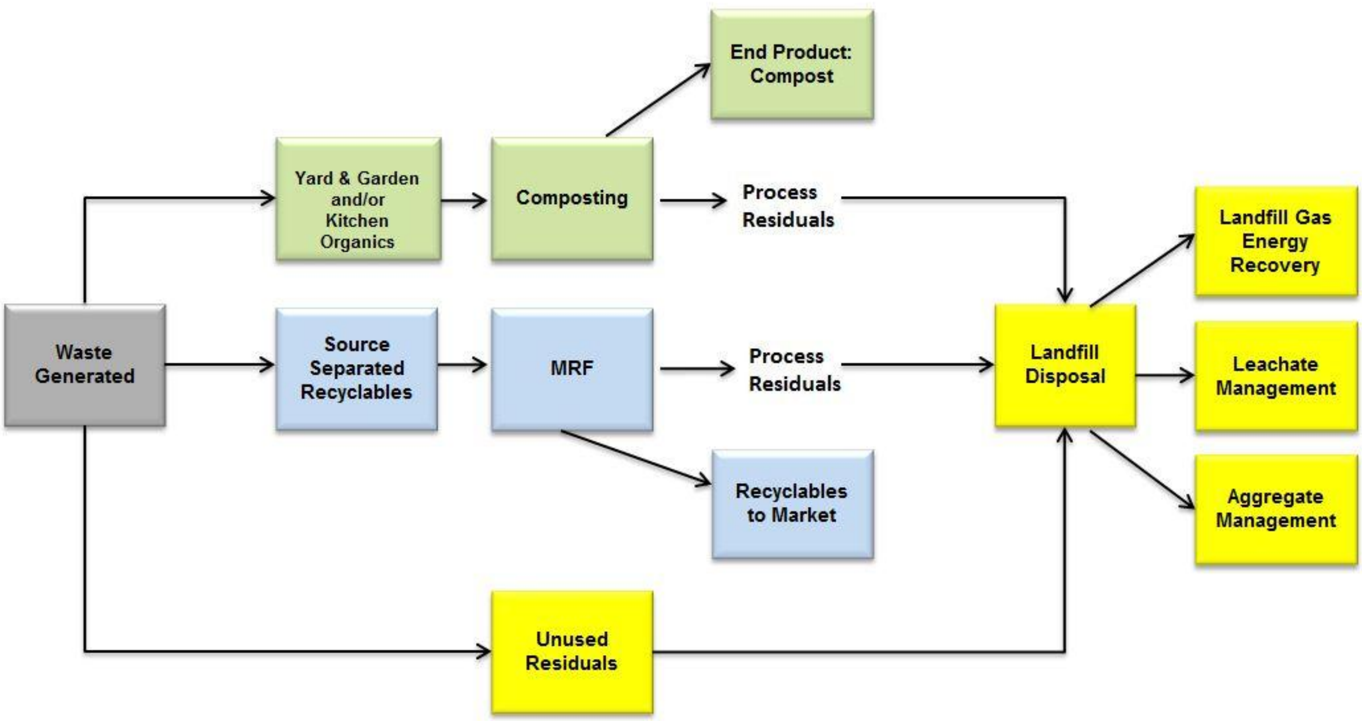
2.4 Integration With Other On-site Uses

Available space at the landfill can also be shared with other compatible and synergistic uses. Uses can relate to solid waste management functions, other CRD functions such as liquid waste management or parks, or for other private or public activities. For example, areas within the landfill property boundary can be used for composting, biosolids management / treatment, parking (e.g. for parks) and parks equipment storage and operations.

3. Current Situation

Residuals management in the Capital Region consists of disposal of municipal solid waste (MSW) at the Hartland Landfill, owned and operated by the CRD, and disposal of C & D waste at the Highwest Landfill, owned and operated by Tervita (formerly Hazco Environmental). There may also be some residual waste that flows out of the region via private haulers, however the amount is considered negligible. Figure 3 below shows the resource recovery and residuals management system.

Figure 3. Hartland Landfill Resource Recovery and Residuals Management System



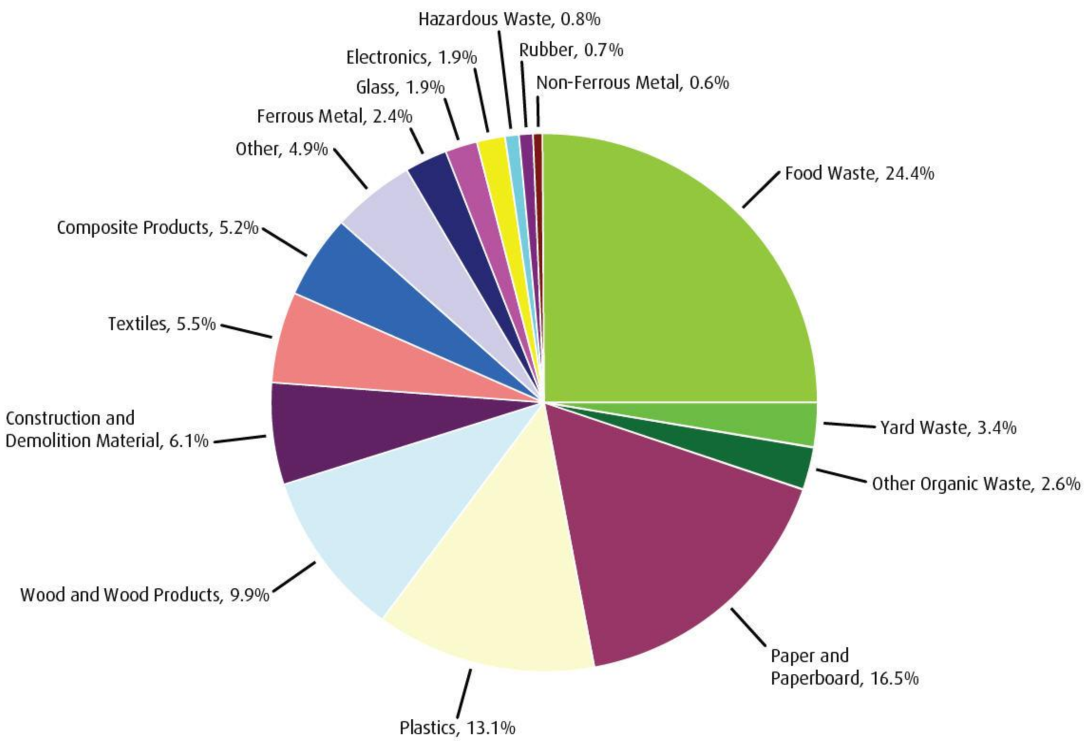
With this system, the CRD achieved a diversion rate of 48% in 2012 with 129,279 tonnes of waste disposed at the Hartland Landfill. Approximately 121,500 tonnes of waste was diverted from landfill through programs relating to the first 4 Rs of the waste management hierarchy.

Based on the Stage 1 Report for the Integrated Solid Waste and Resource Management Plan (ISWRMP), the annual per capital disposal rate at the Hartland Landfill is 0.36 tonnes per person per year. The disposal rate has dropped by almost 50% from 1989 when the disposal rate was 0.67 tonnes per person per year. The contributing sources of wastes disposed at both the Hartland Landfill and Highwest Waste Management Facility are as follows:

- C & D – 16%
- Residential – 38%
- ICI – 46%

Figure 4 below shows the composition by weight of waste disposed at the Hartland Landfill based on a waste composition study completed in 2010.

Figure 4. Composition by Weight of Waste Disposed at the Hartland Landfill



Food waste, yard waste and other organic waste make up 30% of the disposed waste. Other major contributors to disposal include paper and paperboard (16.5%), plastics (13%), wood and wood products (9.9%) and C & D waste (6.1%). The Stage 1 Report indicates that 75% of what is currently landfilled is potentially recyclable or compostable. Of the waste originating from the C & D sector, asphalt and wood shingles make up 69% of the waste disposed at the Hartland Landfill.

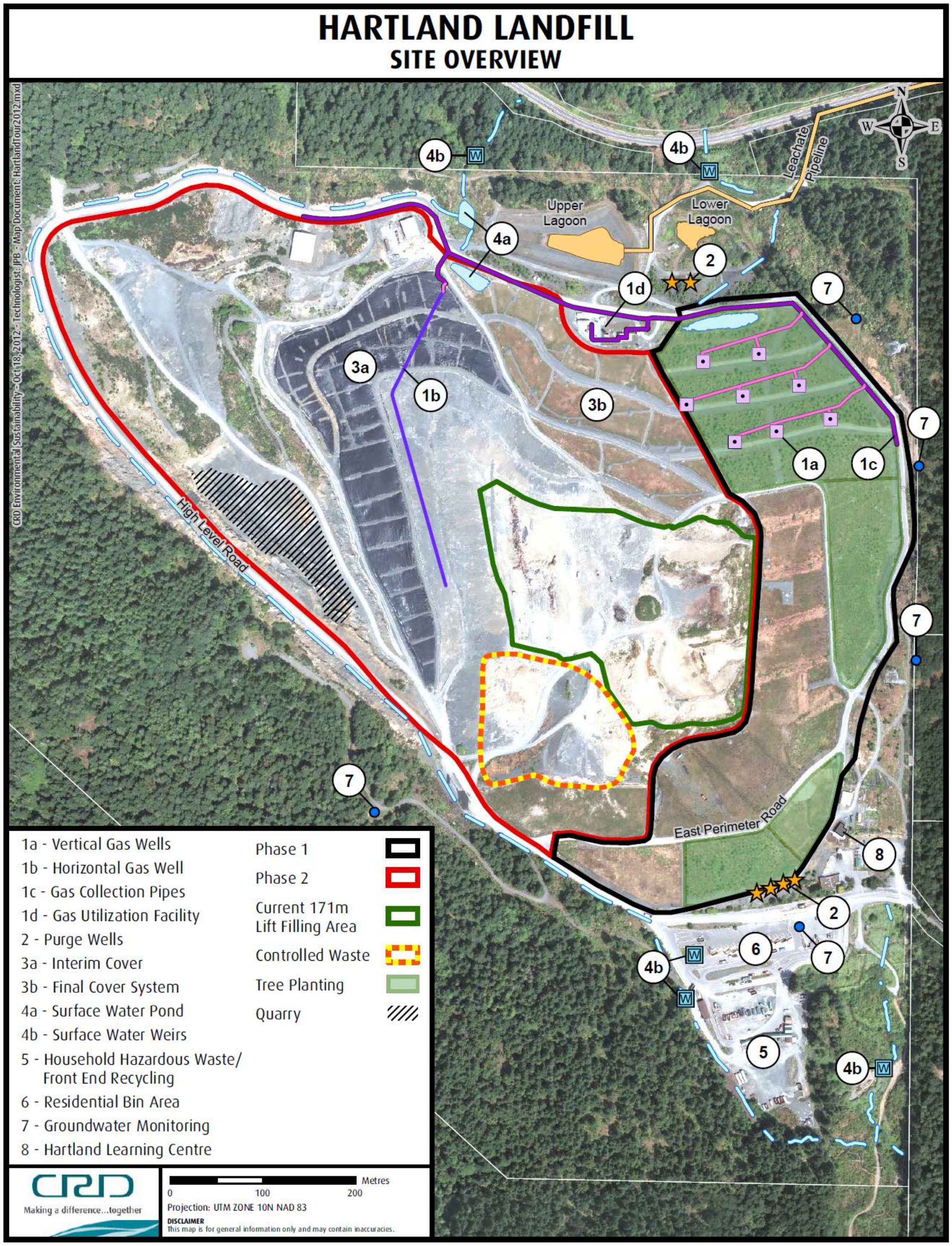
3.1 Hartland Landfill

The Hartland Landfill is the primary disposal facility in the CRD. The landfill is located approximately 14 km north of the City of Victoria. The landfill property is bordered by:

- CRD-owned, undeveloped land to the west and south
- Mount Work Regional park to the west
- Department of National Defense to the north
- Private residential properties to the east and southeast

Figure 5 on the following page shows an overview of the landfill and various site features. The landfill is operated under Operational Certificate (OC) # PR12659 issued under the *Environmental Management Act*. The landfill also operates under the approved Solid Waste Management Plan. Other relevant regulations include the *Waste Discharge Permit*, the CRD *Sewer Use Bylaw # 2922*, the CRD *Hartland Tipping Fee and Regulation Bylaw* as well as by the CRD *Ticket Information Authorization Bylaw.*

Figure 5. Hartland Landfill Site Overview



In 2012, the Hartland landfill received approximately 129,000 tonnes of refuse and 7,500 tonnes of Controlled Waste, which included 1,400 tonnes of asbestos, for a total of 137,900 tonnes.

History and Overall Development Strategy

Disposal at Hartland Landfill began sometime in the 1950s and the landfill was privately owned and operated until 1975 when the CRD purchased the property. The landfill continued to be privately operated until 1985 when the CRD took over the operations.

The filling area is divided into two large phases defined as Phase 1 and 2. Phase 1, the original landfill, covers an area of approximately 20 hectares and reached its capacity in 1996. Cell closure and capping of Phase 1 was completed 1997. The original landfill does not have an engineered liner system to contain leachate. Environmental controls were put in place beginning in the mid-1980s and consist of a leachate containment berm, purging wells and leachate lagoons.

Siting of Phase 2 began in 1985 and the selected site was a 2.5 hectare lake which was drained, excavated and lined. Filling of Phase 2 began in 1997, prior to which interim filling was performed between Phase 1 and 2.

A design and operations plan for the landfill was prepared in 1993. The report outlined the planned Phase 2 expansion and included the concept of quarrying rock as a means of increasing landfill capacity. Subsequently a plan for developing the quarry was prepared. In 2005 a strategy was developed for the leachate collection system and the quarry. This included an update to the operations and closure plan. This plan outlines the overall development of the quarry and the development of Phase 2.

Based on a recent survey it is estimated that the remaining volume is 5,469,000 m^3. It is estimated that there has been approximately 6,300,000 tonnes of garbage deposited at the site to the end of 2011. Based on capacity and lifespan estimates prepared in 2013 for this memo, there is approximately 36 years of landfill life remaining with capacity being reached in 2049.

Operations

The landfill operations are performed by CRD and contracted staff. Waste is compacted to a minimum compaction rate of 850 kg/m^3 with a landfill compactor. The estimated waste to cover ratio is 4:1. Alternative Daily Cover (ADC) in the form of a tarp is applied to the active face the end of each work day. The active face is covered with 0.15 meters cover material at the end of each week, creating an enclosed cell and a fire break.

Leachate Management

Leachate and surface runoff from the active landfill areas are directed to two leachate lagoons at the north end of the landfill. The water from these lagoons is then transported by a pipeline to the Northwest Trunk sewer system and ultimately, the Macaulay Point deep ocean outfall. Leachate discharge to sewer is authorized by a permit issued by the CRD Regional Source Control Program and is subject to the CRD Sewer Use Bylaw.

Based on the 2005 Leachate Management Plan, the overall leachate management strategy consists of progressive closure over completed areas of the landfill, lining new areas and constructing new leachate collectors. The 2005 plan made other recommendations including increasing leachate storage capacity at the site and installing horizontal drains on all north-facing slopes of the landfill to minimize the possibility of failure within the landfill.

Surface Water Management

Diversion of clean surface water runoff is important to minimize potential inflow to the leachate collection system and to maintain natural baseflow in existing creeks. Clean surface water runoff from the eastern slopes of Mt. Work is intercepted in lined diversion ditches located west of Phase 2 and directed off site. Precipitation falling on the capped area of Phase 1 is directed to a lined sedimentation pond at the north toe of Phase 1 and then discharged into a wetland that eventually connects to Heal Creek at the north end of the landfill. The overall development of surface water management works is outlined in the 2005 Leachate Management Plan.

Landfill Gas Capture and Use

The CRD is required to actively collect landfill gas (LFG) at the Hartland Landfill under the provision of the BC Landfill Gas Management Regulation (the LFG Regulation). An average of 581 standard cubic feet per minute (scfm) of landfill gas was collected in 2011. The collected landfill gas is drawn under vacuum to the gas plant located on the north toe of Cell 1 of Phase 2. The gas is piped to a generator where power is generated. Gas that cannot be utilized for power generation during for example generator maintenance is flared.

A Long Term Landfill Gas Management Plan was completed for Hartland landfill and submitted to MoE in April 2012. The report indicates that in 2010 the landfill gas collection efficiency was 32% and it has been estimated that in 2012 the collection efficiency was closer to 50%. The Plan outlines measures to improve the efficiency. It is estimated that, if all of the recommendations of the Plan are followed, the landfill gas collection efficiency will reach 75% by 2016.

Environmental Monitoring

In 2011, the environmental monitoring program confirmed that the landfill gas collection system worked effectively to control emissions from Phase 1, the closed area of the landfill. Water quality monitoring indicated that landfill leachate is effectively contained and controlled on site. Leachate quality monitoring confirmed that leachate discharged from the site was in compliance with CRD's Sewer Use Bylaw regulating discharges to the sanitary sewer. Surface water issues associated with runoff from aggregate stockpiled on the Hartland North site are being mitigated by a cover installed on the stockpile and reducing stockpile size. Groundwater flow and quality data indicates that landfill leachate is effectively contained and controlled onsite, and statistical analysis of water quality trends, at key locations north and south of the landfill, indicates that groundwater quality is gradually improving.

Rock Generation and Use

Rock for landfill roads, decking and intermediate cover and other onsite construction purposes is obtained from quarrying rock along the base of the landfill west of Phase 2 prior to placement of waste. Approximately 40,000 m^3 of crushed rock is required on an annual basis for these uses.

The overall development of the quarry and future filling is outlined the 2005 Leachate Management Plan. Two quarry plans were developed for the site, the Minimum Airspace Design and Maximum Airspace Design. The Maximum Airspace Design provides additional capacity and would increase the lifespan of the site. Capacity and lifespan are discussed in a subsequent section of this memo. Operationally, rock excavation volumes need to be considered since surplus rock that is not required for cover will need to be stockpiled for future use.

The CRD is currently planning on updating its aggregate (rock) management plan in conjunction with a landfill capacity study. The updated plan and the study will be based on recent more accurate survey information. These studies will be completed in early 2014 and will form part of the planning process for the Integrated Solid Waste Management Plan. They will be presented to PTAC at a later stage.

3.2 Highwest Waste Management Facility (Tervita)

The Highwest Waste Management Facility (HWMF, or Highwest Landfill) is the only private disposal facility in the CRD. The landfill is located on 23 hectare property at 1943 Millstream Road in the District of Highlands and is owned and operated by Tervita (formerly Hazco Environmental). The entire landfill capacity is estimated at 572,000 m^3. Capacity is expected to be reached around year 2030.

History

The Highwest facility, formerly known as the Chew Landfill, was originally developed as a natural attenuation landfill. Current and future cells are lined with 1.0 meter of low permeability clay (to be confirmed).

A maximum of 25,000 tonnes of selectednon-putrescible wastes may be landfilled at the site annually. The material accepted includes C&D waste and non-hazardous ICI waste. Contaminated soil is also accepted at the site for remediation. It is estimated by Tervita that the landfill lifespan is approximately 20-25 years.

Operational Certificate and Bylaws

The Highwest Landfill is regulated under a Ministry of EnvironmentOperational Certificate, issued on September 24, 2009. The operations are also regulated by the CRD *Solid Waste Disposal Local Service Establishment Bylaw No. 1, 1991.*

A design and operating plan for the landfill outlines its overall development and design. The landfill is divided into eight cells, four existing and four proposed. The design and operating plan provides strategies for landfill liners, progressive closure, leachate management, landfill gas management and environmental monitoring.

Tervita is planning to develop a material recovery facility (MRF) at the site to allow for the salvage of recyclable, reusable and recoverable (as a fuel source) components from the waste delivered to their facility.

Role of Highwest Landfill in CRD Solid Waste Management Plan

The Highwest Landfill should continue to be a part of the Solid Waste Management Plan and Tervita should be engaged to assist with contributing to the overall solid waste management goals of the CRD. The CRD may want to be involved in the development of the new MRF in order to maximize the potential for diversion of C & D waste.

3.3 Closed Landfills

There are four closed landfills in the CRD. The closed landfills are as follows:

- Blackburn Road Landfill – located on Salt Spring Island on privately owned land and is now closed.
- Galiano Island Landfill – located on Galiano Island on land owned by Macmillan Bloedel Limited, was operated by a non-profit volunteer organization and is now closed.
- Saturna Island Landfill – located on privately owned land on Saturna Island and is now closed.
- Port Renfrew Landfill – located on land owned by Fletcher Challenge Canada Limited and is now closed.

The closed landfills are not included in options for residuals management over the long term.

3.4 Current Issues and Challenges at Hartland Landfill

The following issues were identified in a memo prepared by Maura Walker and Associates dated August 7, 2012.

Diversion of Shingles from Landfill

Of the C & D waste disposed of at Hartland Landfill, wood shingles comprise 48% and asphalt shingles are 21%, despite the fact that there are recycling facilities for these products. The challenge is how to most effectively encourage the diversion of old shingles to recycling facilities. (Note: In 2011, the CRD began a pilot project to take asphalt shingles collected at Hartland Landfill to a recycling facility in Nanaimo. The CRD also recently awarded a contract to Tervita for managing asphalt shingles and mattresses at the Highwest Landfill)

Maximizing the Hartland Landfill’s Life

Due to public resistance to new landfill sites, it is unlikely that a replacement landfill for Hartland can be sited within the CRD. As a result it will be necessary to maximize the available capacity at Hartland or identify means to extend its life. CRD staff are conducting a landfill capacity study and an aggregate management study in 2013/2014. Results of these studies will be discussed at an upcoming PTAC meeting.

Understanding and Recognition of Hartland’s Potential

The Hartland Landfill property is a significant public asset that can provide long-term value to the CRD. Options to maximize the value of this site have yet to be fully explored. Understanding the site’s potential could impact decisions related to siting facilities for biosolids treatment and resource recovery.

Unsustainable Financial Model

This is a challenge because the amount of waste diverted has been increasing and garbage levels are decreasing, making the current method of funding programs using tipping fees unsustainable. Budget projections indicate that within three years, revenue from tipping fees will not be able to fund both the CRD’s disposal costs and diversion costs. This projection includes having the collection and processing of residential packaging and printed paper funded through an EPR program. This will be the subject of a future memo.

4. Residuals Management Options

The CRD does not want to site and operate another landfill. The Hartland Landfill is considered a significant asset and must be utilized to the greatest extent possible. Options are considered for preserving and extending landfill life, optimizing operations, recovering energy, generating revenue, for the end-use and for integrating with other strategies. Where possible, the impact of each option on landfill life and landfill capacity is considered.

Through a combination of waste diversion and modifying the conceptual design and filling plans, it is possible to extend the life of the landfill significantly. The sections below outline the potential impact of waste reduction, operational and landfill design related changes. Refer to Section 2.3 for discussion on creating and preserving landfill airspace.

4.1 Waste Diversion

The CRD is planning to increase waste diversion using the first three R's to 70% by 2015. By decreasing the amount of waste disposed at the Hartland Landfill, airspace will be preserved and the landfill lifespan can be extended without increasing the landfill footprint size or changing the landfill design. A number of new waste reduction measures are either being contemplated by the CRD or will be implemented by others in the near future:

- Extended Producer Responsibility (EPR)
- Organics diversion
- Construction and demolition diversion

EPR Programs

EPR programs such as those for beverage containers and tires, are part of an initiative by the BC Government to make producers responsible for the end of life management of products. EPR programs are regulated by the BC Recycling Regulation. Packaging and printed paper generated by the residential sector were recently added to the Regulation. New programs will continue to be added and will continue to impact the amount of waste requiring disposal at landfills. It is understood that furniture and C & D waste will be added soon, although there are currently no details available about these programs.

Organics Diversion

By 2015 the CRD will implement a ban on the disposal of kitchen scraps at the Hartland Landfill. There is currently a ban on disposal of yard and garden waste. As this component of the disposed waste stream is 30%, the region-wide ban on organics will impact the disposal rate and the annual volume consumed at the Hartland Landfill. CRD staff estimate that, beginning in 2015, 30,000 tonnes of organics will be diverted from the landfill annually.

Construction & Demolition Waste Diversion

Wood products and C & D waste make up approximately 16% of the disposed waste stream. Of the waste originating from the C & D sector, approximately 70% is wood and asphalt shingles. Many of the materials in the C&D waste stream are either recyclable or are used as a fuel substitute. For example, some of the wood waste originating in the CRD is chipped and sent to pulp mills for use as hog fuel. Private sector facilities such as the Highwest Landfill accept mixed loads of C & D waste. Tervita plans to construct a materials recovery facility (MRF) at the Highwest Landfill to divert recyclable materials from its landfill. Diversion initiatives such as this should be encouraged and new initiatives should be continuously explored.

4.2 Resource Recovery

As discussed in the Resource Recovery Options Memorandum dated April 13, 2013, the addition of resource recovery measures (Scenarios 1 and 2), would reduce the landfilled volume by 90% and increase the estimated life of the Hartland Landfill by over 80 years. For a summary of the advantages and disadvantages of the various resource recovery options, refer to the Resource Recovery Options Memorandum.

4.3 Optimize Operations

As outlined in Section 2.3, there are operational methods for reducing the volume consumed by waste and increasing the estimated lifespan of the Hartland Landfill.

Compaction and Cover Material Usage

The combination of waste compaction effort and cover usage (i.e. the quarried rock) has an impact on the consumption or airspace and the estimated lifespan of the landfill. Based on previous reporting (Sperling Hansen, 2005) it is understood that the estimated compaction density is 0.85 tonnes/m^3 and the waste to cover ratio is 4:1. Previous lifespan estimates were based on these assumptions. The 2005 Leachate Management Plan, which included other design and operations updates, indicated that a waste to cover ratio target of 6.5:1 could be achieved without the use of alternate daily cover and a target of 8.3:1 could be achieved with the use of alternate daily cover.

Continuous improvements to the waste to cover ratio will preserve landfill airspace and save rock for future use as cover. As the Hartland Landfill will continue to be used for as long as possible, efforts should be made to optimize the compaction effort and use of rock as daily / intermediate cover.

Landfill Gas Use

Landfill gas is collected and used at the Hartland Landfill. Currently, landfill gas is converted to electricity, which is sold to BC Hydro. The collection efficiency is estimated to be 50%. A Long Term Landfill Gas Management Plan outlines measures to improve the efficiency. It is estimated that, if all of the recommendations of the Plan are followed, the landfill gas collection efficiency will reach 75% by 2016. With implementation of organics diversion in the near future, there will be a net reduction in landfill gas production over the life of the landfill. The impact of improved collection efficiency and organics diversion on potential revenue from electricity generation has not been reviewed. A review of the impacts could be undertaken along with a review of other options for landfill gas use, if other uses have not already been reviewed.

Bioreactor Landfill

A bioreactor landfill is a landfill that is designed and operated with the aim of accelerating the waste degradation and biological stabilization of the waste. Recirculating leachate back into the waste mass results in: rapid decomposition, enhanced landfill gas production and rapid waste settlement. The bioreactor landfill concept has drawbacks including potential impacts to existing landfill gas extraction infrastructure, decreased waste stability and increased cost. The Hartland Landfill is located in a wet region and there may be too much moisture in the landfill that impacts the geotechnical stability and landfill gas collection. While the bioreactor concept has not been fully explored for the Hartland Landfill, it is not something that should be considered at this time. In the future if there is interest in this concept, a high level assessment of its feasibility and impact on landfill design / operations could be undertaken.

Landfill Mining

Landfill mining refers to the process whereby the existing waste fill is excavated and screened to separate the daily cover soil component (referred to as fines) from the previously landfilled waste (referred to as waste overs). Landfill mining provides the opportunity to gain additional airspace capacity largely through re-use of fines as daily cover and improved waste compaction during the re-landfilling of waste overs. The amount of airspace gain is highly dependent on the previous applied volume and type of daily cover, however typically, a gain of 25% or more has been achieved at MSW landfills. Mining of MSW landfills is most often undertaken to increase airspace at sites where expansion is more problematic, or where remediation of impacts from the existing landfill can be undertaken as part of the mining process. Recovery of materials from MSW landfills is usually limited to metals, as the quality of the remaining recoverable materials (e.g., paper, plastic, tires), does not usually meet the requirements of material recyclers. Some materials such as concrete and tires can be ground up and re-used for haul roads. In some instances, the overs fraction could be transported and processed at a waste-to-energy facility as a fuel source. Factors such as available landfill capacity, cost, waste age and waste type, leachate and the landfill gas collection system must be considered for determining the feasibility of landfill mining. Given that there are other options for increasing airspace capacity at the Hartland Landfill, landfill mining is not considered a feasible option at this time.

4.4 Potential Site Uses

A challenge identified in the planning process is the lack of understanding of the landfill's long term value. Understanding the site's potential will be critical to decisions related to siting facilities for biosolids treatment and resource recovery. There is potential value in the landfill as a property that could be used in a variety of different ways, both during operation and after the landfill is closed and capped.

4.5 Optimize Landfill Airspace

As outlined in Section 2.3 a combination of factors impact the available landfill airspace. Both landfill geometry and footprint area impact the available airspace and estimated lifespan. By expanding the landfill laterally (i.e. expanding waste footprint) it is possible to gain additional airspace both laterally and vertically (by placing waste on top of existing waste). By changing the design sidelsopes and other aspects of the landfill's design (e.g. benching on sideslopes) it is also possible to increase available airspace. It is also possible, in some circumstances to place additional waste on top of the landfill.

Amendment Number 3 to the current Solid Waste Management Plan (May 2004) outlines the existing landfill buffers. Based on a review of the established buffer zones for the landfill and surrounding land uses, expansion beyond the current footprint may be possible to the northwest towards the Hartland

North Property. This area is within the buffer strip constraints for the landfill. Amendment Number 3 also outlines requirements for vegetative screening and this is one of many considerations that would factor into a decision to expand laterally. A technical feasibility study would need to be undertaken to determine whether a lateral expansion is possible. Factors to consider include, geology, hydrogeology, leachate management, quarrying requirements, screening from surrounding properties and integration with the existing landfill design. A lateral expansion could result in a significant increase in available airspace, but further work is required to confirm this. Given that there are other options for increasing the available airspace and possible alternate uses for the Hartland North Property, lateral expansion is not something that needs to be investigated further in the short term.

Based on a review of the final contour design provided in the 2005 Leachate Management Plan, it appears that further improvements can be made extend the vertical height of the landfill and the optimize the landfill geometry in order to gain additional airspace. However this will impact final liner systems that have been installed and other infrastructure and require MoE approval. Preliminary conceptual design work was undertaken by CRD staff to determine the potential airspace implications. Based on this work it may be possible to increase the vertical height of the landfill by 10 m without expanding the landfill footprint. This option is considered further and discussed in Section 4.6.

Another method of increasing airspace within a limited footprint is to construct an engineered retaining wall at the toe of the landfill against which waste is placed. This allows for additional waste to be placed over existing landfill sideslopes and to potentially increase the overall height of the landfill. An engineered retaining wall was constructed for this purpose at the Nanaimo Regional Landfill and a similar wall is currently being constructed at the Campbell River Landfill. Preliminary wall and filling concepts were developed by CRD staff to determine the potential airspace implications of constructing engineered retaining walls at the toe of the landfill. Based on this work it may be possible to add additional waste over much of the existing waste and further increase the vertical height of the landfill without moving laterally into new areas of the site. This option is considered further and discussed in Section 4.6.

4.6 Impacts on Estimated Lifespan

Preliminary conceptual design work was undertaken to determine the potential to maximize airspace at the landfill without expanding the landfill footprint into new areas of the site. Based on this work, options are available to increase the available airspace and significantly extend the estimated life of the landfill. Options for increased airspace are discussed below. These options are compared to the estimated life of the original fill design and the current filling rate (which does not include new diversion of organic waste).

Original Fill Design

The estimated lifespan for the original fill design and current filling rate was determined. The original fill design is presented in the 2005 Leachate Management Plan. This design was intended to achieve a top landfill height of 207 m. The remaining capacity of this option is approximately 5,469,000 m^3. The current volumetric filling rate is approximately 150,000 m^3 per year. Based on the available capacity and the estimated filling rate, the estimated lifespan may be summarized as follows.

- Remaining life – 36 years
- Year capacity reached – 2049

Updated Fill Concept

With the implementation of curbside food scraps diversion across the region, it is estimated that the volumetric consumption rate of the landfill will be reduced from 150,000 m^3 per year to 125,000 m^3 per year beginning in 2019. A preliminary design has been undertaken to maximize the airspace of the original fill design. This involves maximizing the available airspace from the excavation of rock and adjusting the geometry of the landfill including the top height (additional 10 m of vertical height). The airspace gained from these changes is approximately 4,075,000 m^3. Based on the additional capacity and the decreased filling rate from food scraps diversion, the estimated lifespan may be summarized as follows.

- Remaining life – 70 years
- Additional life gained – 38 years
- Year capacity reached – 2083

The additional life gained is relative to the lifespan estimated for Option 1.

Hartland 2100 Fill Concept

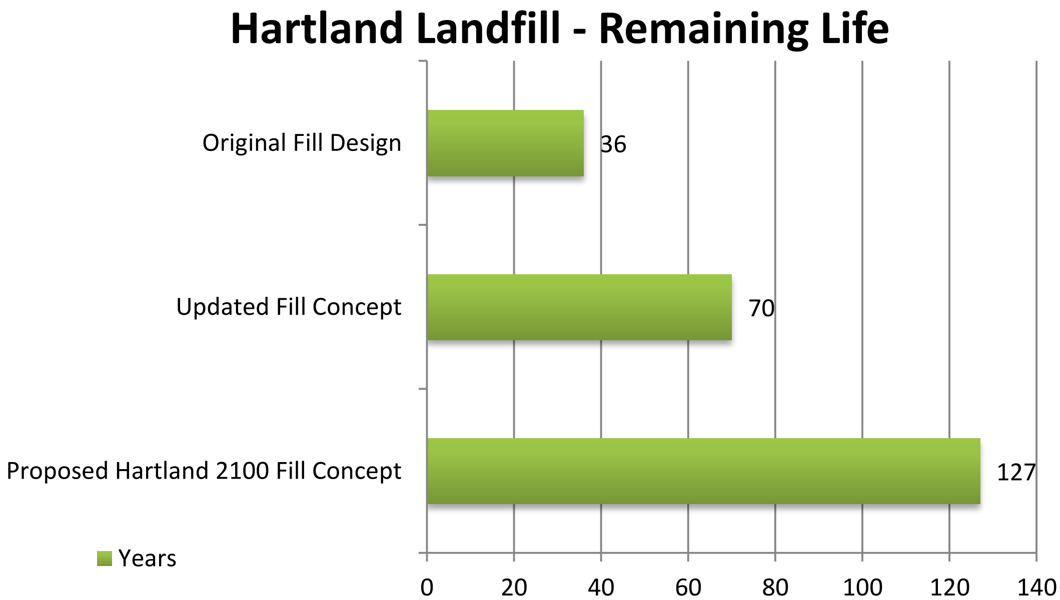
It is estimated that, with the installation of an engineered retaining wall at the toe of the landfill, up to 11,193,000 m^3 of additional capacity could be obtained as compared to the current design. For a toe wall option the top height of the landfill could be extended by 30 m above the current design. Based on the additional capacity and the reduced filling rate, the estimated lifespan may be summarized as follows.

- Remaining life – 127 years
- Additional life gained – 95 years
- Year capacity reached – 2140

The additional life gained is relative to the lifespan estimated for Option 1.

As shown above and below in Figure 6, there is the opportunity to create additional capacity and almost 100 years or more of additional life within the current footprint. This assumes that the Highwest Waste Management Facility continues to accept C & D waste for 20-25 years. The concepts for increasing capacity at the Hartland Landfill are preliminary. These options would require further engineering work to assess feasibility, determine cost / benefit implications, confirm additional capacity and to assess impacts to operations. Capital improvements and changes to operations and filling strategies would be required to implement any of the options.

Figure 6. Hartland Landfill Remaining Life



5. Summary and Conclusion

The Hartland Landfill is a significant asset and must be utilized to the greatest extent possible. Options need to be considered for preserving and extending landfill life, optimizing operations, recovering energy, generating revenue, the landfill's end-use and for integrating with other strategies.

While improvements to operations and undertaking best practices are important, Hartland's most important asset is its airspace. The CRD does not want to site another landfill and therefore it is important to maximize the available airspace and extend the landfill life for as long as possible. Options are available for increasing capacity and extending life to 2100 and beyond, including changing the design within the current footprint and continuing to implement new diversion initiatives. The feasibility of options for increasing capacity should be explored further. The Highwest Waste Management Facility will continue to play an important role for managing C & D waste generated in the region. Impacts to the Highwest facility, for example to the design and lifespan, will also affect the Hartland site.