Comox Strathcona Waste Management

Staff Report

DATE: April 4, 2019

FILE: 5380-03

TO: Chair and Directors
Comox Strathcona Waste Management Board

FROM: Russell Dyson
Chief Administrative Officer

Supported by Russell Dyson
Chief Administrative Officer

R. Dyson

RE: **Regional Organics Composting Project – Anaerobic Digestion**

Purpose

To provide an overview of anaerobic digestion as an organic management technology for the Comox Strathcona Waste Management (CSWM) Regional Organics Composting project.

Recommendation from the Chief Administrative Officer:

THAT the Comox Strathcona Waste Management Board continue to support the use of an aerated compost technology for the Comox Strathcona Waste Management Regional Organics Composting project.

Executive Summary

At the March 2019 CSWM Board (Board) meeting, the Board expressed an interest in better understanding the potential of anaerobic digestion as a solution for the regional organics project. This report compares anaerobic digestion and composting, and provides rationale for continuing to support aerated compost technology for the CSWM regional organic project.

Anaerobic digestion (AD) technology is not recommended for this project due to the amount of food waste available. Phase one of the Regional Organics Composting project is approximately 7,500 tonnes per year, which is below the very low end capacity range of 10,000 tonnes per year.

- AD technology is not suitable to process comingled food and yard waste. If collected separately, it will double curbside collection costs to the municipalities.
- AD capital cost are estimated to range from $25 to $40 million. The current estimate for this Regional Organics Composting project is $12.2 million.
- AD operating costs are estimated to range from $100 to $135 per tonne compared to $60 to $100 per tonne for a composting facility.

The following conclusions can be drawn from the work completed to date. Composting compared to anaerobic digestion:

- Is less sensitive to changes in the feedstock. AD is not suitable to process yard waste;
- Produces compost. The result of an AD process, the digestate, still needs to be stabilized;
- Has lower capital investment cost. Capital cost is approximately half of the cost of AD;
- Has lower operational costs. Operational cost are approximately 60 to 80 per cent lower than AD;
- Requires a lower level of training to run a facility;

- Requires a lower level of expertise to design, build, and operate;
- Has greater space requirements than anaerobic digestion facilities;
- Has equivalent risk to cause an odour nuisance as anaerobic digestion if properly built and operated.

Consultation with the New Building Canada Fund (NBCF) will be required if the Board decides to use an anaerobic digestion technology instead of composting.

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Background
Both the City of Campbell River and the CSWM service have previously analyzed the different technologies available to treat organic waste. The results of these studies shows that aerated static pile composting is the most suitable and viable technology for processing food and yard waste for the CSWM service. Final decision on the exact type of composting processing technology will be determined during the procurement process to allow for a competitive process.

Morrison Hershfield Report
Morrison Hershfield was retained in 2015 to conduct a regional organics management study for the CSWM service area. This study examined a wide range of technologies that could be used to process organic waste. Ultimately, covered aerated static pile composting was selected as the technology for further consideration. The report is attached as Appendix A. The report states (page 1):

- Technologies reviewed for this study include anaerobic digestion, composting and bio-drying;
- Anaerobic digestion is similar to composting; however, decomposition is done in the absence of oxygen and a gas is generated that can be utilized as a fuel;
- There are a variety of different AD systems. Due to the complexity of the technology more infrastructure is required as compared to composting and typically capital and operating costs are higher;
- Based on current conditions and knowledge, costs for AD based on the available tonnes are likely to be higher than that for composting, including the net revenues from energy production and from tipping fees.

Jacobs Report
In November 2017, the Board awarded a contract to Jacobs (formerly CH2MHill Canada) to assist the CSWM service with the planning of the Regional Organics Composting project. As part of this contract, Jacobs has prepared a technical review of the most favorable composting technologies, attached as Appendix B. Once the requirements related to the processing facility location become available, the range of technologies may be adjusted.

Grants
In 2015, the City of Campbell River submitted an application to the Strategic Priorities Fund (SPF) for the construction of an organics composting facility utilizing aerated static piles composting technology at the Norm Wood Environmental Centre (NWEC).

In 2017, following the unsuccessful SPF application from the City of Campbell River, the CSWM service was awarded a $5.5 million grant from the NBCF to construct the regional organics composting facility utilizing the same technology proposed by the City of Campbell River. Further review with the NBCF will be required, if anaerobic digestion is considered as a technology.

Comox Strathcona Solid Waste Management Plan (SWMP)
The Ministry of Environment and Climate Change Strategy (MoE) has confirmed that anaerobic digestion followed by composting would count towards achieving the 70 per cent diversion rate target established in the SWMP.

The SWMP proposed the following in terms of organics management:

- Develop organics processing capacity. Steps:
    1. Assess a pilot project to divert organics from the landfill. (installed in 2013);
    2. Assess a location, including Campbell River, for a regional organics processing facility (NWEC selected);
    3. Assess organics management technologies, including composting and anaerobic digestion. (composting selected by City of Campbell River and by CSWM service in independent studies);
    4. Partner with other local government where possible.
- Yard waste collection:
    - CSWM plans to promote the availability of municipal and regional district yard waste collection services to the public.
- Backyard composting:
    - CSWM plans to maintain the existing backyard composting program to encourage residents to compost at home.

Cost estimates
2018 capital cost estimate from our consultant for the Regional Organics Composting project is $12.17 million. This estimate is based on aerated static piles composting technology and will allow to process 14,500 tonnes of comingled food and yard waste per year. $5.5 million (of the $12.17 million) are funded through the NBCF.

Co-mingled food and yard waste composting program provides the lowest overall costs (to the end taxpayer) from the options analyzed by our consultant. Frequency of curbside collection impacts cost more significantly than the cost per tonne. Anaerobic digestion is not a suitable technology to process comingled food and yard waste or yard waste only; this results in an additional pickup for the separate streams of material.

As a reference, the capital cost estimate from the Capital Regional District (CRD) to build a food waste only anaerobic digestion plant is between $25 million to $40 million. Expected capacity is approximately 15,000 tonnes of food waste per year. Yard waste is collected and processed separately. A related February 2019 Times Colonist press article is attached as Appendix C.

Table 1 below compares AD versus composting capital and operational costs based on CRD and CSWM service cost estimates.

Table 1 AD versus composting Capital and Operational costs.

Technology	Anaerobic Digestion	Composting	Notes
Capital Cost	$25-$40 million/ 15,000 tonnes per year	$12.17 million/ 14,500 tonnes per year - CSWM compost project	Composting Capital cost is approx. half of the cost of AD
Operational Cost	$100 - $135 per tonne	$60 to $100 per tonne	Composting Operational cost is approx. 60%-80% lower than AD

No cost estimate using anaerobic digestion technology is available at this time for the CSWM Regional Organics Composting project.

Compost versus anaerobic digestion comparison

Anaerobic digestion plants capacity range from 10,000 to 350,000 tonnes per year. Phase 1 of the CSWM service will process 14,500 tonnes per year of organic waste of which 7,519 tonnes per year will be food waste. Therefore, if an anaerobic digestion technology is used, the CSWM plant would be below the very low end of capacity range and would result in a higher cost per tonne to process organic waste. Appendix D includes a table comparing anaerobic digestion and composting technologies.

In summary, composting compared to anaerobic digestion:

- Is less sensitive to changes in the feedstock;
- Produces compost;
- Has lower capital investment cost. Capital cost is approximately half of the cost of AD;
- Has lower operational costs. Operational cost are approximately 60 to 80 per cent lower than AD;
- Requires a lower level of training to run a facility;
- Requires a lower level of expertise to design, build, and operate;
- Has greater space requirements than anaerobic digestion facilities;
- Has equivalent risk to cause an odour nuisance as anaerobic digestion if properly built and operated.

Anaerobic digestion:

- It provides an option for resource recovery (biogas), but selling the biogas produced during an anaerobic digestion process can only offset part of the operating costs;
- The result of an AD process, the digestate, still needs to be stabilized, likely in a separate composting facility;
- One of the advantages of using anaerobic digestion is that it allows to treat a large amount of waste within a very small footprint. In our case, the low amount of organic waste to be processed does not justify its use;

- Operating and capital costs related to anaerobic digestion are higher than composting;
- It is not suitable for processing yard waste and would result in a kitchen waste program only;
- There is not enough residential food waste to make anaerobic digestion economically sound;
- Separate food and yard waste streams and final processing solutions would still be required;
- It can be used to treat organic waste from waste treatment plants (biosolids).

Attachments: Appendix A – "Morrison Hershfield report - Regional Organics Management Study"
Appendix B – "Jacobs report – Composting Technology Evaluation"
Appendix C – "Times Colonist – $63M plan for Hartland Landfill includes making gas from food scraps"
Appendix D – "Anaerobic versus composting technologies"

MORRISON HERSHFIELD

REPORT

Regional Organics Management Study

Prepared for:

The Comox Valley Regional District

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Report No. 5140608 September 8, 2015

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EXECUTIVE SUMMARY

Organics represent a significant component of the waste stream that is landfilled. Developing new organics processing capacity is one of the initiatives of the 2012 Solid Waste Management Plan. Other related initiatives include assessing potential sites and technologies, and partnering with other local governments where possible.

Key objectives of this study include reviewing technologies, supplementing work that was done previously, and assessing the economics of having one or two organics processing facilities. Potential facility locations include the Comox Valley Waste Management Centre (CVWMC) near Cumberland and the Norm Wood Environmental Centre in Campbell River. The economics of assessing one or two sites would include estimating costs for facility construction, new transfer station infrastructure, operations and organic waste hauling.

Co-mingled food waste and yard waste is currently collected in Comox and Cumberland as part of a pilot project. The pilot project facility is located at the CVWMC and handles approximately 2,500 tonnes of organics annually. The City of Campbell River recently requested proposals for a new composting facility to be located at the Norm Wood Environmental Centre. This facility could handle the City's organics or it could be scaled up to handle the region's organics. The City has been in discussions with the lead proponent on technology options, financing and costs. The proposed facility to be located at the Norm Wood Environmental Centre is not only a solid waste initiative, it is also a proposed solution for managing biosolids generated at the wastewater treatment facility. The City may be able to save money by composting biosolids rather than upgrading the wastewater treatment facility with a new digester. Campbell River City Council supports the direction to develop the facility.

There is approximately 14,000 tonnes of food waste and yard waste in the region that could be captured and managed at a new processing facility. This consists of approximately 6,000 tonnes from Campbell River and approximately 8,000 tonnes from the southern municipalities (Cumberland, Comox, Courtenay). There is approximately 22,000 tonnes of organics landfilled annually therefore management of 14,000 tonnes would represent an overall regional capture rate of 64%.

Technologies reviewed for this study include anaerobic digestion (AD), various composting methods and bio-drying. Anaerobic digestion is similar to composting, however, decomposition is done in the absence of oxygen and a gas is generated that can be utilized as a fuel. There are a variety of different AD systems. Due to the complexity of the technology more infrastructure is required as compared to composting and typically capital and operating costs are higher. An earlier Integrated Resource Recovery Report (IRR) conducted by another party for the CSWM concluded that the economics of AD could be favourable. However, conditions since completion of the IRR study have changed and the assumptions made at that time may need to be reviewed. Based on current conditions and knowledge, costs for AD based on the available tonnes are likely to be higher than that for composting, including the net revenues from energy production and from tipping fees.

Bio-drying involves utilizing a composting technology to dry the organics for use as a fuel, for example at cement kilns. Benefits include offsetting the use of fossil fuel, less sensitivity to contamination and the speed and simplicity of the process, as compared to composting. Disadvantages include a lack of potential markets for the fuel and the loss of organics that would otherwise be put back on the land. At this time it is not considered further due to uncertainty around the market for this fuel. It may be worth considering this technology again in the future as the markets for the fuel evolve.

Composting is a biological process in which organic material is consumed through microbial activity in the presence of oxygen. The result is a soil-like material that can be applied to the land to improve soil structure and quality. There are a variety of technologies available to meet different needs. Some technologies are fully enclosed, which allows for better control of potential odours and a smaller overall footprint. Others involve processing the feedstock outdoors and often require more space.

There are essentially three composting phases, the pre-processing phase, the active composting phase and the curing phase. Under optimal conditions composting generates very little odour, however there is the potential for odour generation at different stages of the process, for example when feedstock arrives at the facility and during the active composting process. Given that food waste is being considered, some type of in-vessel technology is appropriate for the region's organics.

One of the most popular processes in BC is the covered aerated static pile. It requires considerable space, but in moderate climates offers the lowest cost and greatest flexibility for expansion. It is the technology chosen by Campbell River through a competitive process (with buildings added during the active composting phase to enhance odour control). Capital and operating costs depend on the amount of material managed and the technology. In general, capital costs can range from $100-$500/tonne of installed annual capacity. Capital costs of aerated static pile composting facilities in BC typically range from $200-$300/tonne of installed annual capacity. Expected operating costs could be around $60/tonne for quantities generated in the CSWM service area. Compost can sell at the compost site for $10-$30/tonne depending on the market conditions.

Facility siting criteria consist of environmental considerations, proximity / access considerations and land use considerations. Two potential sites were reviewed for this study, the Comox Valley Waste Management Centre and the Norm Wood Environmental Centre. Both seem to be compatible with a new composting facility and have adequate space available. The Comox Valley Waste Management Centre may provide some benefits in terms of buffers, existing infrastructure and compatibility with the current site use and surrounding land use.

Three scenarios were reviewed to determine potential costs for new composting facilities, transfer stations and waste hauling. The three scenarios are as follows.

- Scenario 1 - Regional Composting Facility in Campbell River
- Scenario 2 - Regional Composting Facility in Comox Valley
- Scenario 3 - Two Smaller Facilities, one in Campbell River and one in Comox Valley

For the purpose of this assessment, The GORE Cover System (GCS) was assumed for all scenarios. It was assumed the first phase of the GORE process would be undertaken in a building, therefore all compost facility capital cost estimates include one building. While the GCS was assumed for the purpose of providing cost estimates for this study and for developing regional costs per tonne, there are other technologies that are suitable. These technologies are likely to have different capital and operating costs. Although the GCS is the preferred technology for Campbell River's process, there are some differences in process and infrastructure assumed for this study as compared to what the City is considering. Technology, process and infrastructure assumptions for this study are the same for all options, allowing a direct comparison of costs across all options.

Estimated costs are summarized in the tables below.

Summary of Capital Costs for Each Scenario

Scenario	1. Regional Composting Facility - Campbell River	2. Regional Composting Facility - Comox Valley	3. Facilities in Campbell River and Comox Valley
CR compost facility capital	$5,799,000	$0	$4,028,000
CV compost facility capital	$0	$5,200,000	$4,056,000
CR transfer station capital	$0	$2,022,000	$0
CV transfer station capital	$2,022,000	$0	$0
Initial trailer cost	$150,000	$75,000	$0
Total capital cost	**$7,971,000**	**$7,297,000**	**$8,084,000**

Summary of Annualized Cost for Regional Scenarios

Scenario	1. Regional Composting Facility - Campbell River	2. Regional Composting Facility - Comox Valley	3. Facilities in Campbell River and Comox Valley
Annualized capital cost	$580,000	$531,000	$588,000
Transfer station operating cost	$230,000	$200,000	$0
Compost facility operating costs	$781,000	$777,000	$1,098,000
Hauling cost	$147,000	$102,000	$0
Total annualized cost	**$1,738,000**	**$1,610,000**	**$1,686,000**
Annualized cost per tonne	**$126**	**$116**	**$122**

Summary of Annualized Cost for Regional Scenarios – With Transfer Backhaul

Scenario	1. Regional Composting Facility - Campbell River	2. Regional Composting Facility - Comox Valley	3. Facilities in Campbell River and Comox Valley
Annualized capital cost	$580,000	$531,000	$588,000
Transfer station operating cost	$230,000	$200,000	$0
Compost facility operating costs	$781,000	$777,000	$1,098,000
Hauling cost	$73,500	$94,500	$0
Total annualized cost	**$1,664,500**	**$1,602,500**	**$1,686,000**
Annualized cost per tonne	**$120**	**$116**	**$122**

Scenario 2 involving construction of a new regional facility at the CVWMC is the lowest cost option. The City of Campbell River has applied for $6.36 million in Union of British Columbia Municipalities Strategic Priorities funding for the proposed facility at the Norm Wood Environmental Centre. If this funding is received, the economics of building and transferring to this facility would need to be reviewed again. The economics of using this facility for organics from outside the City depends on the proposed tipping fee, which is likely to be impacted by a successful grant application. Currently the proposed tipping fee for organics from outside the City boundaries is unknown.

Siting criteria should also be considered when selecting a suitable site and technology. Synergies may exist with a new facility at the CVWMC that are not present at the Norm Wood Environmental Centre, although both sites seem suitable for a new facility.

1. INTRODUCTION

Organics represent the single largest component of the municipal waste stream. At present, an estimated 35-40% of the waste landfilled in the Comox Strathcona Waste Management service area is organic waste such as food and yard waste. Developing local capacity for processing this organic waste represents a significant opportunity to reduce the amount of waste landfilled. The study is one of several initiatives in the 2012 Solid Waste Management Plan for developing organics processing capacity in the Comox Strathcona Waste Management (CSWM) service area.

CSWM is operated by the Comox Valley Regional District (CVRD) and is responsible for two regional waste management centres that serve the Comox Valley and Campbell River, as well as a range of transfer stations and smaller waste-handling and recycling facilities for the electoral areas of the CVRD and the Strathcona Regional District (SRD). The CSWM service also oversees a number of diversion and education programs.

1.1 PROJECT BACKGROUND

The 2012 Solid Waste Management Plan identifies steps to be undertaken to develop regional organics processing capacity. The first step involved establishing a pilot project, which was established at the Comox Valley Waste Management Centre near Cumberland. The pilot project has been running for three years. The next steps are to assess potential locations for a regional processing facility and to assess management technologies.

A Regional Compost Facility Study (M. Walker and Associates and CH2M Hill, 2011) was prepared for Comox Valley Regional District (CVRD) as part of the overall solid waste management planning process that was completed in 2012. The 2011 study provides valuable background information on available organic feedstock, potential procurement, ownership and operational models, organics transfer and feasible technologies. The study also provides a conceptual design and cost estimates for construction and operation.

A report was prepared for the CVRD in 2012 on Integrated Resource Recovery (IRR) options for the region. The report identified anaerobic digestion as a technology that could be used to process regional organics. The report provides some preliminary cost and revenue numbers that should be considered further before a processing technology is selected. The Solid Waste Management Plan also indicates that anaerobic digestion technologies should be reviewed before a full-scale facility is implemented.

Two potential locations for a new facility are the Comox Valley Waste Management Centre, the location of the existing pilot facility, and the Norm Wood Environmental Centre in Campbell River. The City of Campbell River recently undertook a procurement process to establish composting capacity for the City that could also accommodate organics from other parts of the region. The City of Campbell River has entered into discussions and negotiations with a preferred proponent for a facility at the Norm Wood Environmental Centre.

1.2 PROJECT PURPOSE AND SCOPE

A proposal was submitted to the CVRD in July 2014 to undertake further assessment of regional organics management options. Six primary tasks, each consisting of a series of sub-tasks, was proposed:

1. Start-up and Review Background Information
2. Inspect Sites
3. Evaluate Current Situation
4. Review Technologies and Markets
5. Develop Scenarios and Cost Model
6. Prepare Reporting

Key objectives of the study included supplementing information on previously reviewed technologies with new information and assessing the economics of having one or two facilities located at the Comox Valley Waste Management Centre, the Norm Wood Environmental Centre or both locations. The business case analysis for one or two sites would consider the economics of transfer and hauling organics from north to south and vice versa, and the capital and operating costs of composting facilities and transfer stations. The additional technology review work would focus on anaerobic digestion, including reviewing the 2012 IRR report, the current pilot program and other technologies such as bio-drying.

2. Current Situation

The following sections summarize the existing municipal organic collection and management programs, as well as existing infrastructure for transfer and haul of organics.

2.1 Organics Collection Programs

Existing collection programs for organics exist across the Region. **Table 1** shows the current organics curbside collection methods in the four main service areas.

Table 1 Current residential organics collection programs

Service Area	Yard waste collection	Co-mingled food waste and yard waste collection (all year)
Campbell River	Yes (seasonal)	
Comox		Yes
Cumberland		Yes
Courtenay	Yes	

Only yard waste is collected in Campbell River (limited to four months per year) and Courtenay. In June 2013, a composting pilot project commenced with the weekly collection of co-mingled food and yard waste from the Town of Comox and Village of Cumberland.

Apart from the residential curbside collection for organics, yard waste is also collected at the Campbell River and Comox Valley Waste Management Centres.

2.2 Existing transfer station infrastructure

In the Campbell River, Comox, Courtenay and Cumberland areas there is one large-scale transfer station located at the Campbell River Waste Management Centre. This facility currently accepts yard waste but not food waste. To transfer organics to a potential organics facility in Campbell River a new transfer station would be required in the south to transfer organics north. The facility in Campbell River would need to be adapted to accommodate the additional organic waste stream in order to transfer to a potential organics facility in the south. Further discussion on the requirements and potential costs is included in Section 7.

2.3 Existing Organics Processing Facilities

The CVRD owns and operates a biosolids composting facility at the Comox Valley Waste Management Centre. This facility uses a controlled processing system with aerated piles in tunnels and open window curing to process biosolids mixed with clean, chipped wood waste to produce a compost product ("Sky rocket").

A pilot compost facility with an annual capacity of 2,500 tonnes using GORE technology was established in 2013 at the Comox Valley Waste Management Centre. Net Zero Waste Inc. provides the operational service. This facility uses the food and garden waste collected from the curbside collection programs in Comox and Cumberland.

2.4 CITY OF CAMPBELL RIVER ORGANICS FACILITY PROCUREMENT

The Regional 2012 Solid Waste Management Plan, places a high priority on the diversion of organic waste from CSWM landfills, and identifies Campbell River as a potential location for a processing facility.

Following private sector inquiries about Campbell River as a potential location for an organics facility, and discussions with CVRD staff and staff from municipalities within the Comox Valley, the City of Campbell River issued a Request for Proposals (RFP) for the development of an Organics Facility in Campbell River. Staff developed the RFP requirements so that the Facility would also be able to accept and process dewatered biosolids from the Norm Wood Environmental Centre, at a potential future date.

The City is currently land applying biosolids, however within an expected time period on the order of 7 years, the City would need to expand or relocate the land application area and invest in a new digester. Pending Ministry of Environment approval, if composting of biosolids is deemed a viable alternative to the City's current process and the digester is not required, this would result in a significant capital savings.

The City of Campbell River has identified a preferred proponent based on its evaluation of the proposals. The City has submitted an application to the Strategic Priorities Fund for full capital funding for the development of a regional scaled organics facility at Norm Wood Environmental Centre for processing of household, commercial and institutional organics and yard waste. The total capital request was $4.6 million. The facility will have a capacity to treat 4,000 tonnes of source separated organics (SSO) per year and 450 dry tonnes of biosolids per year. This feedstock is guaranteed by the City of Campbell River. Organic waste from the Region can also be processed at this facility since it can be expanded to be capable of processing 13,000 tonnes per year of source separated organics.

The City has the space availability for a facility at Norm Wood and the site is zoned and permitted for an organics facility, including having received approval from the Agricultural Land Commission. The preferred proponent would provide an indoor covered composting system with outdoor curing.

3. Feedstock

A first step in developing regional organics processing capacity is to determine how much feedstock is available for processing. It involves reviewing available data on organic material types and quantities and assessing data from existing municipal collection and management programs.

The sources of organic waste for the composting facility were assumed to be:

- Campbell River Curbside Collection
- Comox Curbside Collection
- Courtenay Curbside Collection
- Cumberland Curbside Collection
- Food waste and compostable paper products collected from institutional, commercial and industrial (IC&I) sources from the CSWM service area
- Yard waste collected at the Campbell River Waste Management Centre
- Yard waste collected in Campbell River Transfer Station
- Biosolids dewatered from Campbell River WWTP

3.1 Current and Future Organic Feedstock

The following information is largely based on estimates presented in Exhibit 2-1 of the Regional Compost Facility Study by Walker and Associates Environmental Consultants and CH2M Hill (2011). Updated figures were provided from CH2M Hill in 2015. This information was used to define the size of organics processing facility required.

Regional quantities of solid waste and organic waste generated in 2014 were analyzed in conjunction with population statistics to develop an understanding of the geographic distribution of organic waste generation within the study area and to estimate future organic waste quantities. Future changes in organic waste quantities were estimated by using “per capita” waste generation rates and population projections.

The estimated quantities of leaf and yard waste (L&YW) diverted is based upon current per household collection quantities for the City of Courtenay (250 kg/household/year). It has been assumed similar service levels would be in place for all contributing areas receiving yard waste collection.

The estimated diversion of residential source separated organic waste (SSO) is based on per capita household data from the two-year food waste collection pilot project in the Regional District of Nanaimo. The following materials are assumed to be included in the SSO diversion program:

- fruits and vegetables
- table scraps and plate scrapings
- meat, chicken, fish, and bones
- dairy products
- bread and baked goods
- coffee grounds/filters and tea bags
- pasta and rice
- eggs and egg shells
- paper towels, napkins and tissues
- soiled newsprint
- paper take-out trays and egg cartons

Based on some of these assumptions above, on population distribution, on available waste composition data, the potentially and realistically available organics for planning purposes is shown in

Table 2 below. These are volumes that have the potential to increase as population grows and participation and system efficiency increases.

Table 2: Estimated Annual Organic Waste Quantities

	Estimated 2014 Quantities			Estimated 2030 Quantities		
Collection	**Leaf and Yard Waste**	**Food Waste**	**Total Tonnes**	**Leaf and Yard Waste**	**Food Waste**	**Total Tonnes**
Campbell River Curbside Collection	2,500	1,200	3,700	2,800	1,300	4,100
Comox Curbside Collection	1,500	700	2,200	1,800	900	2,700
Courtenay Curbside Collection	2,100	1,000	3,100	2,600	1,300	3,900
Cumberland Curbside Collection	350	170	520	450	200	650
ICI from CVRD	-	800	800	-	1,000	1,000
ICI from SRD	-	600	600	-	700	700
Yard waste collected at the CVWMC	1,300	-	1,300	1,600	-	1,600
Yard waste collected in Campbell River	1,200	-	1,200	1300	0	1300
Biosolids dewatered from Campbell River WWTP		400	400			
Total Tonnes	8,950	4,870	13,820	10,550	5,400	16,000

As can been seen from the table above, feedstock quantities for the region are around 14,000 tonnes per year in 2014 and expected to increase to 16,000 tonnes per year in 2030. These quantities are relatively low and limits the selection of technologies to those that are not too complex for practical and cost reasons. The selection of technologies is not going to be substantially altered by increasing volumes until they get into the 20,000 tonnes per year range and above.

The figures above represent what can be collected and captured for one or more new organics management facilities. Based on figures from the 2012 Solid Waste Management Plan, approximately 22,500 tonnes or more of organic waste is currently landfilled. Collecting and managing approximately 14,000 tonnes of organics in one or two facilities would represent an overall regional capture rate of roughly 64%.

4. Technology Review

A range of organics management technologies have been reviewed for the region including various composting technologies and anaerobic digestion. The 2011 Regional Compost Facility Study reviewed numerous potential composting technologies. Based on the study a tunnel system was selected for the basis of a conceptual design and cost estimate.

Recently the GORE Cover System has been utilized effectively for quantities similar to what is generated in the CSWM service area and is currently being used a the Comox Valley Waste Management Centre (CVWMC) in Cumberland to compost approximately 2,500 tonnes. Given that this technology is being employed effectively at the CVWMC and elsewhere in BC (e.g. Abbotsford), it was given further consideration as part of this study.

Other technologies have emerged as possibilities that need to be reviewed again. These include anaerobic digestion (identified in the 2012 IRR study) and bio-drying. As well as reviewing these technologies a preliminary assessment was also undertaken of the technology proposed for use in the City of Campbell River.

General information on each of the available technologies is provided below and then discussion of the applicability of each for CSWM.

4.1 Anaerobic Digestion

Anaerobic digestion (AD) is the biological conversion of organic materials in the absence of oxygen. The process is carried out by anaerobic micro-organisms that convert carbon-containing compounds to biogas, which is a gas primarily consisting of methane (CH_4) and carbon dioxide (CO_2), with trace amounts of other gases. For the process to take place efficiently, six key process parameters must be carefully controlled. These are pH, temperature, carbon to nitrogen ratio (C:N), organic loading ratio, retention time and reaction mixing.

A wide variety of micro-organisms are involved in all stages of the AD process; these prefer neutral pH conditions, optimally in the range of 6.4 – 8.2. Variation from this range is toxic to these organisms, and can slow down or interrupt altogether the production of biogas with high-methane content. Two possible temperature ranges are employed in AD processes, and the temperature range utilized in the process will also dictate the type of bacteria that will be utilized. “Mesophilic” bacteria operate in an optimum temperature range of 35-40°C, while “Thermophilic” bacteria prefer warmer conditions, in the range of 50-55^{o}C. Since AD processes are themselves not exothermic (heat producing), precise temperature control must be incorporated into plant design to maintain desired temperature ranges. C:N ratios of between 20:1 and 30:1 in the feedstock promote the production of methane; as a result feedstock mixes must be carefully monitored to achieve this range and avoid digester inhibition or lower biogas production. The organic loading rate is a measure of the biological conversion capacity of the AD system. Loading a digester above its ideal biological conversion rate will result in lower biogas yield due to accumulation of inhibiting substances in the digester. In terms of retention time, sufficient time in the digester is required to achieve effective biological degradation. While retention times will depend on process design specifics and feedstock characteristics, typical retention times are in the range of 12-30 days. Finally, physical mixing of the feedstock is important as it provides improved contact between the organic material and bacteria, prevents the formation of dead zones and scum layers within the zone, and promotes effective heat transfer.

Since AD works only on the organic fraction of the waste stream, pre-treatment processes are targeted at separation of the organic fraction from the inorganic and other materials that are not suitable for treatment in the AD process. Pre-treatment is also required to achieve:

- the removal of non-digestible materials which take up unnecessary space in the digester;
- the provision of a uniform small particle size in the feedstock to promote efficient digestion;
- the protection of the plant and equipment from waste components that may cause physical damage; and
- the removal of materials which may adversely affect the quality of the digestate.

Mechanical pre-treatment will generally involve the following processes:

- trommels/screens for the removal of the oversized fraction;
- hammer mill (or similar) for size reduction of the feedstock; and
- shredding/mixing of the feedstock (or use of a Hydropulper as a wet pre-treatment process to break down the organics and separate out the heavy and light non-organic fractions).

Following pre-treatment, the organic fraction is first loaded into the reactor where digestion takes place. In the first stage of digestion, organic material is broken down by microbes called acid formers, to produce fatty acids. In the second stage of the digestion process, generally referred to as methanogenesis, another group of microbes called methane producers covert the fatty acids into biogas, which generally contains about 55% methane and 45% carbon dioxide, along with traces of other gases. The material remaining is a partially stabilized organic material that can be used as a soil amendment or separated into solid and liquid fractions. The liquid fraction is disposed of as wastewater, or in some cases can be used as liquid fertilizer if there is an agricultural user nearby. The solid digestate requires composting for full stabilization. The insoluble solids in the digestate are comprised of non-digestible inert material, non-digestible organic materials and microbial biomass.

4.1.1 Feedstock Analysis

The origin of waste that could be accepted and processed at an AD Facility in the CVRD is residential SSO and organic waste from the commercial/industrial sectors. Biosolids could also be used, and if a dry AD system is considered, then some of the yard and garden organics could also be processed. **Figure 1** below depicts typical mixed SSO from the residential and ICI sectors as it would be received at the AD facility. Note however that plastic bags for the collection of kitchen waste would not be acceptable.

Figure 1: Typical SSO

4.1.2 Anaerobic Digestion System Options

Anaerobic digestion technologies can be grouped in by the number of digestion stages – single or two/multiple – and the total solids content – wet process (typically <15% TS) or dry process (typically >20% TS). Following is a discussion on these four options for anaerobic digestion technologies.

Single Stage Process

Production of biogas from anaerobic digestion involves a series of biological processes of which acidification and methanogenisis are the main two. In single stage AD systems, these two processes take place in the same reactor. In two stage AD systems, these processes are performed in separate reactors.

The majority of AD plants in operation today that process SSO utilize single stage (batch or continuous flow) AD systems. The large number of single-stage AD systems is due primarily to the systems' relatively simple design compared to two-stage systems. Typically, this simplicity leads to lower capital costs for the equipment and less technical failures leading to lower operating costs. Depending on the vendors compared, there is very little difference in the biogas production performance of single or two-stage AD systems.

Two Stage Process

The premise behind two-stage (aerobic-anaerobic or both anaerobic) AD systems is to separate the two major biological processes taking place. The first stage has an isolated reactor that has the microbes that produce the acids and acetates needed for decomposing the organic materials and the second stage has another isolated reactor that has the microbes that produce biogas. The advantage to separating these processes is that the microbes in each stage require slightly different environmental conditions (pH levels primarily) to obtain their optimum performances. Optimizing microbe performance can lead to faster breakdown of material and/or higher biogas yields. While this a theoretical advantage, experience has shown that the decrease in production time and the increase in biogas yield may not justify the increase in capital and operating costs for the larger, more complex multi-stage AD systems.

Single-Stage vs. Two-Stage

In general, there is little or no difference in the overall processing capacity or the biogas production rate when comparing single or two-stage AD systems. For SSO, both single or two-stage AD systems would be appropriate however, with the performance being equal, the additional capital and operating costs for a two-stage system could be difficult to justify.

Historic market penetration in Europe of the wet and dry two-stage digesters is very moderate. The advantage of having a faster degradation during the digestion stage is usually not enough to compensate for the higher capital cost of the hydrolysis-stage. Therefore, two-phase digestion has been decreasing and is currently limited to approximately 7% of the installed capacity in Europe.

4.1.3 Solid Content Options

The solid content in an AD system depends on the type of technology used – wet or dry.

Wet AD System

Typically SSO have a solid content anywhere between 20-30%. Wet AD systems dilute the organics to a solid content between 10-15% by adding water on a 1:1 basis (1m^3 of water per tonne of organic material). This diluted mixture is pulped to obtain a consistency of a thick soup.

Typical SSO waste is extremely varied and its composition is ever changing. This is an advantage and a disadvantage for wet AD systems. It could be a disadvantage in that the wet slurry in the reactor can separate into layers of material with a floating scum at the top of the reactor, which could prevent proper mixing and heavier particles at the bottom of the reactor, which could cause damage to the reactors pumps and ancillary equipment. This striation of material in reactors occur in extreme cases and vendors have methods in place to combat this issue. The advantage to the separation of material in wet AD systems is that is used to effectively remove impurities from the time the material is raw feedstock to when it is pulped and being processed. The "purity" of the organic material has little impact on the digestion process but it has a large impact on the waste product from the process. Waste material that is heavily contaminated with metals, plastics, etc. would need to be de-contaminated in order for it to be composted into a saleable product.

Dry AD Systems

Dry AD systems add water to organic feedstock if required only to produce an organic mixture containing 15-40% solids. The majority of dry AD systems utilize plug flow reactor designs. New material goes in one side of the reactor while the fully digested material comes out the other.

Typically, some of the digested residue is re-circulated back to the feeding for inoculation to assure sufficient biological activity and balance.

An advantage to dry AD systems is that they can handle large amounts of contaminants (i.e., metal, glass, plastics, etc). As stated previously, this is a disadvantage to the end product that needs to be handled and processed.

Wet vs Dry AD Systems

There is very little difference in the biogas production performance of wet vs. dry AD systems and very little difference in the capital and operating costs of the actual AD reactors. One of the largest differences between the systems is how they deal with contamination in the organic feedstock and the costs associated with this.

Most new AD systems for SSO in Europe now utilize the dry system.

4.1.4 Technology Applications and Vendors

The following is a list of some of the vendors that are currently marketing anaerobic digestion technologies in Europe and/or North America.

- Organic Waste Systems (OWS) – patented the DRANCO (Dry Anaerobic Composting) process
- Urbaser – agents for Valorga process in North America
- Linde KCA & Linde BRV
- Canada Composting Inc. – BTA process
- Clarke Energy Limited/Haase
- RosRoca (Biostab)
- Kompogas
- Bioferm (Vissmann)
- Bulk Handling Systems - Kompoferm (Eggersmann)

All of the above technologies and others not mentioned have the ability to convert SSO into biogas. A comparison of technology specifics shows that gas output per tonne of feedstock is in the same range for all proven technologies, the amount of digestate expected is similar from most technologies, and operating requirements are also similar. **Table 3** below summarizes the key features of the common technologies listed above.

Table 3: Summary of Key Features and Performance Indicators for AD from SSO AD Costs

Criteria	Range	Comments
Throughput	10,000 to 350,000 tonnes per year	CSWM size is at very low end of technology range
Ideal through put	10,000 to 100,000 tonnes per year	Many reference facilities in this range, although most over 20,000 tonnes per year
Biogas generation	90-120 m^3 per tonne of input	
Digestate expected	30% to 35% of input	Varying degrees of moisture depending on process
Digestate treatment	Composting	Composting essential for all processes to achieve mature product for land application
Labour requirements	6 to 8 staff	For average facility between 20,000 and 100,000 tonnes per year capacity

The capital costs of AD facilities vary widely, depending on size, type of technology and efficiency (see **Table 4**). In the table below, some examples of capital costs that are known are shown. Note, that only two of these are in Canada, the rest from Europe. An AD facility currently being built for the City of Surrey in BC has an estimated capital cost of $70 million at a capacity of 115,000 tonnes per year, resulting in a capital cost per tonne of annual capacity of almost $610/tonne. As with most technical facilities, economies of scale will enable larger facilities to be built at a lower per tonne cost (which explains the trend towards larger facilities). Smaller facilities will likely suffer a cost penalty. This principle applies to composting facilities and is expected to apply to AD facilities as well.

Table 4: Approximate Capital Costs for Anaerobic Digestion Plants

Vendor	Technology Type	Annual Incoming Tonnage Processed	Estimated Capital Costs	Estimated Capital Cost/Tonne of Capacity
Canada Composting (BTA)	Wet	45,000	$18,500,000	$411
Canada Composting (BTA)	Wet	28,000	$10,500,000	$380
Kruger	Wet	38,000	$9,000,000	$237
ISKA	Wet	110,000	$15,500,000	$140
Valorga	Dry	180,000	$50,000,000	$280
Valorga	Dry	14,000	$5,100,000	$365
DRANCO	Dry	22,500	$16,500,000	$730
BRV	Dry	37,000	$15,600,000	$420
Kompogas	Dry	18,000	$12,000,000	$665

4.1.5 AD Summary

As can be seen from the above information, capital costs can vary greatly. True capital costs can only be estimated on the basis of an extensive pre-feasibility engineering exercise involving conceptual design and technology selection, or on the basis of a public competitive process (request for proposal). The costs in the above table are a few years old and based on European plants, so are not directly applicable for BC, but they provide some indication of the potential range. The most recent project in Canada for AD is the City of Surrey's biofuel plant, which will use AD to generate biogas. This plant has been awarded and is in the design phase. For budget purposes, we have assumed the Surrey cost of $610 per tonne of installed capacity, escalated by 20% for a smaller facility (to factor in the reduced economy of scale).

Most AD plants are privately operated, so operating costs are unavailable with any reliability. An older report (BioCycle August 2007, Vol. 48, No. 8, p. 51) provided information about the Dufferin AD facility in the City of Toronto. This facility has a capacity of 25,000 tonnes per year and uses a wet AD technology (BTA). The estimated operating costs at that time were $112 per tonne, excluding digestate treatment and disposal and excluding utilities or energy revenue. It can be assumed that composting, integrated with an AD facility would benefit from much of the infrastructure and thus could be accomplished for about $25 per tonne. Since the Dufferin facility was built, there has been some progress with AD technologies and it is safe to assume that operating costs of a smaller facility, such as for the CSWM service area might be in the $100 per tonne range, including composting of digestate and revenues from the sale of energy.

AD plants can generate revenue from the sales of electricity produced with the bio-gas that is recovered through the process. A very efficient AD facility will be able to generate 250 kWh of electricity per tonne of feedstock. Assuming the electricity could be sold to BC Hydro for 10 cents per kWh, this would result in revenues of $25 per tonne of feedstock. Similarly, revenue can be generated by upgrading the biogas and selling it as fuel.

AD technology, combined with the composting of digestate, and perhaps the composting of some yard and garden waste separately could be considered for the CSWM service area. It is not expected to be financially self-sustaining and even after the sale of energy would require a tipping fee to cover the repayment of capital costs and to cover some of the operating costs. For comparative purposes, capital costs can be assumed to be $730 per tonne of installed capacity, and $100 per tonne for operations and maintenance (inclusive revenue from the sale of energy). These are for comparing AD with other organics management technologies. For budgeting purposes, a more detailed study with conceptual and preliminary engineering followed by cost estimating would be required; or alternatively a public RFP process with well-defined specifications for technology selection.

4.1.6 Observations from the 2012 IRR Report

The Farallon Consultants IRR options report for the CVRD provides discussion on a variety of solid waste and environmental issues. The following section provides a summary of MH's review of the composting and AD aspects of the IRR report.

Composting capital costs appear extremely high at over $1,800 per tonne of installed annual capacity. This is higher than AD, and generally composting is less costly. A compost plant of the size envisioned for the CSWM service area should cost in the order of $200 to $300 per tonne of installed annual capacity based on recent estimates from compost suppliers.

Composting sales seem optimistic. They are based on what the current biosolids compost plant can sell their product for, but do not take into account any transportation costs and the fact that the market might become over-saturated with compost if all of the region's organics are composted.

Composting assumes landfill operating costs will be reduced, which will likely be marginal at best, since most systems at the landfill must be kept operational, despite reduced organics loading.

It is implied that AD is popular in Europe because of legislation and a shortage of landfills. This is correct, and in our observation the main driver in Europe is a combination of organics bans/taxes on organics and feed-in tariff subsidies. In our opinion, it is mostly the subsidized feed in tariffs that are making AD technology financially viable.

Mesophilic AD (low temperature) is proposed and also it is stated that dried digestate could be spread on land without further treatment. According to the BC Organic Matter Recycling Regulation (OMRR), digestate would need to be composted before it can be land applied. Further, the report assumes that digestate will be dried to 5% solids, which is costly. Costs for this part of the process were not apparent during the review.

The AD system proposed is relatively small scale, uses two separate streams/systems (one for biosolids and one for food waste) and has capital costs estimated at $616 per tonne of installed capacity. This is similar to what the Surrey AD facility is estimated at, but Surrey is three times the size. Therefore the capital cost estimate for the AD system seems optimistic.

Operating costs of the AD facility calculate to about $31 per tonne. That is less than half of what the report estimates for composting. We believe these costs need to be reviewed to make sure all operational aspects, including composting and product drying have been included.

The assumed input of food waste to the food waste digester is significantly more than what has been assumed to be a reasonable generation and capture rate for this study and previous studies on organics management for the region. The estimated quantity of food waste for this study is 4,500 tonnes whereas the IRR report uses a figure of almost 19,000 tonnes per year. The estimated total tonnes to the digester is 28,000 and includes a large quantity of soiled paper, which translates into a large tipping revenue. The IRR report may be overestimating the amount of feedstock available for the food waste digester.

Sales of biomethane for buses is very attractive at $25.81 per GJ, versus $7 per GJ for gas sold to Fortis. These numbers would need to be updated in light of changing energy markets.

In summary, it appears that for AD, the IRR Options Report has made a number of assumptions, resulting in an attractive financial scenario. The MH estimates are much more conservative and reflect the recent data that is available to us. This is not a review or comparison of the IRR report, but rather presents our observations as seen from a technical planning perspective.

4.2 BIO-DRYING

Bio-drying involves the use of composting technology to dry organic waste to increase its calorific value for use as a fuel. The fuel is then used in other applications such as cement kilns, where it offsets the use of fossil fuels, thus providing a substantial environmental benefit.

The large scale composting of household and commercial organics in Europe led to a very large amount of finished compost for which there were few established markets. At the same time, there was a growing market for bio-fuels, such as wood and purpose planted crops. These bio-fuels are used to replace fossil fuels such as coal or natural gas, greatly reducing the fossil fuel generated CO_2.

Since the biological activity of composting generates a large amount of heat, technologies were developed to use this heat for drying the organics (instead of composting them fully), thus generating an additional source of bio-fuel for which there are ready markets. Bio-drying can handle the entire organics waste stream, including biosolids. Several compost system suppliers now offer their technology for either composting or bio-drying.

The advantages of bio-drying include:

- Secure markets for the bio-fuel (in Europe), supported by high energy prices in Europe;
- Industrial users of fossil fuels can reduce GHG by switching to bio-fuels;
- The process of bio-drying is simpler than composting, since there is no curing and finishing of the compost required; and
- Bio-fuel is less sensitive to contamination than compost.

Disadvantages of bio-drying in BC include:

- Local markets for bio-fuel may not be available (CSWM), since there is low cost natural gas and wood available;
- There are few large scale industrial users of fossil fuel; and
- Organic materials are not recycled back to the land.

The Resort Municipality of Whistler (RMOW), which operates two agitated container composters (Wright technology), is considering the conversion from composting to the production of bio-fuel. The RMOW is currently reviewing the cost of conversion, and the value of the bio-fuel for use in cement kilns in the Vancouver area. This review is being driven by a high cost for composting and low market value for the finished compost product in the Whistler area.

There is very little cost information available for bio-drying in Canada, since it is a fairly new concept. In a recent personal conversation with a senior executive of a German company involved with both composting and bio-drying (Ulf Harig, UTV), he indicated that bio-drying in Germany using the Gore covers (normally used for composting but with a different membrane) has been very successful. The throughput is doubled for the same capital costs because the process is twice as fast as composting. It is safe to assume that costs would be about half of those of a compost system. In addition, it would require less space, since curing of the finished product would not be required. The decision of whether it is more cost effective to compost, or to bio-dry will depend on the availability of markets for compost or bio-fuel. In some regions, composting is the preferred technology because there is a local desire to recycling the organics back into the soil from where they originally came.

At this time, due to the limited market for bio-dried organics and the uncertainty with this market, it is recommended that CSWM consider selecting a composting technology that can subsequently produce bio-fuel should the demand for bio-fuel increase. Further assessment can be undertaken in the future to determine the potential market for bio-fuel and the cost of shipping the product to market. It may also be necessary to determine whether there is public acceptance of converting organics to fuel since some residents may prefer to have organic waste eventually applied back to the land.

4.3 COMPOSTING TECHNOLOGY REVIEW

In 2011 a study was undertaken by another party of regional compost technology options and costs. Numerous technologies were reviewed and a short-list of potential technologies was provided. It was determined that without a confirmed host site it was not possible to select the most appropriate technology for the region. In order to provide budgetary costs for developing a regional facility a tunnel system was selected. Conceptual design and costing was provided for a tunnel system. Capital costs were estimated at $18 million and mobile equipment costs were estimated at $1.8 million. Annual operating costs were estimated at $750,000 resulting in an operating cost of $38/tonne.

An overview of composting is provided below, followed by a brief overview of the available technologies. More information on composting and the available technologies may be found in a 2013 Environment Canada publication: Technical Document on Municipal Solid Waste Organics Processing.

Additional information on potential costs, and operational and siting considerations is provided at the end of the section.

4.3.1 Composting - Introduction

Composting is a biological process in which organic matter is consumed through microbial activity, in the presence of oxygen, to produce a humus material. Composting technologies can be very simple pile systems, generally only suitable for composting yard waste, or can be more complex systems that are capable of processing mixed organics, which may contain yard waste, food waste, and other household organic materials.

All aerobic compost systems require some form of aeration. This can be passive or active (forced air). Passive systems are generally open piles that utilize feedstock that is not attractive to animals and where moisture and process control are not critical. Typically, passive systems are used for yard waste, biosolids, and industrial sludges. Common passive technologies include: Static pile, bunker, windrow, turned mass bed and passively aerated windrow.

There are three basic components to any composting process which are utilized by the different technologies. In addition, odour needs to be managed during all three phases.

Pre-processing of the waste is required before the composting process begins. Pre-processing may include size reduction, screening, and the addition of amendments. The purpose is to create a homogeneous input into the process, to remove contaminants (such as metals, plastics and glass) and to create a feedstock that has an optimum ratio of carbon to nitrogen. Pre-processing is important because there is little opportunity to alter the mix once the material has been built into piles, laid in beds, or sealed into compost vessels. Typical equipment includes a grinder and/or shredder, screens (such as trommels), and mixing equipment.

The **composting phase** involves the biological breakdown of the material. Once the pre-processing is complete, the organic waste is loaded into the compost system (piles, vessels or beds). The system is then connected to some form of aeration, usually using ducting and blowers, since the process must have access to oxygen at all times otherwise it will become anaerobic and very odorous. During this phase, the temperature, oxygen and moisture levels in the vessel are monitored and adjusted as needed to maintain the optimum operating conditions. Air and moisture are adjusted as required. Any exhaust air is typically run through a biofilter in order to minimize odours being released into the environment.

Once the material has finished in the primary composting process, it must be stabilized and cured in windrows or static piles. During the **stabilization phase**, continued aeration is necessary to complete the composting process. Aeration may be achieved either by using a forced aeration system, or by turning the piles on a regular basis. Once a certain stabilization stage is achieved, the compost enters the **curing phase**, during which aeration is not required. Stabilization typically lasts four to six weeks and is a minimum requirement; curing can last an additional 4-6 weeks, or as long as is possible. Many facilities store cured compost for 12 – 18 months after completion of the primary composting phase. Curing for a large composting facility can require a substantial amount of space.

Odour can be created during any of the phases above. The most critical time is during pre-processing and initial composting phases, when the feedstock is raw, and may have already begun decomposing. The key is containment of odour with subsequent treatment. Most technologies use bio-filters to clean odours. The exception is the covered membrane technology which does not require additional odour treatment during the active composting phase.

4.3.2 Odour Considerations

Under optimal conditions the active composting process produces little or no odour. When the conditions are less than optimal, for example when conditions become anaerobic, odours can be produced. There are two operational steps at composting facilities that have the potential to create odours, handling of incoming feedstock and the active composting process. The characteristics of the incoming feedstock and the way it's been stored can result in odours. For example, anaerobic conditions can be present when grass clippings have been stored in bags for several days. Feedstock with a low C:N ratio such as biosolids or fish processing wastes may be odorous when arriving at the facility. Specific management strategies can be employed to minimize the potential for odours from the incoming feedstock and from handling the feedstock.

During the active composting process less than optimal conditions can result in anaerobic conditions or the production of ammonia from a low C:N ratio. Anaerobic conditions can occur when there is too much moisture present, the porosity is too low, when the pile sizes are too large and when the material is not turned enough or aerated adequately. All of these conditions can result in less than optimal oxygen for the aerobic decomposition process.

Typical odour management strategies focus on both the management of feedstock and controlling the active composting process, which usually involves some form of containment. Emissions treatment consists of employing technologies such as biofilters. To minimize the potential for odours during feedstock management it is important to know the pattern and schedule for deliveries, and to have a plan in place for managing materials that are likely to be odorous. Odour control during the active composting process is best achieved by optimizing the process for ideal aerobic conditions.

Once an odour is generated its transport depends on weather and wind conditions and topography. Odour dispersion modeling can be undertaken to determine whether odours are likely to impact nearby neighbours. Odours from composting facilities may be transported in specific patterns and at specific times based on the factors identified above.

CSWM is considering the composting of food waste and kitchen scraps, along with yard and garden waste and potentially biosolids. This requires the use of closed or "in-vessel" technologies that are able to contain odours, and keep out animals and insects. Therefore, passive and open systems will not be discussed further.

Compost systems using forced aeration and which are suitable for kitchen scraps and food waste generally fall into one of the following categories:

1. Aerated Static Piles (covered for food waste composting);
2. Enclosed aerated static piles (tunnel);
3. Static container;

4. Agitated container;
5. Channel;
6. Agitated bed; and
7. Rotating drum.

4.3.3 Aerated Static Piles (Covered)

Aerated static piles (ASP) use a series of blowers and pipes to push air through the composting feedstock. The use of covers helps to keep out animals and insects, and in some cases to contain odours. One form of covered ASP uses a plastic silage bag to contain the organics, with venting through holes in the bag, or controlled venting at the end of the bag. There is no odour control with this technology if holes in the bag are used. At the end of the process, the plastic cover and internal air distribution pipes are discarded. A picture of such a system is shown in **Figure 2**.

Figure 2: Composting Process Using Agricultural Silo Bags

In Europe, silage bag systems have also been used to first anaerobically digest the organic matter (mostly agricultural feedstocks) and then compost what is left after the biogas has been extracted.

A popular form of covered ASP composting uses membrane covers. This system was first developed by GORE using their patented semi-permeable membrane (similar to that used for GORE-TEX jackets). Other firms, such as GE, are now offering similar products. The GORE Cover system was developed in Germany and there are now over 250 installations worldwide, including several in Canada and BC. Given that the covers are in the open, it is most suitable for climates where temperatures are not too severe, however, the system has been operating successfully in Edmonton, AB for over 10 years (but not in the coldest months). Larger GORE systems, with capacities of up to 180,000 tonnes per year have been installed in Everett, WA and have been operating successfully for several years. An example of a GORE system is shown in **Figure 3.** Smaller GORE systems have been built recently on Vancouver Island, in Abbotsford, and near Pemberton, BC. A small GORE system is currently being designed for the Regional District of Kitimat-Stikine.

The most notable part of the GORE (or equivalent) technology, which sets it apart from other composting technologies, is that it does not rely on a biofilter for odour control. The membrane cover effectively keeps moisture and odours in the compost piles, while allowing the covers to “breathe”. This eliminates the need for separate odour control, usually in the form of biofilters, for the active composting process. Odour control is still required at the receiving and pre-processing end of the plant.

Figure 3: GORE COVER Compost System

The GORE system is also being employed at the Comox Valley Waste Management Centre as a pilot project and has been operating successfully for three years. The existing pilot composting project consists of a static aerated Gore Cover system with a design annual throughput of approximately 2,500 tonnes per year from curbside collection programs in Comox and Cumberland. The Gore Cover system has emerged as a cost effective method for managing organics in BC, in particular for lower tonnages. The system typically requires more space than other technologies, but both capital and operating costs are relatively low. Since this technology is currently being used in the region and because it has become the preferred technology in other parts of BC, it forms the basis of the economic analysis of regional options and potential locations.

4.3.4 Tunnels (enclosed aerated static piles)

Tunnels are solid enclosures around the ASP instead of flexible covers. Separate rooms house blowers and air management and a biofilter is used to remove odours from exhaust air. Tunnels are produced by several manufacturers and are generally made of concrete. They are suitable for very cold climates and have successfully been applied in all parts of Canada, especially on the Prairies and in Ontario. They are generally more expensive than covered ASP. An example of an ASP tunnel is shown in **Figure 4.**

Figure 4: Tunnel System

4.3.5 Static Container

Static containers are essentially large metal boxes, similar to 40 cubic yard roll-off containers. Prepared feedstock is placed inside the container, a blower hooked up to one end, and an extraction pipe that leads to a biofilter for odour control is connected to the other end. After a pre-set number of weeks, the connections are removed and the containers emptied, usually with a special tipping device. These systems are modular and usually smaller. They have not proven to be very popular in the market place in BC. An example of a static container system is shown in **Figure 5**.

Figure 5: Static Container System

4.3.6 Agitated Container

Agitated containers are usually longer metal boxes that have a system of feeding the organics at one end, moving them through the box, and removing them at the other end. They are mechanically much more complex, require high quality materials (stainless steel) and have a reputation for very high costs. However, they are also known to be efficient and use very little space. The Resort Municipality of Whistler has an agitated container system for composting of biosolids and food waste. An example of a similar facility is shown in **Figure 6.**

Figure 6: Wright Compost System (agitated container)

4.3.7 Channel

Channel systems are windrows placed inside a building. Mechanical systems turn and move the windrows once maturity is reached. There is usually no forced aeration. These systems are often larger and require higher tonnages to obtain the economies of scale needed to support the complex materials handling technology. Building corrosion is known to be an issue with these systems. An example of a smaller channel system is shown in **Figure 7**.

Figure 7: Channel Compost System

4.3.8 Agitated Bed

Similar to the channel systems, agitated bed systems involve composting inside a building. Instead of individual rows being turned mechanically, an entire bed is mechanically turned and moved. The capacities of these technologies are usually high, and this technology is used for the City of Edmonton's large mixed waste composter. **Figure 8** shows a typical agitated bed system.

Figure 8: Agitated Bed at the Edmonton Compost Facility

4.3.9 Rotating Drum

Both large and small scale rotating drum systems have been developed and tried in different regions. The advantage of using a rotating drum is constant mixing and aeration of the feedstock, and theoretically, a faster composting process. Due to their cost and mechanical complexity, there have been few plants built with this technology. The Edmonton Compost Facility had several very large rotating drums, which are no longer used due to high operating and maintenance costs, and an unsatisfactory amount of composting that took place inside the drum. The ICC compost facility in Nanaimo uses smaller drums and has had more success. However, they are still costly, and despite feedstock passing through the drums, there is still a long secondary composting period required. A smaller rotating drum system is shown in Figure 9.Vendors of Specific Technologies

Figure 9: Rotating Drum System

Table 5 provides basic information on six composting systems with numerous plants operating around the world. Starting with the covered aerated static piles and then more complex systems a group of vendors has been selected to provide examples of the range of approaches. Although names of vendors have been provided for clarity, this is not an endorsement of any of the following systems.

Table 5: Summary of Information from Selected In-Vessel Composting Technology Vendors

Vendor Name	W.L. Gore & Associates	Ag-Bag Systems Inc.	The Christiaens Group	IPS Composting Systems (Siemens)	International Composting Corporation	Bedminster International (also licensed to others)	Wright Environmental (also licensed to others)
Composting system type	Covered aerated static pile	Covered aerated static pile	Enclosed aerated static pile	Agitated bed	Drums	Drums	Agitated container
Type of waste input	MSW, Yard and Green Waste, Bio-solids	Yard and Green Waste, mixed organics, bio-solids	MSW, Yard & Green Waste, Bio-solids	MSW, Yard & Green Waste, Bio-solids	MSW, Yard & Green Waste, Bio-solids	MSW, Yard & Green Waste, Bio-solids	MSW, Yard & Green Waste, Bio-solids
Flow (continuous or batch)	Continuous	Batch	Batch	Batch	Continuous	Batch	Continuous
Throughput range (t/a)	5,000 – 200,000	1,000 – 50,000	15,000 – 200,000	25,000 – 100,000	10,000-200,000	50,000-300,000	10,000-200,000
Ideal throughput range (t/a)	40,000+	n/a	40,000+	40,000+	40,000+	100,000-200,000	40,000+
Reference facilities	>15 in North America including Everett and Maple Valley, WA and Edmonton (biosolids) approximately 200 world wide	> 15 reference facilities in North America, accepting agricultural wastes, bio-solids and yard/food wastes	> 10 treating MSW; >10 treating organics; Over 50 plants worldwide in total	27 world wide	15 world wide	11 sites worldwide all of which treat MSW	2 IVC plants treating MSW for Aberdeenshire; numerous plants in USA and Canada
Processing stages	2 stage + curing	1 stage + curing	1 stage	1 stage	2 stages	1 stage	1 or more stages
Pre-treatment requirements	Shredding and Mixing	Sizing to 4" maximum with grinder/shredder, mixing and moisture addition if required	Shredding and Mixing	Shredding and Mixing	Shredding and Mixing	Shredding and Mixing	Shredding and Mixing
Retention Time	8 weeks	8-10 weeks	6-8 weeks	8-10 weeks	8-10 weeks	3 days in drums	6-8 weeks
Parameters monitored	Temperature Oxygen	Temperature Oxygen	Air temperatures – return & supply Material temperatures Air humidity Oxygen/ CO_2 concentration Pressure	Temperature Moisture Oxygen	Temperature Oxygen Moisture	Temperature Moisture CO_2 Ammonia	Temperature Oxygen Moisture
Staffing Levels (70,000 tpa facility)	5 – 6	2 – 3	12	12	12	16	6
Building/Civil Works requirements	Concrete pads with minimum 2.5m end push-walls Process building	Graded surface required Process building	Reception hall and treatment building	Reception hall and treatment building	Reception hall and treatment building	Reception hall and treatment building	Reception hall and treatment building
Other Considerations	Low operating cost Low capital cost compared to other composting technologies/methods Canadian/Regional Experience Large number of reference plants Flexible due to modularity	Low operating and capital costs Waste plastic and piping require disposal Odour control may be problematic Specialized hopper equipment required for loading Low process and quality control (never turned)	Company also provides design and manufacture of material handling, and process control/engineering Canadian Experience	No Canadian experience Relatively high number of reference plants	Company also provides design and manufacture of material handling, and process control/engineering Limited reference plants	Short intensive primary composting phase Labour intensive process	Canadian experience Flexible due to modularity Only suitable for source separated organics

4.3.10 Composting Costs

Capital Costs

The capital cost of a composting facility will depend on the total amount of waste to be treated at the facility each year and the particular type of facility installation selected.

The factor most strongly affecting the cost of covered aerated static pile systems is the total amount of waste to be treated, since this will directly affect the aerated pad size and the overall land requirements. The capital cost of other in-vessel systems, whether bed/tunnel installations or modular containerized systems, will also depend on the total amount of waste to be treated at the facility each year and the specific proprietary system chosen. Size influences the capital cost because it governs the size of the aeration system, the number of bays or units required and the overall building requirements.

In general, covered aerated static pile systems tend to be less expensive than other in-vessel composting systems. This is due to the fact that covered aerated static pile systems do not require housing inside a building, and so construction costs can be substantially reduced. However, buildings have been used recently in BC for this technology, at least for the first phase of the overall process in order to provide better odour control while piles are being built. This also raises the cost of the systems.

Process monitoring and control equipment also tends to be simple and less costly that the highly computerized control systems associated with the more mechanically complex composting systems. However, these systems tend to require a larger footprint that their in-building counterparts, so process economics may shift if the cost of land is high, or adequate land for low costs systems is not available.

Table 6 below shows approximate capital costs for a range of composting systems. Capital costs are presented as totals, as well as cost/tonne of installed annual capacity.

Table 6: Approximate Costs for Composting Facilities

Facility Name	Technology Type	Annual Incoming Tonnage Processed	Year Constructed	Estimated Capital Costs	Estimated Capital Cost/Tonne of Capacity
Cedar Grove Composting Facility	Covered aerated static piles	180,000 tonnes	2004	$12 million	$67/tonne
Integrated Municipal Services	Covered aerated static piles	40,000 tonnes	2002	$5.5 million	$137/tonne
Edmonton Composting Facility	Bedminster drums plus, aeration hall	180,000 tonnes	2000	$100 million	$556/tonne
Delaware County	IPS wide bed system	36,000 tonnes	2006	$21 million	$583/tonne
Whistler Compost Facility	Wright Environmental agitated bed composter	18,250 tonnes	2004	$10 million	$548/tonne
Caledon Composting Facility	Herhof static container system	12,000 tonnes	2002	$4 million	$333/tonne

In general, capital costs can range from below $100/tonne of installed annual capacity for a very large covered ASP system consuming a large amount of space, to over $500/tonne of installed annual capacity for a compact and technically more complex system. Capital costs of ASP composting facilities in BC typically range from $200-$300/tonne of installed annual capacity. In recent discussions with the supplier of a covered ASP system, the order of magnitude capital costs for a 40,000 tonne per year system could be around $8 million, which is equivalent to about $200 per tonne of installed capacity. If additional buildings and odour control systems are installed, this cost would be higher.

Operating Costs

Operating costs of compost facilities are typically associated with energy consumption for aeration, fuel for vehicles and machinery, staffing, maintenance of equipment, product testing and residuals disposal. As with most waste management operations, economies of scale tend to make larger facilities more economical to operate, as costs per tonne are lower.

As with capital costs, covered aerated static pile systems tend to be relatively inexpensive to operate, largely because process control equipment is simple, and the process is not mechanically intensive. Composting systems in buildings tend to be more expensive to operate than covered aerated static piles, but less expensive than containerized in-vessel systems. **Table 7** below shows some estimated gross operating costs for various systems; these costs do not include revenue from compost sales.

Table 7: Estimated Operating Costs for Composting Facilities

Facility Name	Technology Type	Annual Tonnage Processed	Estimated Annual Gross Operating Costs	Estimated Gross Operating Cost per Tonne
Cedar Grove Composting Facility	Covered aerated static piles	200,000 tonnes	$4,000,000 /year	$20/tonne
Edmonton Composting Facility	Covered aerated static pile	40,000 tonnes bio-solids	$960,000/year	$24/tonne
Edmonton Composting Facility	Bedminster tunnels, aeration hall	180,000 tonnes	$19,800,000/year	$110/tonne
Delaware County	IPS wide bed system	36,000 tonnes	$1,800,000/year	$50/tonne
Whistler Compost Facility	Wright Environmental in-vessel tunnel composter	18,250 (first year of operation)	$1,003,750/year	$55/tonne
Caledon Composting Facility	Herhof Box system	12,000 tonnes	$568,000/year	$47/tonne

Typically, gross operations and maintenance costs can range from $20-55/tonne excluding finance charges and depending on the size of the facility and whether the facility is running at capacity (the City of Edmonton's Composting Facility is considered an outlier, since it is also designed to handle biosolids treatment). For a facility in the 40,000 tonne per year range; operating costs of $40 to $50 per tonne can be expected, depending on the technology selected. For smaller compost facilities, such as what would be expected in the CSWM service area, $60 per tonne is reasonable for comparative purposes.

The estimated operating cost does not represent a facility's tipping fee. If the facility is owned and / or operated by the private sector, a tipping fee that includes profit and potentially additional contingency may be charged for each tonne of organic waste delivered. The tipping fee will depend on the capital cost of the facility, the operating cost, potential financing provided by the region or municipality and on the nature of the market for the facility (i.e. competition).

Potential Revenues

A high degree of effort is required to identify and establish markets for compost. It is important to identify key markets before moving forward with construction of a centralized composting facility.

Compost uses can be categorized into two broad classifications: those that use small quantities of material and are willing to pay for a high quality product, and those that require large volumes of material and for whom total curing and stabilization of compost is required (volume markets). The following presents several compost users within each of these categories.

Smaller Markets

1. Nurseries
2. Landscapers
3. Topsoil Blenders
4. Retail-Garden Centres
5. Golf courses
6. Specialty Markets

Volume Markets

7. Agriculture
8. Silviculture
9. Transportation and Natural Resources Agencies
10. Sod Markets
11. Mine Reclamation
12. Landfill Cover

All compost technologies claim to produce a high-quality compost product. Depending on local market conditions and demand, finished compost can sell for $10 to $30 per tonne. Very often the value of compost is used to help to offset the transportation costs, resulting in low net revenues from the sale of compost.

4.3.11 Space Requirements

The different composting technologies reviewed above have varying space requirements. Common to all will be the space required for organic feedstock receipt/storage, pre-processing and amendment storage and processing. Curing requirements will also be similar, assuming all use outdoor static pile curing, which is the lowest cost option and essentially requires the storage of finished composting for a matter of weeks or months before it is sold and distributed as soil amendment.

Where technologies differ is in the active composting phase. Covered aerated static piles require the largest amount of space, since organics are bulked with amendment and then put in piles in long rows that are about 8 m wide, 25 m long and 3.5m high. Adding space between the piles results in a substantial amount of space being required for this phase. For example, the active composting pad for a 40,000 tonne per year facility would require about 0.8 ha of space (to which must be added receiving, screening and curing areas, which could easily add another 0.8ha). Other technologies are much more compact, with active composting areas being half or one quarter that size. There is generally a relationship between capital costs and size requirements, with the simpler covered aerated static piles requiring more space, but less capital input. The technologies that require the least amount of space generally have more buildings and equipment for the active composting process.

In **Table 8** below, the various technologies are rated for space requirements.

Table 8: Space Requirements for Composting

Technology	Space requirements
Aerated Static Piles	Large
Enclosed aerated static piles (tunnel)	Low
Static container	Medium
Agitated container	Small
Channel	Medium
Agitated bed	Small
Rotating drum	Small

4.3.12 Composting Technology Summary

The following is a brief summary of composting technologies by capital cost, operating cost, and space requirements. It has been assumed, that properly designed and operated, all of these systems will be able to produce a high quality compost for unlimited agricultural use and that appropriate odour containment and mitigation technologies will achieve a similar and acceptable level of odour control.

Table 9: Compost Technology Summary

Technology	Capital Costs	Operating Costs	Space Requirement	Comments
Aerated Static Piles (Covered)	Low	Low	High	Not suitable for very cold climates, but OK in BC coastal regions. Requires largest amount of space.
Enclosed aerated static piles (tunnel)	Moderate	Moderate	Low	Common in cold climates, small footprint.
Static container	Moderate	Moderate	Moderate	Batch system, more suited for smaller systems.
Agitated container	High	Moderate	Low	Smallest footprint, but high capital cost.
Channel	Moderate	Moderate	Moderate	
Agitated bed	High	Moderate	Low	Usually employed for very large systems.
Rotating drum	High	High	Low	High operating costs due to complexity of equipment maintenance.

In conclusion, a covered aerated static pile system (which is well proven on the West Coast) is likely going to have the lowest cost, but the highest space requirement. The enclosed aerated static pile system, which is also widely used in Canada, will use substantially less space, but the capital costs can be expected to be higher. The third technology that is also used in BC is the agitated container (UBC, Whistler) uses the smallest amount of space, but has the highest capital costs. Any of these systems should be able to handle the source segregated organics from the CSWM service area and produce unrestricted use compost. Other technologies are also available and should not be excluded in a competitive selection process.

4.3.13 General Siting Considerations

When evaluating potential compost facility sites it is important to consider a number of factors including potential impact on nearby receptors (e.g. environment, neighbours). Regional facilities in the Capital Regional District (CRD) and Regional District of Nanaimo have experienced odour related issues that have resulted in negative publicity, staff time to address the issues and, in the case of the CRD the eventual shut down of the facility. This underlines the importance of selecting a suitable site. Operations and the selected technology are also factors that influence whether there may be impacts to nearby receptors. For example, an assessment of the facility in the RDN identified many operational improvements that could be implemented to reduce the generation of odours. Depending on the technology, more space may be required to buffer the facility from potentially sensitive neighbours.

The Technical Document on Municipal Solid Waste Organics Processing (Environment Canada) categorizes the primary siting criteria as follows.

1. Environmental considerations
2. Proximity and access considerations
3. Land use considerations

Each of these categories is further subdivided in to a number of specific considerations. Environmental considerations include, amongst other things, topography, wind speed and direction, and flood plains. Proximity and access considerations include, amongst other things, water sources, utilities and services and feedstock sources. Land-use considerations include, amongst other things, allowable land uses and zoning, adjacent land uses, buffer zones and proximity to other waste management facilities. In general, locations must be compatible with surrounding land uses and result on little or no impact to the environment and surrounding neighbours. It is of great benefit to site a facility where there is access to the existing utilities and other infrastructure that is compatible with a composting operation.

Todd Baker, P.Eng. of Morrison Hershfield undertook site inspections on July 30 and 31, 2014. Inspected sites included the current compost pilot project at the Comox Valley Waste Management Centre in Cumberland, the existing transfer station at the Campbell River Waste Management Centre and the proposed compost facility location at the Norm Wood Environmental Centre in Campbell River. The purpose of the inspections was to assess the suitability of the two potential compost facility locations including the available space and to assess the existing transfer infrastructure. While a detailed assessment of siting considerations is outside the scope of work for this regional study, a high level overview of key considerations and potential benefits or issues is provided for each of the sites being considered. This is provided in the discussion after the summary of potential regional costs in Section 6.

5. Scenarios and Cost Modeling

One of the primary objectives of this study is to determine potential costs of selected regional organics management scenarios. Three primary scenarios were reviewed:

1. A regional composting facility in Campbell River
2. A regional composting facility in Comox Valley
3. Smaller facilities in Campbell River and Comox Valley

Capital and operating costs were estimated for transfer stations and composting facilities for each of the scenarios. The costs to haul organics north or south, depending on the scenario, were also determined in order to provide an annualized cost per tonne for each scenario.

5.1 Summary of the Scenarios

The following section provides a summary of the primary elements of each of the scenarios and some of the key assumptions made to estimate costs.

Scenario 1 - Regional Composting Facility in Campbell River

- New one bay permanent transfer station at the Comox Valley Waste Management Centre
- Transfer of approximately 8,000 tonnes of yard waste and food waste to Campbell River
- Construction of a new GORE Cover System (GCS) composting facility in Campbell River to manage approximately 14,000 tonnes of yard waste, food waste and biosolids

Scenario 2 - Regional Composting Facility in Comox Valley

- New one bay permanent transfer station at the Campbell River Waste Management Centre
- Transfer of approximately 6,000 tonnes of yard waste and food waste to Comox Valley
- Construction of a new GORE Cover System (GCS) composting facility in the Comox Valley to manage approximately 14,000 tonnes of yard waste, food waste and biosolids

Scenario 3 - Two Smaller Facilities in Campbell River and Comox Valley

- No new transfer station infrastructure
- Construction of a new GORE Cover System (GCS) composting facility in the Comox Valley to manage approximately 8,000 tonnes of yard waste and food waste
- Construction of a new GORE Cover System (GCS) composting facility in Campbell River to manage approximately 6,000 tonnes of yard waste, food waste and biosolids

Some of the key assumptions used for the cost estimating are as follows.

- For all scenarios, annual tonnages were based on updated estimates used for the 2011 Regional Compost Facility Study. These estimates were used as the basis for the RFP issued by the City of Campbell River for a new processing facility in Campbell River. Using the same data as that used for Campbell River's process allows a direct comparison of potential facility sizes and costs. New data is available for collection and capture rates for organics in Comox and Cumberland, however further work is required to confirm the numbers.

- For Scenarios 1 and 2 a one-bay, fully enclosed transfer station is required. In both cases the tipping floor and related costs are the same. Quantities are similar and the difference is not great enough to justify having different sizes of transfer facilities.
- The purpose of the cost modeling was to provide comparative annualized costs per tonne for different regional organics management scenarios. Capital and operating costs may need to be reviewed and updated depending on the region's chosen direction for managing organics.
- The GORE Cover System (GCS) was assumed for all scenarios since actual costs and preliminary designs are readily available from a U.S. based supplier, this technology is employed at the CVWMC already and it is the preferred technology being considered in Campbell River. MH worked closely with the supplier on technology costs for all scenarios. It was assumed the first phase of the GORE process would be undertaken in a building, therefore all compost facility capital cost estimates include one building.
- While the GCS was assumed for the purpose of providing cost estimates for this study and for developing regional costs per tonne, there are other technologies that are suitable. These technologies are likely to have different capital and operating costs.
- Although the GCS is the preferred technology for Campbell River's process, there are some differences in process and infrastructure assumed for this study as compared to what the City is considering. Technology, process and infrastructure assumptions for this study are the same for all options, allowing a direct comparison of costs across all options.
- Detailed costing undertaken by the City of Campbell River's preferred proponent was used for reference in developing the capital cost estimates.
- In the case of developing a new composting facility at the CVWMC some cost-savings and operational efficiencies were incorporated in to the analysis. Some of the required infrastructure (e.g. scales) already exists, some mobile equipment is available and the CVWMC may be able to provide some of the required maintenance and operating support. If a facility is built at the CVWMC there may be ways of realizing additional cost-savings and efficiencies that were not considered for this study.
- Estimated capital costs include 15% for engineering and 30% for contingency. Estimated operating costs include 30% for contingency.
- No government financing would be provided for composting facilities in any of the scenarios. Determining the impact of potential financing options could be the next step in determining the best solution.
- Backhaul opportunities may existing for either scenario that involves transfer and the impact of backhauling was reviewed. Backhauling opportunities should be considered again depending on the direction chosen for managing organics in the region.
- For transfer of organics, it was assumed that tub-style trailers, each with a 20 tonne capacity would be used. Transfer costs are based on actual hauling costs charged to the CVRD for the Campbell River transfer station.

The following sections provide an overview of the estimated costs and the results.

5.2 Cost Modeling

Estimates were made for compost and transfer facility capital and operating costs. Capital costs were annualized over 20 years at 4% interest to determine annualized costs. The annualized capital costs were summed with the transfer station operating, compost facility operating and hauling costs to determine the total annualized cost for each scenario. This total annualized cost was converted to an annualized cost per tonne for each scenario to compare the costs of each scenario.

Detailed costing tables are provided in Appendix A. A summary of the capital costs for each scenario is included in the table below.

Table 10: Summary of Capital Costs for Each Scenario

Scenario	1. Regional Composting Facility - Campbell River	2. Regional Composting Facility - Comox Valley	3. Facilities in Campbell River and Comox Valley
CR compost facility capital	$5,799,000	$0	$4,028,000
CV compost facility capital	$0	$5,200,000	$4,056,000
CR transfer station capital	$0	$2,022,000	$0
CV transfer station capital	$2,022,000	$0	$0
Initial trailer cost	$150,000	$75,000	$0
Total capital cost	**$7,971,000**	**$7,297,000**	**$8,084,000**

A summary of the annualized costs and overall results is provided in the table below.

Table 11: Summary of Annualized Cost for Regional Scenarios

Scenario	1. Regional Composting Facility - Campbell River	2. Regional Composting Facility - Comox Valley	3. Facilities in Campbell River and Comox Valley
Annualized capital cost	$580,000	$531,000	$588,000
Transfer station operating cost	$230,000	$200,000	$0
Compost facility operating costs	$781,000	$777,000	$1,098,000
Hauling cost	$147,000	$102,000	$0
Total annualized cost	**$1,738,000**	**$1,610,000**	**$1,686,000**
Annualized cost per tonne	**$126**	**$116**	**$122**

The impact of potential backhaul of waste material is shown in the table below.

Table 12: Summary of Annualized Cost for Regional Scenarios – With Transfer Backhaul

Scenario	1. Regional Composting Facility - Campbell River	2. Regional Composting Facility - Comox Valley	3. Facilities in Campbell River and Comox Valley
Annualized capital cost	$580,000	$531,000	$588,000
Transfer station operating cost	$230,000	$200,000	$0
Compost facility operating costs	$781,000	$777,000	$1,098,000
Hauling cost	$73,500	$94,500	$0
Total annualized cost	**$1,664,500**	**$1,602,500**	**$1,686,000**
Annualized cost per tonne	**$120**	**$116**	**$122**

Referring to **Table 10**, total capital costs for composting facilities and transfer stations for the three scenarios are similar, ranging from $7.3 million for Scenario 2 to $8.1 million for Scenario 3. The lower cost of a regional composting facility for Scenario 2 as compared to Scenario 1 is related to constructing a regional facility at the CVWMC where some of the required infrastructure (e.g. scales) is already in place.

Referring to **Table 11,** total annualized costs range from $1.6 million for Scenario 2 to $1.7 million for Scenarios 1 and 3. Annualized costs per tonne range from $116/tonne for Scenario 2 to $122/tonne for Scenario 3 and $126/tonne for Scenario 1.

Referring to **Table 12**, a potential backhaul was considered for Scenarios 1 and 2 resulting in lower hauling costs for these scenarios. This lowers the annualized cost per tonne for Scenario 1 to $120/tonne. The annualized cost for Scenario 2 does not change since it assumed that only a limited amount of drywall is available to be backhauled to Campbell River. MH staff discussed backhaul options with the current waste hauling contractor and based on these discussions potential backhaul opportunities exist for both scenarios. For example, wood waste or municipal solid waste could be hauled from Campbell River to the Comox Valley (wood for use in the biosolids composting facility and garbage to the CVWMC) and gypsum could be hauled from the CVWMC to Campbell River for processing and subsequent transport to end-markets. At this time only a limited amount of drywall could be backhauled northward and therefore this does not result in a full time backhaul.

Potential backhaul options should be considered again if the region decides to develop a regional facility in Campbell River or the Comox Valley. Given that this study assumes that specialized, lower volume trailers would be used to haul organics, overall transfer station and hauling operations should be reviewed to optimize the use of trailers and to keep overall transfer costs down. Since waste is already being hauled from Campbell River to the CVWMC in larger trailers, it may be more economical to continue to use these trailers for waste, or other trailer options could be reviewed in order to find the best solution for hauling a range of different materials including organics.

The option of hauling some organics south to Nanaimo was considered. It is estimated that the annualized cost per tonne for transferring the Comox Valley's organics to Nanaimo would be over $170/tonne, including the tipping fees at the facility currently being used by the Regional District of Nanaimo. There are other barriers to transferring organics to Nanaimo – the facility may only have an additional 3,000 tonnes of capacity and the facility only accepts food waste and yard / garden waste separately, not co-mingled as is being considered in the Comox Valley Regional District.

5.3 CapEx and OpEx

It is useful to provide both CapEx and OpEx (capital and operating expenditures) in terms of dollars per tonne in order to compare to typical ranges for other facilities. The estimated CapEx and OpEx numbers for each of the scenarios are provided below.

Estimated CapEx

- **Scenario 1**
  - Campbell River Regional Facility - $289/tonne
- **Scenario 2**
  - Comox Valley Regional Facility - $259/tonne

- **Scenario 3**
  - Campbell River Facility for North Tonnes - $471/tonne
  - Comox Valley Facility for South Tonnes - $353/tonne

The CapEx numbers provided above do not include costs for engineering and they do not factor in contingency amounts included in the overall cost modeling. The OpEx numbers below also do not include the contingency amounts included in the overall cost modeling.

Estimated OpEx

- **Scenario 1**
  - Campbell River Regional Facility - $43/tonne
- **Scenario 2**
  - Comox Valley Regional Facility - $43/tonne
- **Scenario 3**
  - Campbell River Facility for North Tonnes - $69/tonne
  - Comox Valley Facility for South Tonnes - $55/tonne

Comparing to the general CapEx and OpEx numbers provided in Section 5, the numbers above are considered within the expected range of costs anticipated for the size and types of facilities considered for the analysis.

5.4 TIPPING FEE ANALYSIS

Based on discussions with the GCS supplier, it is understood that potential tipping fees consist of the annualized capital cost per tonne, the operating cost per tonne and profit, which can be assumed to range from approximately $5/tonne to $20/tonne depending on the market conditions and the competitive process established for building a new facility. Based on this, approximate ranges of tipping fee were determined for the three scenarios using the capital and operating numbers in the cost model. Contingencies and engineering amounts were not included in the tipping fee analysis. It is assumed that the private sector is responsible for the entire capital investment required. Potential tipping free ranges are as follows.

- **Scenario 1**
  - Campbell River Regional Facility - $70/tonne to $84/tonne
- **Scenario 2**
  - Comox Valley Regional Facility - $67/tonne to $82/tonne
- **Scenario 3**
  - Campbell River Facility for North Tonnes - $109/tonne to $123/tonne
  - Comox Valley Facility for South Tonnes - $86/tonne to $101/tonne

If capital money is invested by any municipality and / or the region, these tipping fees would be reduced since proponents would not need to invest their own capital. For example, the City of Campbell River has indicated that if it invests $2.5 million the tipping fee for a facility in Campbell River to handle organics from Campbell River would be $105/tonne.

It may also be possible to reduce potential tipping fees further by increasing guaranteed tonnages to the facility or facilities. Based on discussions with compost facility vendors in BC, it may be possible to achieve a tipping fee of $65/tonne for total annual tonnages of 10,000 – 20,000 tonnes. In the Fraser Valley tipping fees for existing facilities are around $65/tonne and in some cases lower. Potential costs and tipping fees depend on a number of factors. For example if elaborate controls are required for managing odours, leachate, etc. then capital costs, operating costs and tipping fees will be higher.

The City of Campbell River has applied for $6.36 million in Union of British Columbia Municipalities Strategic Priorities funding for the proposed facility at the Norm Wood Environmental Centre. If this funding is received, the economics of building and transferring to this facility would need to be reviewed again. The economics of using this facility for organics from outside the City depends on the proposed tipping fee, which is likely to be impacted by a successful grant application. Currently the proposed tipping fee for organics from outside the City boundaries is unknown.

5.5 Discussion

The cost modeling indicates that the lowest cost option involves constructing a regional facility at the CVWMC (Scenario 2). Scenario 3 is the next lowest cost option not considering any backhaul options for the transfer of organics. Scenario 1 is less costly than Option 3 if cost savings can be realized with a backhaul from Campbell River to the Comox Valley. Scenario 2 without the transfer backhaul is $4/tonne less than Scenario 1 with the transfer backhaul, therefore Scenario 2 is the lowest cost alternative considering all economic factors.

Factors other than cost need to be considered. Considering the potential impacts of a new facility is critical. As an example, proper siting will minimize the potential risks related to odours and the related costs for managing odours. As discussed in Section 6, siting criteria may be grouped in terms of environmental considerations, proximity and access considerations, and land use considerations. It is outside the scope of this study to undertake a detailed siting assessment and a comparison of the two sites being considered for a new facility. However, some general observations and considerations are provided below.

The CVWMC is currently used for the purpose of managing wastes and will continue to be used this way for many years. Landfilling and composting are already being undertaken at this facility. The nearest residences are approximately 1.5 km from the site. The site has the space available for a new composting facility and compatible infrastructure is present, for example scales, a public waste drop off area and equipment maintenance shops. Waste management staff are present at the site and may be able to help administer and support a new composting facility. A leachate treatment system for the landfill will be constructed as part of the next phase of development and stormwater controls are present across the landfill site. Mobile equipment (e.g. loaders) is present at the site and there may be opportunities to use this equipment to lower overall costs. The 2011 Regional Compost Facility Study indicates that significant savings may be achieved by co-locating a composting facility with an existing or new solid waste facility.

The Norm Wood Environmental Centre is currently being used for treating wastewater and for managing biosolids (land application). The site is less than 500 m from the nearest businesses and residents. The site is compatible with the proposed use – the City has successfully applied to the Agricultural Land Commission to use the site for a new composting facility and the site is appropriately zoned. New infrastructure will be required for managing waste materials including scales and a public drop off area.

Costs for extending utilities and access roads to the new composting facility may also be higher than that required for a new facility at the CVWMC given the proposed locations of the new facilities within each site. Further work would be required to confirm this. Given the proximity to nearby receptors, it may be necessary to implement additional odour controls, beyond what has been assumed for this study, which would increase the overall cost to build and maintain the facility.

The proposed facility to be located at the Norm Wood Environmental Centre is not only a solid waste initiative, it is also a proposed solution for managing biosolids generated at the wastewater treatment facility. The City may be able to save money by composting biosolids rather than upgrading the wastewater treatment facility with a new digester. Campbell River City Council supports the direction to develop the facility.

Both the CVWMC and Norm Wood Environmental Centre may be suitable for a new composting facility, however there may be benefits to using the CVWMC if only one site is being considered. If two smaller facilities are being considered, then it should be possible to design and implement systems that are appropriate for each community and that are compatible with surrounding land uses.

In terms of available markets for compost and the impact on the business case, it is assumed to be equal across all options and therefore not considered as part of the overall comparison of scenario costs. Further work may be required to determine whether there are differences across the region for demand and marketability of compost.

6. KEY CONSIDERATIONS AND CONCLUSIONS

The following section provides a summary of some of the key considerations and conclusions outlined in the assessment of regional organics management options.

- There are two potential sites being considered for a new facility, the Comox Valley Waste Management Centre, the site of the existing composting pilot project and the Norm Wood Environmental Centre, the location of Campbell River's wastewater treatment facility.
- The City of Campbell River has received proposals for developing a new facility at the Norm Wood Environmental Centre and the City is currently negotiating with the preferred proponent.
- Approximately 14,000 tonnes of yard waste and food waste was considered for collection and management at one or two new organics management facilities. This represents an overall capture rate of approximately 64% of the available organics.
- Anaerobic digestion (AD) is typically more costly both from capital and operating perspective than composting. Based on a review of costs for other facilities and based on recent experience it is assumed that capital costs could be over $700/tonne of installed annual capacity and operating costs (including net sale of energy) could be $100/tonne or more.
- The 2012 IRR report may provide optimistic costs and revenues for the implementation of an AD system for the region. Additionally, the IRR report is very optimistic in terms of available tonnes to be managed at a new facility.
- Bio-drying, the process of converting organics to fuel using a composting technology, is a new concept in Canada and therefore potential users of the fuel are not aware of it, or have not yet considered it. While it is possible to create a fuel using available technologies, there is uncertainty in the market right now. CSWM should continue to monitor developments in this area and continue to consider potential opportunities. Many composting technologies can be converted to bio-drying in the future.
- There are numerous composting technologies available – many have been reviewed for CSWM as part of the 2011 study and for this study. There are pros and cons to each of the technologies – some require more space, some manage odours better and there are differences in processing times. Capital and operating costs also differ.
- In general, capital costs for compost facilities can range from $100/tonne to $500/ tonne of installed capacity. Operating costs of approximately $60/tonne may be expected for a smaller facility suitable for the CSWM service area. Finished compost can sell for between $10/tonne and $30/tonne depending on market conditions.
- Odours and facility siting are important considerations. Done well, composting generates very little odour however there are many opportunities for odours to be generated at various stages of the process from feedstock receipt at the facility through to the end of the process and curing.
- Facility siting criteria consist of environmental considerations, proximity / access considerations and land use considerations. Two potential sites were reviewed for this study, the Comox Valley Waste Management Centre and the Norm Wood Environmental Centre. Both sites are compatible with a new composting facility, however the Comox Valley Waste Management Centre provides some benefits in terms of buffers, existing infrastructure and compatibility with the current site use and surrounding land use.

- Three scenarios were reviewed to determine potential costs for new composting facilities, transfer stations and waste hauling. The three scenarios are as follows.
    - Scenario 1 - Regional Composting Facility in Campbell River
    - Scenario 2 - Regional Composting Facility in Comox Valley
    - Scenario 3 - Two Smaller Facilities in Campbell River and Comox Valley
- Total capital costs for composting facilities and transfer stations for the three scenarios are similar, ranging from $7.3 million for Scenario 2 to $8 million for Scenarios 1 and 3.
- Total annualized costs range from $1.6 million for Scenario 2 to $1.7 million for Scenarios 1 and 3. Annualized costs per tonne range from $116/tonne for Scenario 2 to $122/tonne for Scenario 3 and $126/tonne for Scenario 1.
- A potential backhaul was considered for Scenarios 1 and 2 resulting in lower hauling costs for these scenarios. This lowers the annualized cost per tonne for Scenario 1 to $120/tonne. There is no change in the annualized cost per tonne for Scenario 2 due to the limited quantity of drywall that is available for backhaul to Campbell River.
- Potential tipping fees for a new facility could range from approximately $67/tonne to $123/tonne depending on the size of the facility and market conditions.
- Scenario 2 involving construction of a new regional facility at the CVWMC is the lowest cost option.
- Other considerations such as siting criteria should also be considered for selecting a suitable site and technology. Synergies may exist with a new facility at the CVWMC that are not present at the Norm Wood Environmental Centre, although both sites seem suitable for a new facility.

While this assessment focuses primarily on the anticipated costs of the different scenarios, there may be factors to consider that are outside the scope of this study. Additional environmental, social and political considerations may also need to be discussed.

APPENDIX A: ***DETAILED COST TABLES***

TABLE A-1 - TRANSFER STATION CAPITAL COST ESTIMATE

Item #		Item	Unit	Quantity	Unit Price	Total Price
1		**Site Preparation**				
	1.01	Mobilization and demobilization	LS	1	$50,000.00	$50,000.00
	1.02	Site grading and preparation	LS	1	$100,000.00	$100,000.00
	1.03	Excavation for building foundation	LS	1	$20,000.00	$20,000.00
	1.04	Retaining wall and lock blocks	LS	1	$110,000.00	$110,000.00
	1.05	Landscaping and topsoil	LS	1	$30,000.00	$30,000.00
		Subtotal				**$310,000.00**
2		**Building and Equipment**				
	2.01	Concrete foundations, slabe on grade, hoppers, push walls, wear slab	m^2	500	$500.00	$250,000.00
	2.02	Transfer station building	m^2	500	$400.00	$200,000.00
	2.03	Rollup doors	each	2	$10,000.00	$20,000.00
	2.04	Lift up doors	each	2	$7,000.00	$14,000.00
	2.05	Man doors	each	2	$1,500.00	$3,000.00
	2.06	Office	LS	1	$40,000.00	$40,000.00
		Subtotal				**$527,000.00**
3		**Surfacing, barriers, signs and fencing**				
	3.01	Road base (100 mm thick)	m^2	5000	$6.50	$32,500.00
	3.02	Medium coarse asphalt (75 mm thick)	m^2	5000	$38.00	$190,000.00
	3.03	Traffic barriers and curbing	LS	1	$20,000.00	$20,000.00
	3.04	Road painting	LS	1	$2,000.00	$2,000.00
	3.05	Lay down pads	LS	1	$10,000.00	$10,000.00
	3.06	Signs	LS	1	$3,000.00	$3,000.00
	3.07	Fencing and gates	LS	1	$15,000.00	$15,000.00
		Subtotal				**$272,500.00**
4		**Utilities**				
	4.01	Water supply	LS	1	$10,000.00	$10,000.00
	4.02	Fire suppression (fire protection system, hydrants)	LS	1	$35,000.00	$35,000.00
	4.03	Storm drain system and stormwater diching / swales	LS	1	$40,000.00	$40,000.00
	4.04	Sanitary and leachate	LS	1	$40,000.00	$40,000.00
	4.05	Oil / water separator	LS	1	$10,000.00	$10,000.00
	4.06	Electrical and lighting	LS	1	$70,000.00	$70,000.00
		Subtotal				**$205,000.00**
5		**Miscellaneous**				
	5.01	Geotechnical assessment	LS	1	$30,000.00	$30,000.00
	5.02	Access road allowance	LS	1	$50,000.00	$50,000.00
		Subtotal				**$80,000.00**
		Construction Subtotal				**$1,394,500.00**
6		**Engineering, Construction Oversight and Contingency**				
	6.01	Engineering and construction oversight (15%)				$209,175.00
	6.02	Contingency (30%)				$418,350.00
		Subtotal				**$627,525.00**
		Total Project				**$2,022,025.00**

TABLE A-2 - TRANSFER STATION OPERATING COST - COMOX VALLEY TRANSFER STATION

Item #		Item	Unit	Quantity	Unit Price	Total Price
1		**Staffing and Labour**				
	1.01	Diversion and operations support coordinator ($67,000/yr x 1.1 benefits x 20% utility)		1	$14,740.00	$14,740.00
	1.02	Scalehouse operator ($45,000/yr x 1.1 benefits x 20% utility)		1	$9,900.00	$9,900.00
	1.03	Waste management attendant ($54,000/yr x 1.1 benefits x 50% utility)		1	$29,700.00	$29,700.00
	1.04	Loader operator ($60,000/yr x 1.1 benefits x 50% utility)		1	$33,000.00	$33,000.00
	1.05	Administration staff ($50,000 x 1.1 benefits x 20% utility)		1	$11,000.00	$11,000.00
	1.06	Engineering and technical support ($100,000 x 5% utility)		1	$5,000.00	$5,000.00
		Subtotal				**$103,340.00**
2		**Building and Equipment**				
	2.01	Building, roads and site works maintenance	LS	1	$2,000.00	$2,000.00
	2.02	Mechanical / electrical	LS	1	$5,000.00	$5,000.00
	2.03	Equipment maintenance	LS	1	$10,000.00	$10,000.00
	2.04	Safety gear	LS	1	$500.00	$500.00
	2.05	Tools and supplies	LS	1	$1,000.00	$1,000.00
	2.06	Contribution to trailer replacement	LS	1	$18,750.00	$18,750.00
		Subtotal				**$37,250.00**
3		**Utilities**				
	3.01	Fuel - loader (8 hrs./day x 260 days/yr 7.5 L/hr x 50% utility)		1	$11,700.00	$11,700.00
	3.02	Contribution to loader lease		1	$10,000.00	$10,000.00
	3.03	Contribution to other on-site utilities		1	$5,000.00	$5,000.00
		Subtotal				**$26,700.00**
4		**Administration and Consulting**				
	4.01	Administration, legal, accounting, insurance		1	$5,000.00	$5,000.00
	4.02	Approvals, reporting, consulting		1	$5,000.00	$5,000.00
		Subtotal				**$10,000.00**
		Operating Subtotal				**$177,290.00**
5		**Contingency**				
	5.01	Contingency (30%)				$53,187.00
		Subtotal				**$53,187.00**
		Total Project				**$230,477.00**
					Operating cost per tonne	**$29.10**

TABLE A-3 - TRANSFER STATION OPERATING COST - CAMPBELL RIVER TRANSFER STATION

Item #		Item	Unit	Quantity	Unit Price	Total Price
1		**Staffing and Labour**				
	1.01	Diversion and operations support coordinator ($67,000/yr x 1.1 benefits x 30% utility)		1	$22,110.00	$22,110.00
	1.02	Scalehouse operator ($45,000/yr x 1.1 benefits x 30% utility)		1	$14,850.00	$14,850.00
	1.03	Waste management attendant ($54,000/yr x 1.1 benefits x 50% utility)		1	$29,700.00	$29,700.00
	1.04	Loader operator ($60,000/yr x 1.1 benefits x 30% utility)		1	$19,800.00	$19,800.00
	1.05	Administration staff ($50,000 x 1.1 benefits x 5% utility)		1	$2,750.00	$2,750.00
	1.06	Engineering and technical support ($100,000 x 5% utility)		1	$5,000.00	$5,000.00
		Subtotal				**$94,210.00**
2		**Building and Equipment**				
	2.01	Building, roads and site works maintenance	LS	1	$2,000.00	$2,000.00
	2.02	Mechanical / electrical	LS	1	$5,000.00	$5,000.00
	2.03	Equipment maintenance	LS	1	$10,000.00	$10,000.00
	2.04	Safety gear	LS	1	$500.00	$500.00
	2.05	Tools and supplies	LS	1	$1,000.00	$1,000.00
	2.06	Contribution to trailer replacement	LS	1	$9,375.00	$9,375.00
		Subtotal				**$27,875.00**
3		**Utilities**				
	3.01	Fuel - loader (8 hrs./day x 260 days/yr 7.5 L/hr. x 50% utility)		1	$7,020.00	$7,020.00
	3.02	Contribution to loader lease		1	$10,000.00	$10,000.00
	3.03	Contribution to other on-site utilities		1	$5,000.00	$5,000.00
		Subtotal				**$22,020.00**
4		**Administration and Consulting**				
	4.01	Administration, legal, accounting, insurance		1	$5,000.00	$5,000.00
	4.02	Approvals, reporting, consulting		1	$5,000.00	$5,000.00
		Subtotal				**$10,000.00**
		Operating Subtotal				**$154,105.00**
5		**Contingency**				
	5.01	Contingency (30%)				$46,231.50
		Subtotal				**$46,231.50**
		Total Project				**$200,336.50**
					Operating cost per tonne	**$33.96**

Table A-4 - Composting Facility Capital Cost - Campbell River (North Tonnes)

Item #		Item	Unit	Quantity	Unit Price	Total Price
1		**Site Preparation**				
	1.01	Mobilization and demobilization	LS	1	$50,000.00	$50,000.00
	1.02	Site grading and preparation	LS	1	$50,000.00	$50,000.00
	1.03	Access road and drainage	m	515	$567.00	$292,005.00
	1.04	Landscaping and topsoil	LS	1	$30,000.00	$30,000.00
	1.05	Yard waste drop off area	LS	1	$6,000.00	$6,000.00
		Subtotal				**$428,005.00**
2		**Buildings and Foundations**				
	2.01	Steel frame building (24.5 x 55 m)	LS	1	$346,000.00	$346,000.00
	2.02	Concrete push walls and floor	LS	1	$446,175.00	$446,175.00
	2.03	Office and entrance	LS	1	$60,000.00	$60,000.00
	2.04	Scale and scalehouse	LS	1	$30,000.00	$30,000.00
		Subtotal				**$882,175.00**
3		**Surfacing, barriers, signs and fencing**				
	3.01	Sub-base (300 mm thick)	m^2	4500	$15.75	$70,875.00
	3.02	Road base (150 mm thick)	m^2	4500	$10.50	$47,250.00
	3.03	Medium coarse asphalt (100 mm thick)	m^2	4100	$27.00	$110,700.00
	3.04	Traffic barriers and curbing	LS	1	$10,000.00	$10,000.00
	3.05	Signs	LS	1	$3,000.00	$3,000.00
	3.06	Fencing and gates	LS	1	$15,000.00	$15,000.00
		Subtotal				**$256,825.00**
4		**Equipment and Vehicles**				
	4.01	GORE cover system	LS	1	$675,000.00	$675,000.00
	4.02	Winder	LS	1	$150,000.00	$150,000.00
		Subtotal				**$825,000.00**
5		**Utilities**				
	5.01	Water supply	LS	1	$23,000.00	$23,000.00
	5.02	Sanitary	LS	1	$28,000.00	$28,000.00
	5.03	Fire suppression (fire protection system, hydrants)	LS	1	$75,000.00	$75,000.00
	5.04	Electrical and lighting	LS	1	$75,000.00	$75,000.00
		Subtotal				**$201,000.00**
6		**Odour, Leachate and Storm water Management**				
	6.01	Storm drain system and stormwater diching / swales	LS	1	$15,000.00	$15,000.00
	6.02	Leachate tanks and recirculation	LS	1	$20,000.00	$20,000.00
	6.03	Biofilter	LS	1	$50,000.00	$50,000.00
		Subtotal				**$85,000.00**
7		**Miscellaneous**				
	7.01	Operator training	LS	1	$50,000.00	$50,000.00
	7.02	Geotechnical investigation	LS	1	$25,000.00	$25,000.00
	7.03	Permitting consulting	LS	1	$25,000.00	$25,000.00
		Subtotal				**$100,000.00**
		Construction Subtotal				**$2,778,005.00**

TABLE A-4 - COMPOSTING FACILITY CAPITAL COST - CAMPBELL RIVER (NORTH TONNES)

Item #		Item	Unit	Quantity	Unit Price	Total Price
8		**Engineering, Construction Oversight and Contingency**				
	8.01	Engineering and construction oversight (15%)				$416,700.75
	8.02	Contingency (30%)				$833,401.50
		Subtotal				**$1,250,102.25**
		Total Project				**$4,028,107.25**

Tonnes managed	**5,900**
Capex per tonne	**$471**
Capex per tonne (inc. engineering and contingency)	**$683**

TABLE A-5 - COMPOST FACILITY OPERATING COST - CAMPBELL RIVER (NORTH TONNES)

Item #		Item	Unit	Quantity	Unit Price	Total Price
1		**Staffing and Labour**				
	1.01	Scalehouse operator and waste management attendant	hrs.	2080	$30.00	$62,400.00
	1.02	Loader operator and probe placement ($150/hr. X 8.5 hours/week)	hrs.	442	$150.00	$66,300.00
	1.03	Waste management attendant	hrs.	1638	$45.00	$73,710.00
	1.04	Manager	LS	1	$84,000.00	$84,000.00
		Subtotal				**$286,410.00**
2		**Building and Equipment**				
	2.01	Building, roads and site works maintenance	LS	1	$2,000.00	$2,000.00
	2.02	Mechanical / electrical repairs and maintenance	LS	1	$5,000.00	$5,000.00
	2.03	Safety gear	LS	1	$500.00	$500.00
	2.04	Tools and supplies	LS	1	$1,000.00	$1,000.00
	2.05	Contribution to cover replacement	LS	1	$26,571.00	$26,571.00
		Subtotal				**$35,071.00**
3		**Utilities and Rentals**				
	3.01	Loader maintenance and insurance	LS	1	$20,000.00	$20,000.00
	3.02	Power	LS	1	$1,770.00	$1,770.00
	3.03	Grinder and screening rentals	LS	1	$50,000.00	$50,000.00
		Subtotal				**$71,770.00**
4		**Administration, Consulting and Testing**				
	4.01	Approvals, reporting, consulting	LS	1	$10,000.00	$10,000.00
	4.02	Annual training	LS	1	$5,000.00	$5,000.00
		Subtotal				**$15,000.00**
		Operating Subtotal				**$408,251.00**
5		**Contingency**				
	5.01	Contingency (30%)				$122,475.30
		Subtotal				**$122,475.30**
		Total Project				**$530,726.30**

Tonnes managed	**5,900**
Operating cost per tonne	**$69**
Operating cost per tonne (inc. contingency)	**$90**

TABLE A-6 - COMPOSTING FACILITY CAPITAL COST - COMOX VALLEY (SOUTH TONNES)

Item #		Item	Unit	Quantity	Unit Price	Total Price
1		**Site Preparation**				
	1.01	Mobilization and demobilization	LS	1	$50,000.00	$50,000.00
	1.02	Site grading and preparation	LS	1	$50,000.00	$50,000.00
	1.03	Access road and drainage	m	150	$567.00	$85,050.00
	1.04	Landscaping and topsoil	LS	1	$30,000.00	$30,000.00
	1.05	Yard waste drop off area	LS	1	$0.00	$0.00
		Subtotal				**$215,050.00**
2		**Buildings and Foundations**				
	2.01	Steel frame building (24.5 x 60 m)	LS	1	$366,000.00	$366,000.00
	2.02	Concrete push walls and floor	LS	1	$547,250.00	$547,250.00
	2.03	Office	LS	1	$40,000.00	$40,000.00
	2.04	Scale and scalehouse	LS	1	$0.00	$0.00
		Subtotal				**$953,250.00**
3		**Surfacing, barriers, signs and fencing**				
	3.01	Sub-base (300 mm thick)	m^2	5000	$15.75	$78,750.00
	3.02	Road base (150 mm thick)	m^2	5000	$10.50	$52,500.00
	3.03	Medium coarse asphalt (100 mm thick)	m^2	4500	$27.00	$121,500.00
	3.04	Traffic barriers and curbing	LS	1	$10,000.00	$10,000.00
	3.05	Signs	LS	1	$3,000.00	$3,000.00
	3.06	Fencing and gates	LS	1	$0.00	$0.00
		Subtotal				**$265,750.00**
4		**Equipment and Vehicles**				
	4.01	GORE cover system	LS	1	$800,000.00	$800,000.00
	4.02	Winder	LS	1	$150,000.00	$150,000.00
		Subtotal				**$950,000.00**
5		**Utilities**				
	5.01	Water supply	LS	1	$50,000.00	$50,000.00
	5.02	Sanitary	LS	1	$28,000.00	$28,000.00
	5.03	Fire suppression (fire protection system, hydrants)	LS	1	$75,000.00	$75,000.00
	5.04	Electrical and lighting	LS	1	$75,000.00	$75,000.00
		Subtotal				**$228,000.00**
6		**Odour, Leachate and Storm water Management**				
	6.01	Storm drain system and stormwater diching / swales	LS	1	$15,000.00	$15,000.00
	6.02	Leachate tanks and recirculation	LS	1	$20,000.00	$20,000.00
	6.03	Biofilter	LS	1	$50,000.00	$50,000.00
		Subtotal				**$85,000.00**
7		**Miscellaneous**				
	7.01	Operator training	LS	1	$50,000.00	$50,000.00
	7.02	Geotechnical investigation	LS	1	$25,000.00	$25,000.00
	7.03	Permitting consulting	LS	1	$25,000.00	$25,000.00
		Subtotal				**$100,000.00**
		Construction Subtotal				**$2,797,050.00**

TABLE A-6 - COMPOSTING FACILITY CAPITAL COST - COMOX VALLEY (SOUTH TONNES)

Item #		Item	Unit	Quantity	Unit Price	Total Price
8		**Engineering, Construction Oversight and Contingency**				
	8.01	Engineering and construction oversight (15%)				$419,557.50
	8.02	Contingency (30%)				$839,115.00
		Subtotal				**$1,258,672.50**
		Total Project				**$4,055,722.50**

Tonnes managed	**7,920**
Capex per tonne	**$353**
Capex per tonne (inc. engineering and contingency)	**$512**

TABLE A-7 - COMPOST FACILITY OPERATING COST - COMOX VALLEY (SOUTH TONNES)

Item #		Item	Unit	Quantity	Unit Price	Total Price
1		**Staffing and Labour**				
	1.01	Waste management attendant	hrs.	2080	$30.00	$62,400.00
	1.02	Loader operator and probe placement ($150/hr. X 10 hours/week)	hrs.	520	$150.00	$78,000.00
	1.03	Waste management attendant	hrs.	1560	$45.00	$70,200.00
	1.04	Manager	LS	1	$84,000.00	$84,000.00
		Subtotal				**$294,600.00**
2		**Building and Equipment**				
	2.01	Building, roads and site works maintenance	LS	1	$2,000.00	$2,000.00
	2.02	Mechanical / electrical repairs and maintenance	LS	1	$5,000.00	$5,000.00
	2.03	Safety gear	LS	1	$500.00	$500.00
	2.04	Tools and supplies	LS	1	$1,000.00	$1,000.00
	2.05	Contribution to cover replacement	LS	1	$30,857.00	$30,857.00
		Subtotal				**$39,357.00**
3		**Utilities and Rentals**				
	3.01	Loader maintenance and insurance	LS	1	$20,000.00	$20,000.00
	3.02	Power	LS	1	$2,376.00	$2,376.00
	3.03	Grinder and screening rentals	LS	1	$65,000.00	$65,000.00
		Subtotal				**$87,376.00**
4		**Administration, Consulting and Testing**				
	4.01	Approvals, reporting and consulting	LS	1	$10,000.00	$10,000.00
	4.02	Annual training	LS	1	$5,000.00	$5,000.00
		Subtotal				**$15,000.00**
		Operating Subtotal				**$436,333.00**
5		**Contingency and Profit**				
	5.01	Contingency (30%)				$130,899.90
		Subtotal				**$130,899.90**
		Total Project				**$567,232.90**

Tonnes managed	**7,920**
Operating cost per tonne	**$55**
Operating cost per tonne (inc. contingency)	**$72**

TABLE A-8 - COMPOSTING FACILITY CAPITAL COST - CAMPBELL RIVER (REGIONAL TONNES)

Item #		Item	Unit	Quantity	Unit Price	Total Price
1		**Site Preparation**				
	1.01	Mobilization and demobilization	LS	1	$50,000.00	$50,000.00
	1.02	Site grading and preparation	LS	1	$80,000.00	$80,000.00
	1.03	Access road and drainage	m	515	$567.00	$292,005.00
	1.04	Landscaping and topsoil	LS	1	$30,000.00	$30,000.00
	1.05	Yard waste drop off area	LS	1	$8,000.00	$8,000.00
		Subtotal				**$460,005.00**
2		**Buildings and Foundations**				
	2.01	Steel frame building (24.5 x 80 m)	LS	1	$460,000.00	$460,000.00
	2.02	Concrete push walls and floor	LS	1	$701,000.00	$701,000.00
	2.03	Office and entrance	LS	1	$30,000.00	$30,000.00
	2.04	Scale	LS	1	$200,000.00	$200,000.00
		Subtotal				**$1,391,000.00**
3		**Surfacing, barriers, signs and fencing**				
	3.01	Sub-base (300 mm thick)	m^2	8000	$15.75	$126,000.00
	3.02	Road base (150 mm thick)	m^2	8000	$10.50	$84,000.00
	3.03	Medium coarse asphalt (100 mm thick)	m^2	7000	$27.00	$189,000.00
	3.04	Traffic barriers and curbing	LS	1	$20,000.00	$20,000.00
	3.05	Signs	LS	1	$3,000.00	$3,000.00
	3.06	Fencing and gates	LS	1	$25,000.00	$25,000.00
		Subtotal				**$447,000.00**
4		**Equipment and Vehicles**				
	4.01	GORE cover system	LS	1	$1,100,000.00	$1,100,000.00
	4.02	Winder	LS	1	$150,000.00	$150,000.00
		Subtotal				**$1,250,000.00**
5		**Utilities**				
	5.01	Water supply	LS	1	$23,000.00	$23,000.00
	5.02	Sanitary	LS	1	$28,000.00	$28,000.00
	5.03	Fire suppression (fire protection system, hydrants)	LS	1	$75,000.00	$75,000.00
	5.04	Electrical and lighting	LS	1	$75,000.00	$75,000.00
		Subtotal				**$201,000.00**
6		**Odour, Leachate and Storm water Management**				
	6.01	Storm drain system and stormwater diching / swales	LS	1	$25,000.00	$25,000.00
	6.02	Leachate tanks and recirculation	LS	1	$25,000.00	$25,000.00
	6.03	Biofilter	LS	1	$75,000.00	$75,000.00
		Subtotal				**$125,000.00**
7		**Miscellaneous**				
	7.01	Operator training	LS	1	$75,000.00	$75,000.00
	7.02	Geotechnical investigation	LS	1	$25,000.00	$25,000.00
	7.03	Permitting consulting	LS	1	$25,000.00	$25,000.00
		Subtotal				**$125,000.00**
		Construction Subtotal				**$3,999,005.00**

TABLE A-8 - COMPOSTING FACILITY CAPITAL COST - CAMPBELL RIVER (REGIONAL TONNES)

Item #		Item	Unit	Quantity	Unit Price	Total Price
8		**Engineering, Construction Oversight and Contingency**				
	8.01	Engineering and construction oversight (15%)				$599,850.75
	8.02	Contingency (30%)				$1,199,701.50
		Subtotal				**$1,799,552.25**
		Total Project				**$5,798,557.25**

Tonnes managed	**13,820**
Capex per tonne	**$289**
Capex per tonne (inc. engineering and contingency)	**$420**

TABLE A-9 - COMPOST FACILITY OPERATING COST - CAMPBELL RIVER (REGIONAL TONNES)

Item #		Item	Unit	Quantity	Unit Price	Total Price
1		**Staffing and Labour**				
	1.01	Waste management attendant	hrs.	2080	$30.00	$62,400.00
	1.02	Waste management attendant	hrs.	2080	$30.00	$62,400.00
	1.03	Loader operator and probe placement ($150/hr. X 11.5 hours/week)	hrs.	598	$150.00	$89,700.00
	1.04	Waste management attendant	hrs.	1482	$45.00	$66,690.00
	1.05	Manager	LS	1	$84,000.00	$84,000.00
		Subtotal				**$365,190.00**
2		**Building and Equipment**				
	2.01	Building, roads and site works maintenance	LS	1	$5,000.00	$5,000.00
	2.02	Mechanical / electrical repairs and maintenance	LS	1	$10,000.00	$10,000.00
	2.03	Safety gear	LS	1	$1,000.00	$1,000.00
	2.04	Tools and supplies	LS	1	$2,000.00	$2,000.00
	2.05	Contribution to cover replacement	LS	1	$53,143.00	$53,143.00
		Subtotal				**$71,143.00**
3		**Utilities and Rentals**				
	3.01	Loader maintenance and insurance	LS	1	$30,000.00	$30,000.00
	3.02	Power	LS	1	$4,146.00	$4,146.00
	3.03	Grinder and screening rentals	LS	1	$100,000.00	$100,000.00
		Subtotal				**$134,146.00**
4		**Administration, Consulting and Testing**				
	4.01	Approvals, reporting, consulting	LS	1	$20,000.00	$20,000.00
	4.02	Annual training	LS	1	$10,000.00	$10,000.00
		Subtotal				**$30,000.00**
		Operating Subtotal				**$600,479.00**
5		**Contingency**				
	5.01	Contingency (30%)				$180,143.70
		Subtotal				**$180,143.70**
		Total Project				**$780,622.70**

Tonnes managed	**13,820**
Operating cost per tonne	**$43**
Operating cost per tonne (inc. contingency)	**$56**

TABLE A-10 - COMPOSTING FACILITY CAPITAL COST - COMOX VALLEY (REGIONAL TONNES)

Item #		Item	Unit	Quantity	Unit Price	Total Price
1		**Site Preparation**				
	1.01	Mobilization and demobilization	LS	1	$50,000.00	$50,000.00
	1.02	Site grading and preparation	LS	1	$80,000.00	$80,000.00
	1.03	Access road and drainage	m	150	$567.00	$85,050.00
	1.04	Landscaping and topsoil	LS	1	$30,000.00	$30,000.00
	1.05	Yard waste drop off area	LS	1	$0.00	$0.00
		Subtotal				**$245,050.00**
2		**Buildings and Foundations**				
	2.01	Steel frame building (24.5 x 80 m)	LS	1	$460,000.00	$460,000.00
	2.02	Concrete push walls and floor	LS	1	$701,000.00	$701,000.00
	2.03	Office	LS	1	$30,000.00	$30,000.00
	2.04	Scale and scalehouse	LS	1	$0.00	$0.00
		Subtotal				**$1,191,000.00**
3		**Surfacing, barriers, signs and fencing**				
	3.01	Sub-base (300 mm thick)	m^2	8000	$15.75	$126,000.00
	3.02	Road base (150 mm thick)	m^2	8000	$10.50	$84,000.00
	3.03	Medium coarse asphalt (100 mm thick)	m^2	7000	$27.00	$189,000.00
	3.04	Traffic barriers and curbing	LS	1	$20,000.00	$20,000.00
	3.05	Signs	LS	1	$3,000.00	$3,000.00
	3.06	Fencing and gates	LS	1	$0.00	$0.00
		Subtotal				**$422,000.00**
4		**Equipment and Vehicles**				
	4.01	GORE cover system	LS	1	$1,100,000.00	$1,100,000.00
	4.02	Winder	LS	1	$150,000.00	$150,000.00
		Subtotal				**$1,250,000.00**
5		**Utilities**				
	5.01	Water supply	LS	1	$50,000.00	$50,000.00
	5.02	Sanitary	LS	1	$28,000.00	$28,000.00
	5.03	Fire suppression (fire protection system, hydrants)	LS	1	$75,000.00	$75,000.00
	5.04	Electrical and lighting	LS	1	$75,000.00	$75,000.00
		Subtotal				**$228,000.00**
6		**Odour, Leachate and Storm water Management**				
	6.01	Storm drain system and stormwater diching / swales	LS	1	$25,000.00	$25,000.00
	6.02	Leachate tanks and recirculation	LS	1	$25,000.00	$25,000.00
	6.03	Biofilter	LS	1	$75,000.00	$75,000.00
		Subtotal				**$125,000.00**

Table A-10 - Composting Facility Capital Cost - Comox Valley (Regional Tonnes)

Item #		Item	Unit	Quantity	Unit Price	Total Price
7		**Miscellaneous**				
	7.01	Operator training	LS	1	$75,000.00	$75,000.00
	7.02	Geotechnical investigation	LS	1	$25,000.00	$25,000.00
	7.03	Permitting consulting	LS	1	$25,000.00	$25,000.00
		Subtotal				**$125,000.00**
		Construction Subtotal				**$3,586,050.00**
8		**Engineering, Construction Oversight and Contingency**				
	8.01	Engineering and construction oversight (15%)				$537,907.50
	8.02	Contingency (30%)				$1,075,815.00
		Subtotal				**$1,613,722.50**
		Total Project				**$5,199,772.50**

Tonnes managed	**13,820**
Capex per tonne	**$259**
Capex per tonne (inc. engineering and contingency)	**$376**

TABLE A-11 - COMPOST FACILITY OPERATING COST - COMOX VALLEY (REGIONAL TONNES)

Item #		Item	Unit	Quantity	Unit Price	Total Price
1		**Staffing and Labour**				
	1.01	Waste management attendant	hrs.	2080	$30.00	$62,400.00
	1.02	Waste management attendant	LS	2080	$30.00	$62,400.00
	1.03	Loader operator and probe placement ($150/hr. X 11.5 hours/week)	hrs.	598	$150.00	$89,700.00
	1.04	Waste management attendant	hrs.	1482	$45.00	$66,690.00
	1.05	Manager	LS	1	$84,000.00	$84,000.00
		Subtotal				**$365,190.00**
2		**Building and Equipment**				
	2.01	Building, roads and site works maintenance	LS	1	$2,000.00	$2,000.00
	2.02	Mechanical / electrical repairs and maintenance	LS	1	$10,000.00	$10,000.00
	2.03	Safety gear	LS	1	$1,000.00	$1,000.00
	2.04	Tools and supplies	LS	1	$2,000.00	$2,000.00
	2.05	Contribution to cover replacement	LS	1	$53,143.00	$53,143.00
		Subtotal				**$68,143.00**
3		**Utilities and Rentals**				
	3.01	Loader maintenance and insurance	LS	1	$30,000.00	$30,000.00
	3.02	Power	LS	1	$4,146.00	$4,146.00
	3.03	Grinder and screening rentals	LS	1	$100,000.00	$100,000.00
		Subtotal				**$134,146.00**
4		**Administration, Consulting and Testing**				
	4.01	Approvals, reporting, consulting	LS	1	$20,000.00	$20,000.00
	4.02	OMRR testing	LS	1	$10,000.00	$10,000.00
		Subtotal				**$30,000.00**
		Operating Subtotal				**$597,479.00**
5		**Contingency**				
	5.01	Contingency (30%)				$179,243.70
		Subtotal				**$179,243.70**
		Total Project				**$776,722.70**

Tonnes managed	**13,820**
Operating cost per tonne	**$43**
Operating cost per tonne (inc. contingency)	**$56**

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Memorandum

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Subject	**Composting Technology Evaluation**	**Project Name**	Comox Valley Regional District Composting Facility
Attention	Gabriel Bau	**Project No.**	700041CH
From	John Berry		
Date	December 19, 2018		
Copies to	File		

1. Introduction

Jacobs[1] and Morrison Hershfield are assisting the Comox Valley Regional District (CVRD) and its member municipalities with the planning and procurement of a new organic waste transfer station and a regional composting facility that will service municipalities in the southern portion of the Comox Strathcona Waste Management (CSWM) service area.

As part of this project, Jacobs identified several composting methods and technologies that could potentially be used to manage the organic waste collected in the service area. This technical memorandum outlines the results of the technical feasibility of these methods and technologies and identifies the range of options that at this preliminary stage appear more appropriate. Once the requirements related to the processing facility location become available, this range of technologies may vary.

The list of processing methods and technologies considered in this evaluation was limited to composting in order to increase the CSWM service waste diversion rate according to the CSWM Solid Waste Management Plan (SWMP). According to the Ministry of Environment, anaerobic digestion is not considered a reduction, re-use or recycling alternative, and therefore any diversion achieved through this processing method would not count towards the 70% diversion rate target established in the SWMP. Additionally, the grant funding for the CSWM Service Regional Organics Compost project provided by the New Building Canada Fund was based on the use of composting as the processing method.

To evaluate appropriateness and sustainability, Jacobs undertook a two-step evaluation process. The initial screening consisted of a “fatal flaw analysis” that was based on several pass/fail criteria. The second step was a qualitative analysis based on several technical criteria developed by Jacobs.

[1] *On December 15, 2017, all CH2M HILL companies became part of Jacobs and are now wholly owned direct subsidiaries of Jacobs. CH2M HILL Canada Limited remains a separate legal entity and we will continue to operate and conduct business under this entity in Canada; however, we refer to ourselves in deliverables, including this technical memorandum, as Jacobs.*

2. Initial Screening Analysis

A long list of processing methods was established and included within the scope of the initial screening. Based on previous reviews completed in the study area and discussions with CVRD, the processing methods were limited to composting.

A set of initial screening criteria for the processing technologies was established in consultation with personnel from CVRD. These screening criteria were applied on a pass/fail basis by Jacobs based on the background research completed and professional judgment. If a processing method or technology failed to meet any one criteria, it was excluded from further consideration. Exhibit 1 presents the criteria and the results from the initial screening process.

3. Secondary Analysis of Processing Options

To provide a relative comparison of the processing methods, a secondary analysis was conducted using a set of criteria developed by Jacobs and reviewed by CVRD personnel. The secondary evaluation criteria were based on performance requirements that are common to the organic processing industry, and on specific issues of importance to CVRD. The secondary criteria included operational considerations, space requirements, odour control, resource consumption, leachate and surface water quality, worker health and safety, development considerations, and additional processing requirements required to meet product maturity requirements.

The evaluation of processing options was done based on Jacob's professional judgment and experience, and each technology was given a relative ranking of low, low to moderate, moderate, moderate to high, or high.

The evaluation took into consideration necessary supporting infrastructure that would be required along with the processing technologies (e.g. buildings, HVAC systems, curing pads, weigh scales, surface water ditches, ponds and other controls, curing facilities, etc.) so that all technologies would meet a consistent performance specification. This approach is necessary to provide a balanced evaluation of the technologies.

Exhibit 2 summarizes the results from the secondary analysis and the relative scoring of each processing technology.

attachments: Exhibit 1
Exhibit 2

/jb

EXHIBIT 1:
INITIAL SCREENING OF ORGANIC WASTE PROCESSING TECHNOLOGIES

Processing Method/Technology	Demonstrated as being capable of handling commingled food waste/yard waste from residential sources	Successfully operating on a commercial basis with a similar capacity for more than 5 years	Suitable for year-round operation in the local climate	Ability to comply with current Provincial & Federal regulations with commingled food waste/yard waste as the primary feedstock [1]	Able to effectively control nuisance conditions when processing commingled food waste/yard waste in an urban-industrial location[1]	Practical relative to CSWM situation [2]	Pass/Fail Evaluation
Outdoor Passively Aerated Systems							
Passively Aerated Static Pile	No	No	Yes	No	No	No c	**Fail**
Bunker	No	No	Yes	No	No	No b	**Fail**
Passively Aerated Windrow	No	No	Yes	No	No	No b	**Fail**
Turned Windrow	Yes	Yes	Yes	Yes	No	No c	**Fail**
Unaerated Turned Mass Bed	No	No	Yes	Yes	No	Yes	**Fail**
Outdoor (i.e. unenclosed) Forced Aeration Systems							
Positively Aerated Static Pile	Yes	Yes	Yes	Yes	No	Yes	**Fail**
Negatively Aerated Static Pile	Yes	Yes	Yes	Yes	Yes	Yes	**Pass**
Covered Aerated Static Pile (postive or negative aeration)	Yes	Yes	Yes	Yes	Yes	Yes	**Pass**
Aerated Turned Mass Bed	Yes	No	Yes	Yes	No	Yes	**Fail**
Indoor or Fully Enclosed Forced Aeration Systems							
Positively Aerated Static Pile	Yes	Yes	Yes	Yes	Yes	Yes	**Pass**
Negatively Aerated Static Pile	Yes	Yes	Yes	Yes	Yes	Yes	**Pass**
Covered Aerated Static Pile (postive or negative aeration)	Yes	Yes	Yes	Yes	Yes	Yes	**Pass**
Aerated Turned Mass Bed	No	No	Yes	Yes	Yes	Yes	**Fail**
Channel	Yes	Yes	Yes	Yes	Yes	Yes	**Pass**
Agitated Bed	Yes	Yes	Yes	Yes	Yes	Yes	**Pass**
Static Containers/Vessels	Yes	Yes	Yes	Yes	Yes	Yes	**Pass**
Agitated Containers/Vessels	Yes	Yes	Yes	Yes	Yes	Yes	**Pass**
Onsite Agitated Containers/Vessels	No	No	Yes	Yes	Yes	No b	**Fail**
Tunnel	Yes	Yes	Yes	Yes	Yes	Yes	**Pass**
Small Rotating Drum	Yes	Yes	Yes	Yes	Yes	Yes	**Pass**
Large Rotating Drum	Yes	Yes	Yes	Yes	Yes	No a, b	**Fail**

General Notes:

1. Technology is considered In combination with other infrastructure employed in a typical installation.
3. Financial feasibility including cost of acquiring land for processing and post-processing (e.g. curing) activities is not considered in this screening criteria

Rationale for Practicality Assessment:

a. Not compatible with residential SSO material generated/collected in study area.
b. Capacity restriction of technology relative to projected feedstock quantities in the study area.
c. Processing method requires excessive amount of land.

EXHIBIT 2: SECONDARY EVALUATION OF ORGANIC WASTE PROCESSING TECHNOLOGIES

Processing Method/Technology	Operational Considerations								
	Typical pre-processing requirements	Typical post-processing requirements	Reliability of processing equipment and support equipment	Maintenance requirements for processing and support equipment	Ability to handle high/low variations in feedstock quantities	Level of technical & process training required to operate system	Typical processing time from receiving through production of final product(s) [1]	Ease of Documenting PFRP[2] Conditions	Potential for exposure of workers to poor air quality
Outdoor (i.e. unenclosed) Forced Aeration Systems									
Negatively Aerated Static Pile	Shredding/Mixing	Curing & Screening	High	Low	High	Moderate	4 to 6 months	High	Low
Covered Aerated Static Pile (positive or negative aeration)	Shredding/Mixing	Curing & Screening	High	Low	High	Moderate	4 to 6 months	High	Low
Indoor or Fully Enclosed Forced Aeration Systems									
Positively Aerated Static Pile	Shredding/Mixing	Curing & Screening	High	Low	High	Moderate	4 to 6 months	High	Moderate to High
Negatively Aerated Static Pile	Shredding/Mixing	Curing & Screening	High	Low	High	Moderate	4 to 6 months	High	Moderate to High
Covered Aerated Static Pile (positive or negative aeration)	Shredding/Mixing	Curing & Screening	High	Low	High	Moderate	4 to 6 months	High	Moderate to High
Channel	Shredding	Curing & Screening	Moderate to High	Moderate	Moderate to High	Moderate to High	4 to 6 months	Moderate to High	Moderate to High
Agitated Bed	Shredding	Curing & Screening	Moderate to High	Moderate to High	Moderate to High	High	4 to 6 months	Moderate to High	Moderate to High
Static Containers/Vessels	Shredding/Mixing	Curing & Screening	High	Moderate	High	Moderate	4 to 6 months	High	Low
Agitated Containers/Vessels	Shredding	Curing & Screening	Moderate to High	Moderate to High	High	Moderate to High	4 to 6 months	Moderate to High	Low
Tunnel	Shredding/Mixing	Curing & Screening	High	Low to Moderate	High	Moderate to High	4 to 6 months	High	Moderate
Small Rotating Drum	Shredding	Add'l Composting, Curing & Screening	Moderate	Moderate to High	Moderate to High	Moderate	4 to 6 months	Moderate to High	Low

Notes:
1. Range includes winter and summer conditions, and assumes all curing of compost is done outdoors.
2. PFRP = Process to Further Reduce Pathogens, to reduce populations of human and plant pathogens, as well as destroy noxious weed seeds.

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EXHIBIT 2: SECONDARY EVALUATION OF ORGANIC WASTE PROCESSING TECHNOLOGIES

Processing Method/Technology	Odours and Nuisances				Residuals	
	Potential for offsite Odour impacts	Potential for wildlife attraction	Potential for offsite dust impacts	Potential for offsite litter impacts	Leachate and contaminated surface water quantity	Leachate and contaminated surface water strength
Outdoor (i.e. unenclosed) Forced Aeration Systems						
Negatively Aerated Static Pile	Moderate	Low to Moderate	Moderate	Moderate	Moderate to High	Low to Moderate
Covered Aerated Static Pile (positive or negative aeration)	Moderate	Low to Moderate	Moderate	Moderate	Moderate to High	Low to Moderate
Indoor or Fully Enclosed Forced Aeration Systems						
Positively Aerated Static Pile	Low	Low	Low	Low	Low	Moderate
Negatively Aerated Static Pile	Low	Low	Low	Low	Low	High
Covered Aerated Static Pile (positive or negative aeration)	Low	Low	Low	Low	Low	High
Channel	Low	Low	Low	Low	Low	Moderate
Agitated Bed	Low	Low	Low	Low	Low	High
Static Containers/Vessels	Low	Low	Low	Low	Low	High
Agitated Containers/Vessels	Low	Low	Low	Low	Low	High
Tunnel	Low	Low	Low	Low	Low	High
Small Rotating Drum	Low	Low	Low	Low	Low	Moderate to High

Notes:
1. Range includes winter and summer conditions, and assumes all curing of compost is done outdoors.
2. PFRP = Process to Further Reduce Pathogens, to reduce populations of human and plant pathogens, as well as destroy noxious weed seeds.

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EXHIBIT 2: SECONDARY EVALUATION OF ORGANIC WASTE PROCESSING TECHNOLOGIES

Processing Method/Technology	Resource Consumption				Financial	
	Potable water consumption	Power consumption	Fuel consumption	Land requirements (including odour treatment and curing)	Relative construction cost per tonne of annual capacity	Relative O&M costs per tonne of feedstock
Outdoor (i.e. unenclosed) Forced Aeration Systems						
Negatively Aerated Static Pile	Low to Moderate	Low	Low to Moderate	Low to Moderate	Low to Moderate	Low to Moderate
Covered Aerated Static Pile (positive or negative aeration)	Low to Moderate	Low	Low to Moderate	Moderate	Moderate	Low to Moderate
Indoor or Fully Enclosed Forced Aeration Systems						
Positively Aerated Static Pile	Low to Moderate	Moderate	Low to Moderate	Low to Moderate	Moderate to High	Moderate
Negatively Aerated Static Pile	Low to Moderate	Moderate	Low to Moderate	Low to Moderate	Moderate	Moderate
Covered Aerated Static Pile (positive or negative aeration)	Low to Moderate	Moderate	Low to Moderate	Moderate	Moderate to High	Moderate
Channel	Low to Moderate	Moderate to High	Low	Low to Moderate	High	Moderate to High
Agitated Bed	Low to Moderate	Moderate to High	Low	Low	High	Moderate to High
Static Containers/Vessels	Low to Moderate	Moderate	Moderate	Moderate	High	Moderate to High
Agitated Containers/Vessels	Low to Moderate	Moderate to High	Low	Low to Moderate	High	Moderate
Tunnel	Low	Moderate	Low	Low	High	Moderate
Small Rotating Drum	Low	Moderate to High	Low	Moderate	High	High

Notes:
1. Range includes winter and summer conditions, and assumes all curing of compost is done outdoors.
2. PFRP = Process to Further Reduce Pathogens, to reduce populations of human and plant pathogens, as well as destroy noxious weed seeds.

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EXHIBIT 2: SECONDARY EVALUATION OF ORGANIC WASTE PROCESSING TECHNOLOGIES

Processing Method/Technology	Development Considerations			
	Time requirements for construction and commissioning	Modularity/ Expandability to Handle Increases in Feedstock Quantities	Ability to be expanded without affecting operations	Anticipated permitting difficulty
Outdoor (i.e. unenclosed) Forced Aeration Systems				
Negatively Aerated Static Pile	Low to Moderate	High	High	Moderate
Covered Aerated Static Pile (positive or negative aeration)	Low to Moderate	High	High	Moderate
Indoor or Fully Enclosed Forced Aeration Systems				
Positively Aerated Static Pile	Moderate	Moderate to High	Moderate	Low to Moderate
Negatively Aerated Static Pile	Moderate	Moderate to High	Moderate	Low to Moderate
Covered Aerated Static Pile (positive or negative aeration)	Moderate	Moderate to High	Moderate	Low to Moderate
Channel	Moderate	Low to Moderate	Low to Moderate	Low to Moderate
Agitated Bed	High	Low to Moderate	Low to Moderate	Moderate
Static Containers/Vessels	Low to Moderate	High	High	Moderate
Agitated Containers/Vessels	Moderate	High	High	Moderate
Tunnel	High	Low to Moderate	Low to Moderate	Moderate
Small Rotating Drum	Moderate to High	High	Moderate	Moderate

Notes:
1. Range includes winter and summer conditions, and assumes all curing of compost is done outdoors.
2. PFRP = Process to Further Reduce Pathogens, to reduce populations of human and plant pathogens, as well as destroy noxious weed seeds.

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LATEST NEWS Temporary 'delineators' to be installed this week on deadly stretch of highway in Langford

$63M plan for Hartland Landfill includes making gas from food scraps

Bill Cleverley / Times Colonist
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Aerial photo of Hartland Landfill.
Photograph By CAPITAL REGIONAL DISTRICT

Up to $63 million in improvements to the Hartland Landfill will be up for consideration by Capital Regional District directors Wednesday.

CRD staff are recommending spending about $23.7 million to build a facility to clean up and convert landfill gas into usable natural gas.

And, staff say, the region should proceed with an anaerobic digester system at a cost of between $25 million and $40 million to process food scraps into biogas.

The expectation is both projects will be funded through money on hand, grants and borrowing, said Larisa Hutcheson, CRD general manager parks and environmental services. "We're very optimistic that this [gas conversion] project would attract grants both at the provincial and federal level. Alternative fuels is really where the province of B.C. is putting their grant opportunities as well as the feds."

By the time the CRD issues a request for proposals for organics processing, it might be looking for a private-sector partner that could bring money to the table, she said.

Anaerobic digestion is a process in which microorganisms break down biodegradable material in the absence of oxygen. In addition to biogas, it also produces a soil supplement.

The organics transfer station at Hartland Landfill currently accepts kitchen scraps at $120 per tonne.

But it costs the CRD $145.89 per tonne to have kitchen scraps hauled to the mainland for composting — a difference that is expected to cost the CRD about $400,000 this year.

Were the CRD to build a composting facility here, it would cost between $2 million and $8 million, staff say.

But the CRD has had a troubled history with organics composting.

In 2013, the region contracted with Foundation Organics to deal with kitchen scraps on a Central Saanich farm.

The CRD pulled the operating licence in less than a year after neighbours complained about strong odours.

Since then, Greater Victoria's kitchen scraps have been either hauled from Hartland to a recycling plant in Cobble Hill or taken to the Lower Mainland.

Gross operating costs for a composting facility are estimated to range from $60 to $100 per tonne compared to gross operating costs for anaerobic digestion of $100 to $135 per tonne, staff say.

However, the higher cost of anaerobic digestion can be significantly offset by revenue from the sale of biogas, while composting cannot be expected to generate any revenues other than tipping fees.

Waste buried in the landfill produces gas including methane, or biogas that is generated from decomposing organic waste.

Currently, Hartland Landfill gas is collected and used to generate electricity that is sold to B.C. Hydro.

But the volume of gas exceeds the capacity of the power-generation equipment.

So staff have evaluated two options:

• Install a gas processing plant at Hartland to create renewable natural gas which can then be sold to FortisBC. (Estimated capital investment $23.7 million; annual maximum return 12.7 per cent.)

• Expand the existing power generation equipment and sell more electricity to B.C. Hydro. (Estimated capital investment $4.5 million with annual net revenues of $300,000).

CRD staff have prepared detailed business cases for the gas-conversion options and are recommending they be considered by directors behind closed doors "to ensure potential contract negotiations with B.C. Hydro or FortisBC are not compromised."

Hutcheson acknowledged that the capital investments are high but said rates of return are better.

"On the organics processing side, anaerobic digestion really is a way to process organics in a controlled manner," she said, adding that the process "also produces biogas which we can put into the renewable natural gas facility and really amplify the benefits there."

The staff reports say production of renewable natural gas "opens up several opportunities" for the CRD to show climate leadership toward meeting its goal of becoming carbon neutral by 2030.

There is more environmental benefit in cleaning up the landfill gas than simply using it to generate electricity, Hutcheson said.

"Electricity is already green because with the hydro electricity, you're not offsetting fossil fuels. So that's really where the benefit is, you're offsetting the fossil fuels."

The market also favours gas, she said.

"We can actually do better upgrading and selling our gas as gas than converting that gas into power."

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Anaerobic Digestion (AD) vs. Composting

Comox Strathcona Waste Management

	AD	Composting	Comments
Source of organic waste	Food waste only	Food and yard waste	Higher cost to Muni or end taxpayer
Capacity	10,000 TPY of Food waste	Lower requirements	AD = Greater Cost Phase 1: 7,500 TPY food waste
Capital and operational cost	Higher	Lower	Est. Composting: Capital cost /2 AD Operational cost 60 to 80% AD
Land requirements	Lower	Higher	Composting more land
Final product	Biogas + Organic to be stabilized	Compost	Revenues - resource recovery will not offset additional cost
Potential odour nuisance	Same	Same	Must be design and operated properly
Expertise	Higher	Lower	AD = higher technical skill