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Report #EWW 10-65

REPORT TO CORE AREA LIQUID WASTE MANAGEMENT COMMITTEE
MEETING OF WEDNESDAY 08 SEPTEMBER 2010

SUBJECT **BIOSOLIDS EMERGENCY DISPOSAL BACKUP PLAN – CORE AREA WASTEWATER TREATMENT PROGRAM**

ISSUE

The Capital Regional District (CRD) needs to establish an emergency backup disposal plan for biosolids in the event that the proposed primary disposal option to cement kilns is interrupted or if the kilns stop accepting dried biosolids.

BACKGROUND

The Core Area Liquid Waste Management Committee (CALWMC) approved draft Amendment No. 7 to the Core Area Liquid Waste Management Plan (LWMP) on 25 November 2009. The sludge treatment process outlined in this plan included anaerobic digestion, biogas recovery and cleaning, phosphorous recovery, biosolids drying and beneficial reuse of the dried biosolids as a fuel substitute in the cement industry[1], soil amendment and fertilizer products. The CALWMC approved the following motion:

> That all land application of biosolids (including use as a fertilizer, soil amendment or compost) be removed from consideration from the Core Area Liquid Waste Management sewage strategy, and that the preferential strategy for disposal of dried bio-solids focus on sale as a fuel for cement kilns and/or to power one or more "waste-to-energy" facilities, both of which are currently proposed in recent Core Area Liquid Waste Management Committee reports.

At the 13 January 2010, the CALWMC received a report from staff recommending the Hartland landfill as the emergency backup disposal option to be included in the LWMP amendment No. 8. The CALWMC approved the following motion:

> That the report be tabled pending a further report on all potential emergency back-up options, including pros/cons of each (costs, potential income generation, social and environmental impacts) for consideration and debate by this Committee.

The report attached as Appendix A, *Core Area Wastewater Treatment Program Biosolids Emergency Disposal Backup Plan, 21 July 2010,* serves to address the 13 January 2010 motion. The report provides a review of all potential options available to the CRD for the emergency disposal of biosolids.

The emergency backup disposal option must consist of a facility owned and operated by the CRD or a facility owned by a third party and that would accept the biosolids for a fee and have sufficient reserve capacity at all times. Eleven emergency disposal backup options have been examined as outlined in the table under financial implications and all of these options fall into three categories:

1) Thermal destruction facility – fluidized bed, waste-to-energy (WTE) or gasification
2) Land application – composting or direct land application
3) Landfill – Hartland landfill or a dedicated land disposal facility

[1] Disposal at cement kilns has not been confirmed at this time. Negotiations are ongoing.

A preliminary screening of the options was completed using the same criteria outlined in the 2009 biosolids management plan, as follows:

1) Capacity available at all times
2) Can be implemented by 2016
3) Use of a proven technology
4) No capital cost beyond approved project budget

The only options that pass the preliminary screening criteria include disposal at Hartland landfill (option 1a) and interim disposal at Hartland landfill followed by disposal at a future CRD combined WTE facility for biosolids and municipal solid waste (option 11). The two options of shipping biosolids to facilities in Oregon and Washington (options 7 and 10) received a "fail" under "capacity available at all times" because of possible provincial legislation that would prohibit the export of waste material. However, these were carried forward for further evaluation in the triple bottom line (TBL) analysis because details of potential legislation are not available. The option of hauling to a third party composting facility on Vancouver Island (Option 9) also received a "fail" under "capacity available at all times" because there is no guarantee that the current spare capacity will be available in 2016 upon the completion of the Core Area Wastewater Treatment Program. However, this option was carried forward for further evaluation in the TBL because it could be a backup alternative in the future.

The consulting team was unable to identify a third party thermal destruction facility in British Columbia that would accept dried biosolids.

The options that require a dedicated thermal destruction facility received a "fail" under "no capital cost beyond approved project budget" and were not carried forward for further evaluation in the TBL. The capital cost of these options is between $37 and $46 million and they are not included in the approved LWMP. The residual of bottom ash and fly ash from one of these facilities would likely be disposed of at Hartland landfill. This ash represents about 25% (by weight) of the dried biosolids.

Section 6, Table 6.4 in the attached report provides the results of the TBL analysis for the five options that were selected for further evaluation. The two highest ranked disposal options are disposal at the Hartland landfill mixed with municipal solid waste (option 1a) and a third party composting facility on Vancouver Island (option 9)

Section 4 of the report outlines the capital and operating costs for each option as well as the advantage and disadvantages of each.

<u>ALTERNATIVES</u>

1. That the CALWMC recommend to the Board approval of Hartland landfill as the emergency biosolids disposal backup plan for the Core Area Wastewater Treatment Program.

2. That the CALWMC direct CRD staff to enter into negotiations with a third party composting facility on Vancouver Island as the emergency biosolids disposal backup plan for the Core Area Wastewater Treatment Program.

3. That the CALWMC direct CRD staff to enter into negotiations with a third party composting facility in Washington state as the emergency biosolids disposal backup plan for the Core Area Wastewater Treatment Program.

FINANCIAL IMPLICATIONS

The table below provides a list of all eleven options that were considered along with the capital and annual operating costs.

Options		Capital Cost	Annual Operating Cost
1	Disposal at Hartland landfill: a) Biosolids mixed with municipal solid waste (MSW) in active landfill b) Using biosolids as cover material c) Biocell at Hartland landfill	 0 0 $5,194,000	 $583,000 Not a suitable use $423,000
2	Dedicated land disposal and processing facility	$53,876,000	$1,125,000
3	Waste to energy (WTE) for biosolids only	$46,900,000	$1,200,000
4	Fluidized bed combustion (FBC) for biosolids only	$37,520,000	$1,000,000
5	Waste to Energy (WTE) facility with biosolids and MSW combined	$18,300,000 (Portion attributable to biosolids)	$836,000 (Portion attributable to biosolids)
6	Ship to other WTE in BC	0	No facility available at this time
7	Ship to WTE in Marion County, Oregon	0	$2,441,000
8	Gasification a) Existing facility such as Dockside Green b) New facility by third party	0 - If facility constructed by third party	No facility available at this time
9	Ship to a third party composting facility on Vancouver Island	0	$580,000
10	Ship to a third party composting facility outside of Canada	0	$759,000
11	Combination of two options: a) Disposal at Hartland landfill initially b) WTE for biosolids and MSW	a) 0 b) To be confirmed by CRD studies under way	a) $583,000 b) To be confirmed by CRD studies under way

The tipping fees would be payable to the CRD for options 1, 2, 3, 4, 5 and 11 and payable to a private operator for the other options. Any costs for emergency biosolids disposal above “normal” operating costs would be cost shared by the core area and westshore municipalities.

The overall program budget of $783 million would need to be increased by approximately $40 million to have a dedicated thermal destruction facility included in the LWMP.

CONCLUSION

The two options that ranked the highest in the TBL (1a and 9) have no capital cost to implement and the annualized operating cost for each is approximately $580,000 based on current tipping fees at each facility. These annualized operating costs are lower than the annual operating costs for any of the other options. As well, the operating costs would only be paid if the primary disposal method is temporarily unavailable.

The only emergency backup option that fully meets the preliminary screening criteria at this time is disposal to the Hartland landfill.

The development of additional disposal options besides just fuel for cement kilns would offer the CRD more flexibility such that if the market from cement kilns is no longer available temporarily or on a permanent basis, the biosolids could be directed to one of the other disposal options.

RECOMMENDATION

That the Core Area Liquid Waste Management Committee recommend to the Board approval of Hartland landfill as the emergency biosolids backup plan for the Core Area Wastewater Treatment Program.

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J.A. (Jack) Hull, MBA, PEng
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Concurrence

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COMMENTS

TB:ta
Attachment: 1

Capital Regional District

Core Area Wastewater Treatment Program
Biosolids Emergency Disposal Backup Plan

July 21, 2010

Prepared by:

Stantec Consulting Ltd.

Brown and Caldwell

This report was prepared by Stantec Consulting Ltd. / Brown and Caldwell for the Capital Regional District. The material in it reflects our best judgment in light of the information available to us at the time of preparation. Any use which a third party makes of this report, or any release of or decisions made based on it, are the responsibilities of such third parties. Stantec Consulting Ltd./ Brown and Caldwell accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

Table of Contents

Executive Summary

The wastewater treatment plant will produce sludge from the primary clarifiers and from secondary treatment. These will be mixed and pumped to the anaerobic digesters. It should be noted that the material removed from the 6 mm screens and the grit facilities includes various inorganic materials which would affect the quality of the biosolids and these materials must be disposed at the landfill site.

The processing of biosolids as included in the Liquid Waste Management Plan amendment # 8 approved by the CRD includes the following four components:

- Anaerobic sludge digesters operating at 55^0C to produce Class A biosolids and biogas; the digesters can also accept source separated organics (SSO) from municipal solid waste as well as fats, oil and grease in order to increase the production of biogas. Depending on the rate of population growth, the total quantity of sludge that will be produced in the year 2030 at the wastewater treatment facility at McLoughlin Point averages between 22 and 29 tonnes per day (dry weight). This sludge is to be pumped to digesters located at the Hartland landfill;

- The biogas generated in the digesters is to be cleaned up, scrubbed of hydrogen sulfide gas and sold to a gas utility company. The digesters will consume approximately 50% (between 11.6 and 13 tonnes per day dry weight) of biosolids and producing biogas in the process;

- The net production of biosolids, estimated to be in the range of 14.4 to 16 tonnes per day will be dewatered using centrifuges to increase the solids content from 4% to 25%; and

- Following dewatering, the biosolids will be thermally dried to increase the solids content to 95% prior to shipping to cement kilns on the Lower Mainland for use as a fuel in the cement production operations.

The anaerobic digesters are operated at a temperature of 55^0C in order to destroy pathogens. The end product of anaerobic digestion at this temperature is a Class A biosolids. The other benefits of high temperature anaerobic digestion are:

- Increased gas production – Approximately 50% of the solids are destroyed and converted to gas. This reduces the ultimate volume of biosolids to be disposed / reused; and,

- Microconstituents – Recent research have indicated that 80% removal of many microconstituents such as pharmaceutical and personal care products that end up in the sludge can be achieved with anaerobic digestion with a retention time of 15 days.

- High temperature digestion produces a Class A biosolids that meets the requirements of the BC Organic Matter Recycling Regulation (OMRR) and which provides flexibility for disposal and end product uses.

On December 9, 2009 the CRD Board of Director adopted a resolution that all land application of biosolids including use as a fertilizer, soil amendment or compost be removed from the Core Area Liquid Waste Management Program, and that the preferential strategy for disposal of dried biosolids focus on sale as a fuel for cement kilns and/or power at one or more waste-to-energy facilities. On January 13, 2010 the Core Area LWMP Committee adopted a resolution that a report on biosolids emergency backup plan be tabled pending a further report on other potential emergency backup options, including pros/cons of each.

Need for and Emergency Disposal Backup Plan

The ultimate re-use of the biosolids is dependent upon the ability to market the dried biosolids to the cement industry. Since the cement operations could shut down or decide for some reason to no longer accept the wastewater biosolids product, there is a need for a backup plan. Emergency backup is needed to provide reliable disposal at all times and under all circumstances for all the dried biosolids generated by the wastewater treatment plant. Emergency backup must be operational on an as-needed basis at all times and meet the principal criterion of reliability.

The objectives of emergency backup include:

- Control – Reliable disposal at all times and under all circumstances under the complete control of the CRD. This can take two forms: (1) the facility is owned by the CRD, or (2) the CRD has a long term contract with another agency or a privately-owned facility;
- Availability by plant construction completion or 2016;
- Reserve capacity – Sufficient capacity must be held in reserve to receive all the biosolids produced by the CRD;
- Continued availability – The backup alternative must remain available at all time after the completion of the wastewater treatment plant;
- Process reliability – Processing reliability is vital to a successful program, and
- Legal obligations – Under the Waste Management Act, the solids produced by a wastewater treatment facility continue to be considered a waste until they are dealt with in accordance with various regulations such as the Organic Matter Recycling Regulation or are disposed in accordance with an approved Liquid Waste Management Plan.

Options for Biosolids Emergency Disposal

Several options have been examined and are summarized in Table E.1. All of these options fall into the following three categories:

- Thermal destruction – This can be achieved in a fluidized bed incinerator, a waste to energy facility or a gasification plant (Options 3, 4, 5, 6, 7, 8 and 11);
- Land application – Further processing using composting followed by land application of the composted product (Option 9) or direct land application of biosolids (Option 10); and,
- Landfill – Hartland landfill or a dedicated land disposal facility owned by the CRD (Options 1, 2 and 11).

It should be noted that disposal methods that include thermal destruction will not entirely eliminate the need for landfill disposal since the incineration process will produce ash. It is estimated that 20% (by weight) of the solids that are fed into a waste-to-energy plant will be left as bottom ash and an additional 4% as fly ash and air pollution control residue.

In evaluating the reliability of backup options, those that are under the complete control of CRD (i.e. owned by the CRD) will rate higher that facilities owned by a third party since companies can go out of business or regulations prohibiting the export of waste could be implemented. The reliability of land application options depends on a market for the continued acceptance of the product. Finally the size and scope of commercial operations impacts the reliability for emergency disposal since larger facilities are more likely to have spare capacity available with a very short notice.

Table E.1 – Summary of Option for Biosolids Emergency Disposal

Options		Remarks
1	Disposal at Hartland landfill: a) Biosolids mixed with municipal solid waste (MSW) in active landfill b) Using biosolids as cover material c) Biocell at Hartland landfill	Disposal of biosolids that have been dewatered to 25% solids could also be disposed of temporarily in the event of a thermal dryer breakdown
2	Dedicated land disposal of liquid biosolids	Applicable to dewatered or dried biosolids; requires 80 ha of suitable land and significant additional capital investment
3	Waste to energy (WTE) facility for biosolids only	Dried biosolids with a 95% solids content - limited power generation -
4	Fluidized bed combustion (FBC) for biosolids only	Dried biosolids with a 50% or 95% solids content to minimize supplemental fuel

Options		Remarks
5	Waste to Energy (WTE) facility with biosolids and MSW combined	A WTE for MSW is in the earlier planning stage by the CRD – earliest completion date of 2017
6	Ship to other WTE facilities in BC	Dried biosolids with a 95% solids content to minimize hauling cost and truck traffic
7	Ship to other WTE facilities outside of Canada	Dried biosolids with a 95% solids content to minimize hauling cost and truck traffic
8	Gasification a) Existing facility such as Dockside Green b) New third party facility	Dried biosolids with a 95% solids content to minimize supplemental fuel, hauling cost and truck traffic
9	Ship to a third party composting facility in BC	Dried biosolids with a 95% solids content to minimize hauling cost and truck traffic
10	Ship to a third party land application facility outside of Canada	Dried biosolids with a 95% solids content to minimize hauling cost and truck traffic
11	Combination of two options: a) Disposal at Hartland landfill initially b) WTE for biosolids and MSW after 2017	Applicable in case of delays in approval of an amendment to the solid waste management plan (SWMP)

The estimated capital and operating and maintenance cost for all of the options is summarized in Table E.2.

Table E.2 – Summary of Capital and O&M Cost for Biosolids Disposal Backup Options

Options		Capital Cost	Annual O&M Cost
1	Disposal at Hartland landfill: a) Biosolids mixed with municipal solid waste (MSW) in active landfill b) Using biosolids as cover material c) Biocell at Hartland landfill	 0 None $5,194,000	 $583,000 Not a suitable use $423,000
2	Dedicated land disposal and processing facility	$53,876,000	$1,125,000
3	Waste to energy (WTE) for biosolids only	$46,900,000	$1,200,000
4	Fluidized bed combustion (FBC) for biosolids only	$37,520,000	$1,000,000
5	Waste to Energy (WTE) facility with biosolids and MSW combined	$18,300,000 (Portion attributable to biosolids)	$836,000 (Portion attributable to biosolids)

	Options	Capital Cost	Annual O&M Cost
6	Ship to other WTE in BC	0	No facility available at this time
7	Ship to WTE in Marion County, Oregon	0	$2,441,000
8	Gasification a) Existing facility such as Dockside Green b) New facility by third party	0 - If facility constructed by third party	No facility available with capacity and permit available at this time
9	Ship to a third party composting facility on Vancouver Island	0	$580,000 or more depending on location of facility
10	Ship to a third party land application site on Vancouver Island	0	$759,000
11	Combination of two options: a) Disposal at Hartland landfill initially b) WTE for biosolids and MSW after 2017	a) 0 b) To be determined by CRD studies under way	a) $583,000 b) To be determined by CRD studies under way

To put the above cost into perspective, it should be noted that the annual cost of hauling dried biosolids to cement kilns located on the lower mainland is estimated at: $565,000 per year. Unless a facility is constructed to respond to an emergency such as the facilities described Options 2 to 5, it would not be possible to respond to that emergency with the possible exception of a biocells at Harland landfill.

Review of Options

a) New Thermal Destruction Facility for Biosolids Only

The total project budget for the approved wastewater treatment program for the Core Area is $782 million. This amount does not include the cost of constructing a dedicated combustion facility, a waste to energy or a gasification plant for biosolids only. The cost of such a facility is in the range of $37 to $46 million. It would be beyond the scope of the approved project to spend such a high sum to construct a backup facility. For this reason, options which include the construction of stand-alone facilities for the thermal destruction of biosolids have been eliminated. This includes Options 3 and 4.

b) Third-Party Thermal Destruction Facility

At this time, no third party waste to energy or gasification plants located in BC that would accept biosolids have been identified. The supplier of gasification plants in Victoria

(Dockside Green), Kamloops and New Westminster has indicated that these existing facilities are not designed or permitted to accept biosolids. The large WTE facilities in Burnaby (Metro Vancouver) and Williams Lake (Epcor) have indicated they either do not have the capacity or are not permitted to accept biosolids. No response has been received from the operator of the co-generation facilities located at mills on Vancouver Island in Crofton and Port Alberni. It is our understanding that the Crofton mills is temporarily closed. The cogeneration plant located at Elk Falls in Campbell River is a gas fired facility that does not accept solid fuels such as wood waste or dried biosolids.

New waste to energy or gasification plants are in the planning stage and it is possible that a facility with sufficient capacity and capability to accept biosolids will be constructed by 2016. However, at this time, the option of using a third party waste to energy or gasification facility located in BC does not meet the requirement for the emergency disposal of biosolids since no existing facility will accept the biosolids.

The Marion County waste to energy facility located 50 km south of Portland, Oregon is a large facility that would accept the biosolids. However, the tipping fee is high at $260 per tonne and the hauling cost is significant. It is our understanding the province of BC is considering legislation banning or restricting the export of solid waste. Also, there is a risk that changes in US regulations could affect this option. For these reasons, this option is not recommended.

c) New Dedicated Land Disposal Facility

Options which include capital cost for the construction of new disposal facility such as a biocells (Option 1c) or a dedicated land disposal facility (Option 2) have been eliminated because they are beyond the scope of the wastewater treatment program because of the high capital cost. Also land disposal does not meet the policy objectives of the CRD. The dedicated landfill option has a high capital cost similar to thermal destruction. Biocells are still considered an emerging technology.

d) Third Party Composting or Land Application Facilities

There are two medium sized composting facilities on Vancouver Island located at Cobble Hill and Nanaimo that currently have the capacity to accept the biosolids. However, there is no guarantee that the capacity will be available in 2016 or beyond. It is difficult for facilities of this size to set aside a portion of their capacity in case the CRD needs it at an undetermined future date and period of time. The tipping fee for these two facilities is in the range of $80 to $85 per tonne and the hauling costs are moderate especially if large 30 tonne capacity truck trailers are used in order to minimize the number of truck loads. The annual cost for this option is estimated at approximately $580,000 or more depending the location of the facility. Because of the uncertainties regarding the availability of spare capacity, this option is not recommended at this time. Also composting does not meet the current objective of the CRD of avoiding land application since the end product of any composting facility will be applied to land.

There are at least two land application firms in Central Washington State that offers a highly competitive rate of $40 per tonne for land application including hauling from Seattle. However, land application does not meet the objectives of the CRD and shipping biosolids over such a long distance would consume a lot of diesel fuel. Also this option could be affected by the potential provincial legislation banning or restricting the export of solid waste. This option is not recommended.

e) CRD Owned Facility

The waste to energy facility currently under consideration by the CRD would meet all the criteria for an emergency backup plan and would be under the total control of the CRD. However, this project is still at the conceptual level and, if approved by the CRD and other parties involved, the earliest start date is 2017. Should this project go ahead, it could become the primary resource recovery option for the dried biosolids.

Disposal of biosolids at Hartland landfill does not meet the objective of the CRD. However, it could be considered as an interim measure until a regional waste to energy facility is constructed. Landfilling of biosolids along with municipal solid waste is common practice throughout Canada including Winnipeg, Calgary and Regina. Application of biosolids to a well designed landfill with a leachate collection system has minimal risk of groundwater contamination. Option 11 consists of emergency disposal of biosolids at Hartland landfill until a regional facility is operational. With this option, the disposal of biosolids at the landfill may not occur since disposal at cement kilns would remain as the primary disposal method until such time as a regional WTE facility becomes operational.

The BC Ministry of the Environment has requested that the CRD incorporate beneficial reuse options into the biosolids management plan. Using dried biosolids as a fuel at cement kilns is a beneficial use. Other options examined earlier for a portion of the biosolids include incorporating biosolids into a soil amendment product such as biosolids growing medium and using biosolids for mine reclamation. The Province has produced good regulations to ensure that contamination of ground water and land resources does not occur. The policy of prohibiting biosolids from being applied to land has resulted in eliminating good commonly used options which could provide alternative biosolids management and disposal systems. Because of the high level of treatment provided in the thermophilic anaerobic digesters coupled with regulations that are designed to protect the environment and public health, there is no technical basis for a complete ban on land application of biosolids.

Analysis

A preliminary screening of options was carried out to eliminate options that cannot provide the required capacity, cannot be implemented by 2016, and are not using proven technology. This process eliminated Options 1b), 1c), 2, 5 and 8a) from further consideration. Also options that would require a significant capital expenditure that is entirely attributable to the Core Area wastewater treatment program are also eliminated. The overall project budget of $782 million for the wastewater treatment program has already been approved by the CRD and new significant capital expenditures would raise the project cost by $38 to $47 million for Options 3 and 4.

Table E.3 – Preliminary Screening of Biosolids Emergency Disposal Backup

Emergency Back-up Candidate Option		Capacity Available at All Times	Can be implemented by 2016	Use of proven technology	Capital cost not included in WWTP project
1a)	Disposal at Hartland Landfill	Pass	Pass	Pass	Pass
1b)	Use as cover material at Hartland landfill	**Fail (1)**	Pass	**Fail (1)**	Pass
1c)	Biocell at Hartland Landfill	Pass	Pass	**Fail**	**Fail**
2	Dedicated land disposal and processing facility	Pass	**Fail**	Pass	**Fail**
3	Waste to energy (WTE) for biosolids only	Pass	Pass	Pass	**Fail**
4	Fluidized bed combustion (FBC) for biosolids only	Pass	Pass	Pass	**Fail**
5	Waste to Energy (WTE) facility with biosolids and MSW combined	Pass	**Fail**	Pass	Pass
6	Ship to other WTE in BC	**Fail - None identified**	**Fail - None identified**	Pass	Pass
7	Ship to other WTE outside of Canada	**Fail (3)**	Pass	Pass	Pass
8a	Gasification – Existing facility such as Dockside Green	**Fail**	**Fail**	**Fail**	Pass
8b)	Gasification – new facility by third party	**Fail - None identified**	**Fail - None identified**	Pass	**Fail**
9	Ship to a third party composting facility on Vancouver Island	**Fail (2)**	Pass	Pass	Pass
10	Ship to a third party land application facility in the US	**Fail (3)**	Pass	Pass	Pass
11	Combination of two options: Disposal at Hartland landfill initially followed by WTE for biosolids and MSW	Pass	Pass	Pass	Pass – if WTE developed as a stand- alone project

(1) Based on pilot studies carried out by the CRD, operational difficulties have been identified. Also the use of biosolids as cover could not be done on a continuous basis
(2) Spare capacity may not be available in 2016 and beyond
(3) Pending provincial legislation may prohibit the export of waste material

Based on the above preliminary screening, the only options that would pass all criteria include disposal at Hartland landfill and interim disposal at Hartland landfill followed by disposal at a combined WTE facility for biosolids and MSW. The two options of shipping waste to facilities in the US received a "failed" under available capacity at all times because pending provincial legislation may prohibit the export of waste material. However because details of the proposed legislation is not available, these options were carried forward for further evaluation in the triple bottom line analysis. The option of hauling to a third party composting facility also received a "fail" under available capacity at all times because there is no guarantee that current spare capacity will be available in the future. However this option was carried forward because of its potential to be a backup alternative in the future.

These five options were evaluated using a modified Triple Bottom Line (TBL) as an analysis tool. Due to the preliminary nature of this investigation, a full analysis was not conducted. Instead the economic, social, and environmental impacts were ranked 1-5 (worst to best) based on predicted impact. The summary of the TBL evaluation from Section 6 is presented in **Table E.4** below.

Table E.4 – Ranking of Short List of Options

Options		Economic	Environmental	Social	Total
1	Disposal at Hartland landfill: a) Biosolids mixed with municipal solid waste (MSW) in active landfill	5	12	10	27
2	Ship to WTE in Marion County, Oregon	1	8	7	16
3	Ship to a third party composting facility on Vancouver Island	4	16	7	27
4	Ship to land application in Central Washington	3	12	6	21
5	Combination of two options: a) Disposal at Hartland landfill initially b) WTE for biosolids and MSW	2	12	7	21

Based on the preliminary TBL assessment, the two alternatives with the highest score are disposal at Hartland landfill and ship to a third party composting on Vancouver Island. However as discussed elsewhere in this report, there is no guarantee that third party composting facilities on Vancouver Island will have the reserve capacity in 2016 and beyond to accept the dried biosolids on an emergency basis. Also both of these options would require amending the CRD policy of no land application of biosolids.

The options of shipping biosolids to a land application site in Central Washington and initial disposal at Hartland landfill followed by disposal at a future regional WTE facility are tied for second place. The option of shipping biosolids to the US potentially has the negative public perception of exporting waste to another country and the risk that future regulations will ban this activity. The option of eventual disposal at a regional WTE facility depends on approval of a very large capital expenditure which may not occur. The option of shipping to a WTE facility in Oregon has the lowest rating.

Recommendations:

The emergency backup disposal alternative should consist of a facility owned and operated by the CRD or a facility owned by a third party and that would accept the biosolids for a fee and set aside the reserve capacity for use by the CRD at any time.

The two potential facilities owned by the CRD include Hartland landfill and a waste to energy facility for the disposal of municipal solid waste that is currently in the early planning stage. Third party facilities include composting, waste to energy or gasification plants that are owned by other agencies or the private sector. The following emergency disposal backup plan is recommended:

1. Continue to investigate using third party waste to energy and gasification facilities on Vancouver Island or on the lower mainland for the emergency disposal of biosolids. Dried biosolids will not be produced until 2016 and it is possible that by that time, existing facilities will be expanded or new facilities constructed.

2. Should the CRD proceed with the construction of a waste to energy facility for municipal solid waste, this could become the primary disposal method for biosolids.

3. Until a waste to energy facility becomes available, Hartland landfill should be designated as the preferred emergency disposal method.

4. Reconsider the CRD policy objective of avoiding land application of biosolids, using biosolids for the production of soil amendments such as compost and biosolids growing medium and application of dried biosolids for mine reclamation. Land application has been proven as an acceptable disposal option at many locations in North America and British Columbia and it is also considered a viable option under current Provincial Regulations.

Section 1 Introduction

In November 2009, Stantec/Brown and Caldwell Consultants completed a biosolids management plan (BMP) to handle bio-solids generated from secondary wastewater treatment facilities to be constructed and operational by 2016. The main recommendations from this plan included:

- All biosolids will be stabilized by anaerobic digestion followed by dewatering and thermal drying to produce a Class A dried product;
- From 50% to 90% of biosolids product should be initially directed to cement kiln fuel, preserving options for diverting dried product to other beneficial uses in the future;
- In addition to cement kiln uses, biosolids should be further used to develop a diverse program including topsoil product blending, dried fertilizer product, and mine reclamation;
- The portion of biosolids that is not sold to cement kilns would be mixed with sand to produce a soil amendment or composted to produce a fertilizer product both of which could be sold to the general public;
- Implement and evaluate a demonstration, pilot-scale biocell program at the Hartland landfill considering GHG reduction and energy recovery; a biocell at the landfill would combine anaerobic digestion and composting;
- There is a significant benefit to co-digesting food waste with biosolids. The CRD should proceed to investigate the best strategy for handling food waste strictly from a municipal solid waste (MSW) perspective. This further study would compare cost and benefits of food waste digestion together with or separate from biosolids;
- The next step in evaluating the potential for further integration of biosolids with MSW would be the development of a MSW Management Plan. Integration of MSW with biosolids handling in the end may include combining handling of the two waste streams; and.
- Emergency disposal of dried biosolids should be accommodated at Hartland landfill.

The biosolids management plant has since been revised and includes the following four main components:

- Anaerobic sludge digesters operating at 55^{0}C (thermophilic) to produce Class A biosolids and biogas; the digesters could also accept source separated organics, fats, oil and grease in order to increase the production of biogas. Depending on the rate of population growth, the total quantity of raw sludge that will be produced in the year 2030 at the wastewater treatment facility at McLoughlin Point averages between 22 and 29 tonnes per day (dry weight). This sludge would be pumped to digesters located at Hartland landfill;
- The biogas generated in the digesters is to be cleaned up, scrubbed of hydrogen sulfide gas and sold to a gas utility company. The digesters will consume between 11.6 and 13 tonnes per day of biosolids and produce biogas in the process;
- The net production of biosolids, estimated to be in the range of 14.4 to 16 tonnes per day will be dewatered using centrifuges to increase the solids content from 4% to 25%; and,
- Following dewatering, the biosolids will be thermally dried to increase the solids content to 95% prior to shipping to cement kiln on the Lower Mainland for use as a fuel in the cement production operations.

The ultimate re-use of the biosolids as proposed above is dependent upon the ability to market the dried solids to the cement industry. Since the cement operations could shut down or decide for some reason to no longer accept the wastewater bio-solids product, the BMP plan emphasized the need for a backup plan.

Emergency backup was recommended to provide reliable disposal at all times and under all circumstances for all the dried biosolids generated by the wastewater treatment plant. Emergency backup must be operational on an as-needed basis at all times and meet the principal criterion of reliability.

On December 9, 2009, the CRD adopted a resolution that all land application of biosolids including use as a fertilizer, soil amendment or compost be removed from the Core Area Liquid Waste Management Plan and that the preferential strategy for disposal of dried biosolids focus on sale as a fuel for cement kilns and/or power one or more waste-to-energy facilities. On January 13, 2010, the Core Area Liquid Waste Management Committee (CALWMC) adopted a resolution that a report on biosolids emergency backup plan be tabled pending a further report on other potential emergency backup options, including pros/cons of each.

It was further indicated that eliminating land application of biosolids as a primary option would also preclude landfilling at Hartland as a backup option. The elimination of land-based utilization reduces redundancy and emphasizes the need for emergency backup in the event of disruption of the cement kiln market. It should be noted that disposal to a landfill is quite different from the other land application techniques because landfills are designed to contain all of the materials within its boundaries by capturing any leachate and returning it to the wastewater treatment facility. The Hartland landfill is the primary disposal option for the biosolids from the Saanich Peninsula and Sooke WWTPs. The CRD currently landfills approximately 620 tonnes per year (dry weight of non digested dewatered sludge from the Saanich Peninsula WWTP and approximately 84 tonnes per year of dewatered sludge from the Sooke WWTP.

It should be noted that disposal methods that include thermal destruction such as a waste-to-energy facility will not entirely eliminate the need for landfill disposal since the incineration process will produce ashes. It is estimated that 20% (by weight) of the solids feed into a waste-to-energy plant will be left as bottom ash and an additional 4% as fly ash and air pollution control residue. The bottom ash could be marketed for another use and disposal at a landfill site is required if this market is not available. Potential use of bottom ash include embankment fill material, road base material and aggregate in asphalt or concrete. The fly ash and residual from air pollution control equipment will generally require disposal in a special landfill. Based on directing 16 tonnes per day of digested biosolids to a waste-to-energy plant, the total ash production is estimated at 3.8 tonnes per day. The fly ash residuals which will likely require disposal at a special landfill would be at least 0.6 tonnes per day. The remainder which consist of the bottom ash, can be reused or must be disposed of at a landfill.

In response to the Liquid Waste Management Plan (LWMP) Amendment # 7, the Minister of the Environment, in a letter dated February 9, 2010, wrote: *"I strongly encourage you to reconsider the opportunities to beneficially use biosolids as a fertilizer and soil amendment product as options for use. You should also develop an emergency contingency plan to handle biosolids that are surplus to the uses identified".*

This report is prepared in response to the Minister's letter on developing an emergency contingency plan. Regarding land application, there are stringent provincial and federal regulations on metal contents and organic component which are similar to commercially available fertilizer and soil amendment products and these are designed to protect the soil matrix and the groundwater from contamination by these products.

This report briefly describes all the backup options for biosolids ultimate disposal and /or reuse, preliminary cost estimates and an overview of the environmental, social, and financial impacts for the options that were retained for a triple bottom line analysis.

Section 2 Objectives of Emergency Disposal / Utilization

2.1 Objectives of Backup Alternatives

The BMP introduced the concepts of primary alternatives and backup alternatives. The primary alternative, in this case using dried biosolids as fuel in cement kilns in the lower mainland to replace coal, is driven by the CRD's objective for beneficial re-use or resource recovery including the recovery of biogas and phosphorus from the digestion process. The primary alternative is intended to receive most of the biosolids generated but does not have to meet the strict reliability constraints. Should the primary alternative fail for any reason, the biosolids must be readily and quickly transferable to the backup alternative on a temporary basis.

The objectives of emergency backup include:

- Control – Reliable disposal at all times and under all circumstances under the complete control of the CRD. This can take two forms:
    - The facility is owned by the CRD, or
    - The CRD has a long term contract with another agency or a privately-owned facility.
- Availability by 2016 – The wastewater treatment facility will become operational in 2016 and will start producing solids immediately. The backup alternative must be in place by that date in case the primary alternative of shipping dried biosolids to cement kiln is not available at the time the plants are completed.
- Reserve capacity – Sufficient capacity must be held in reserve at all times to receive all the biosolids produced by the CRD.
- Continued availability – The backup alternative must remain available at all time after the completion of the wastewater treatment plants.
- Process reliability – Processing reliability is vital to a successful program. Process reliability includes the selection of a proven technology that will treat and/or process the product if the backup alternative includes equipment for further processing (e.g. composting) or combustion (e.g. waste-to-energy)
- Legal obligations – Under the Waste Management Act, the solids produced by a wastewater treatment facility continue to be considered a waste until they are dealt with in accordance with various regulations such as the Organic Matter Recycling Regulation or are disposed in accordance with an approved Liquid Waste Management Plan.

2.2 Examples of Backup Alternatives

Table 2.1 provides a cross-section of primary and backup alternatives for the disposal or reuse methods in municipal wastewater treatment facilities.

Table 2.1 – Examples of Primary and Backup Methods for the Disposal of Biosolids

	Primary Disposal and/or Reuse Method	Back up Alternative
Metro Vancouver	• Stockpiling of biosolids at some treatment plants; • Land application of dewatered biosolids in the BC Interior	Considering a waste-to-energy facility
Okanagan (Kelowna, Vernon, Penticton)	Composting with wood waste as bulking agent	Landfill
Whistler	Composting with organics	Landfill
Calgary	Land application of liquid biosolids	Considering landfilling in a biocell
Edmonton	Composting	
Regina	Land application	Landfill
Winnipeg	• Approximately one-third of biosolids to landfill • Two thirds applied to land	Landfilling of all biosolids
Toronto	Biosolids hauled to disposal and/or reclamation facility in Michigan	
Seattle	Land application	Landfill
Tacoma	Topsoil manufacturing	Landfill

The designation of biosolids management options as either primary or backup strategies is rather arbitrary. Providing a variety of management options as originally proposed in the biosolids management plan (e.g. fuel for cement kilns, production of soil amendment or compost to produce a fertilizer or use for mine reclamation), although a mix of primary options, also provides the flexibility for one option to backup another as well as producing a variety of beneficial biosolids products.

Section 3 Composition of Biosolids

The wastewater treatment plant will produce sludge from the primary clarifiers and from secondary treatment. These two sludges will be thickened, mixed and pumped to the anaerobic digesters that have an average retention time of 15 days. It should be noted that the material removed from the 6 mm screens and the grit facilities includes various inorganic material which would adversely affect the quality of the biosolids and these materials must be disposed at the landfill site. Screenings contain inert substances such as plastics as well as materials that are difficult to stabilize and that can cause mechanical equipment malfunction. Screenings and grit are very odourous, putrecible and hard to handle, and should not be mixed with sludge.

The anaerobic digesters are operated at a temperature of 55^0C in order to destroy pathogens. The end product of anaerobic digestion at this temperature is a Class A biosolids. The other benefits of high temperature anaerobic digestion are:

- Increased gas production – Approximately 50% of the solids are destroyed and converted to gas. This reduces the ultimate volume of biosolids to be disposed / reused
- Microconstituents – Recent research have indicated that 80% removal of many microconstituents such as pharmaceutical and personal care products can be achieved with anaerobic digestion with a retention time of 15 days.

In order to meet the requirements for Class A biosolids, the concentration of a number of metals must meet the Provincial Organic Matter Recycling Regulation (OMRR). An example of metal concentration in the biosolids from the CRD Saanich Peninsula wastewater facility is provided in **Table 3.1**. The metal contents for the last four years are compared with the OMRR criteria.

Table 3.1 – Saanich Peninsula Wastewater Treatment Plant
Biosolids Analysis (mg/kg of dry solids)

	2005	2006	2007	2008	OMRR – Class A
Arsenic	< 15	< 15	< 15	< 15	75
Cadmium	0.60	< 1.5	< 1.5	< 1.5	20
Chromium	2.4	< 6	< 6	< 6	100 (for compost)
Cobalt	< 6	< 6	< 6	< 6	150
Copper	253	219	210	189	400 (for compost)
Lead	< 150	< 150	16	10	500
Mercury	0.29	0.14	0.16	0.20	5
Molybdenum	< 12	< 12	3.14	3	20
Nickel	< 15	< 15	< 15	< 15	180

	2005	2006	2007	2008	OMRR – Class A
Selenium	< 2	< 6	< 6	< 6	14
Zinc	164	112	102	102	1850

Note: the symbol "Less Than" (<) indicates the metal concentration is below the detection level of the test utilized.

In addition to meeting the above metal concentrations, the requirements for producing Class A biosolids include:

1) Stabilization in thermophilic anaerobic digesters with a minimum temperature of 50^0C and a minimum retention time of 10 days;

2) The mass of volatile solids must be reduced by more than 38%;

3) Maximum fecal coliform level less than 1,000 MNP per gram of dry solids; and,

4) Foreign matter content less than 1% dry weight and no sharp foreign matter.

As indicated above, the proposed digesters will be designed to achieve a temperature of 55^0C, a retention time of 15 days at average flow and 10.7 days at the peak 14-day flow. The mass of volatile solids reduction achieved in the digester is approximately 60%.

Biosolids will be further processed by dewatering followed by thermal drying to achieve 95% solids concentration. The thermal process ensures that the end product will be pathogen free, and the physical properties will be more conducive to proposed end uses as well as reduce transportation and handling costs. Thermal drying technologies and dried product uses are discussed extensively in the Biosolids Management Plan.

It appears that some of the information found in the literature regarding organic chemicals that have been found in biosolids does not take into account the impact of proposed high quality sludge stabilization process (i.e. thermophilic anaerobic digestion with 15 days of retention time), the small number of industries in the Victoria area and the source control program. The proposed solids treatment train for the Core Area wastewater treatment program was developed to produce biogas, fuel substitute, phosphorus recovery and to ensure that high quality biosolids meeting the requirements of regulations in Canada and the US would be produced in order to maximize their reuse potential, provide flexibility, and to minimize additional capital and operational cost of further processing.

Section 4 Disposal / Utilization Options

4.1 General

As indicated in Table 4.1, several options were identified as backup alternatives for the disposal of biosolids. In all cases, it is assumed that biosolids produced at the wastewater treatment facilities will be stabilized in thermophilic anaerobic digesters and will result in the creation of a Class A biosolids and thermally dried.

Table 4.1 – Options for Biosolids Emergency Disposal

Options		Remarks
1	Disposal at Hartland landfill: a) Biosolids mixed with municipal solid waste (MSW) in active landfill b) Using biosolids as cover material c) Biocell at Hartland landfill	Disposal of biosolids that have been dewatered to 25% solids could also be disposed of temporarily in the event of a thermal dryer breakdown
2	Dedicated land disposal of liquid biosolids	Applicable to dewatered or dried biosolids; requires 80 ha of suitable land and significant additional capital investment
3	Waste to energy (WTE) facility for biosolids only	Dried biosolids with a 95% solids content to increase power generation
4	Fluidized bed combustion (FBC) for biosolids only	Dried biosolids with a 95% solids content to minimize supplemental fuel
5	Waste to Energy (WTE) facility with biosolids and MSW combined	A WTE for MSW is in the earlier planning stage by the CRD – earliest completion date of 2017
6	Ship to other WTE in BC	Dried biosolids with a 50% or 95% solids content to minimize hauling cost and truck traffic
7	Ship to other WTE outside of Canada	Dried biosolids with a 95% solids content to minimize hauling cost and truck traffic
8	Gasification a) Existing facility such as Dockside Green b) New facility	Dried biosolids with a 95% solids content to minimize supplemental fuel, hauling cost and truck traffic
9	Ship to a third party composting facility in BC	Dried biosolids with a 95% solids content to minimize hauling cost and truck traffic
10	Ship to a third party land application facility outside of Canada	Dried biosolids with a 95% solids content to minimize hauling cost and truck traffic

Options		Remarks
11	Combination of two options: a) Disposal at Hartland landfill initially b) WTE for biosolids and MSW	Applicable in case of delays in approval of an amendment to the solid waste management plan (SWMP) under Option 5

The Biosolids Management Plan provided a variety of beneficial biosolids products which offered the advantage of providing flexibility such that if the market from the major product of fuel for cement kilns is no longer available temporarily or on a permanent basis, the biosolids could be directed to one of the alternate primary management options. It minimized the chance of having to revert to the alternative backup option of landfill disposal. The Biosolids Management Plan also recognized that directing biosolids to a waste to energy facility integrated with municipal solid waste would be a desirable long term goal.

As a result of the policy of no land application of any biosolids, the primary options have been reduced to only one strategy of producing fuel for cement kilns. The provincial and federal regulations are designed to protect the soil matrix and the groundwater from contamination as well as the protection of public health. The other outstanding public concern appears to be the uncertainty with respect to pharmaceutical and other endocrine disruption compounds. The process train consisting of secondary treatment and thermophilic (55^0C) anaerobic digestion of sludge will remove significant proportions of a large number of the organic compounds of concern.

The initial plan was to produce a variety of biosolids end use products and strategies which are acceptable in most jurisdictions in Canada and the US. The long term plan was to integrate biosolids disposal with the larger municipal solid waste stream in a waste to energy facility.

4.2 Option 1 – Hartland Landfill

4.2.1 Disposal with Municipal Solid Waste

The proposed digestion facility will produce Class A biosolids that meet the requirements of the BC Organic Matter Recycling Regulation and are suitable for land application. Class A biosolids are not a special or hazardous waste. Therefore this product is suitable for disposal with municipal solid waste when dewatered to 25% solids content or as a dried product. The daily volume and weight of biosolids produced for various solids content is shown in Table 4.2.

Table 4.2 - Daily Volumes and Tonnage of Biosolids

	Volume (m^3/day)	Weight (tonne/day)
Biosolids with 25% solids content	54	58
Biosolids with 50% solids content	26	29
Biosolids with 95% solids content	12	15

By comparison, the daily amount of municipal solid waste currently disposed at Hartland landfill of 385 tonnes/day is approximately 25 times more than the dry biosolids.

Operating Cost

The operating costs for disposal of biosolids to Hartland landfill shown in **Table 4.3** have been developed with the assumption that the biosolids facility will be located in the north portion of Hartland Landfill and there would be an internal road connecting the biosolids facility with the active landfill area. For ease of comparison between the various options, all the costs are in 2010 dollars. The advantages and disadvantages of this option are listed in **Table 4.4**.

Table 4.3 – Daily Operating Cost of Disposal of Biosolids at Hartland Landfill

Disposal at Hartland Landfill	
Direct Operating Costs	
Annual Disposal Costs ($100/tonne)	$548,000
Hauling Costs	$36,000
Annual Operating Costs	$583,000

Capital Cost

There are no additional capital costs incurred with this option. It is assumed that an internal road between the biosolids facility and the landfill will be constructed as part of the site development included in the capital cost of the biosolids facility at Hartland landfill.

Table 4.4 – Advantages/Disadvantages of Disposal at Hartland Landfill

Advantages	Disadvantages
This option is totally under the control of the CRD and can be implemented with very short notice	Biosolids will use up capacity at the landfill especially for biosolids that have not been dried and have a low solids content
No regulatory approvals required since biosolids is not a special waste	Inconsistent with organics diversion goals
No capital cost	Increases methane release at landfill
No need to pay a fee to reserve spare capacity	Loss of carbon offset by not using dried biosolids as fuel in cement kiln
Low hauling cost especially if the biosolids facility is located on the Hartland landfill property	No beneficial reuse of biosolids
Minor increase in methane recovery from the landfill when biosolids are mixed with MSW	Inconsistent with CRD policy objective of no land disposal
Owned and operated by CRD (not subject to private market)	
No social impact resulting from truck traffic if	

Advantages	Disadvantages
biosolids facility is located at Hartland landfill	
Low environmental impact since landfill site already controls leachate production	

4.2.2 Using Biosolids as Cover Material

There could be an opportunity to use biosolids mixed with compost or soil as part of a final cover and immediately plant it with grass to prevent erosion. However, final covers happen infrequently approximately every 3 to 5 years depending on the cell location and proximity to the exterior of the landfill. The option of using biosolids as intermediate cover was also examined. Discussions with CRD staff on this option have identified the following potential concerns:

- Odours;
- Dust and/or mud (depending on the weather);
- Public, operators, and staff complaints;
- Inadequate working surface for trucks and equipment (i.e. rutting, getting stuck, etc.);
- Tracking of biosolids all over the roads;
- Potential increase in "hot spots" from landfill gas combined with biosolids;
- Leachate mounding (which could cause slope stability/seismic issues); and,
- Leachate chemistry (biosolids spread over a large area could change the chemistry and possibly sewer discharge exceedences).

As a result of these concerns, this option was eliminated and was not analyzed further.

4.2.3 Biocell at Hartland Landfill

A biocell is an innovative closed loop landfill reactor system that is operated in three stages. In the first stage, the bioreactor mimics an anaerobic digester to capture biogas released from decomposing biosolids mixed with solid wastes. The captured gas can then be converted to power. The anaerobic stage is maintained at a critical moisture level through leachate recirculation. After 5–6 years, the gas generation rate decreases and the biocell is converted to an aerobic composting system. Air is injected into the solid waste using the same infrastructure used for gas collection. The aerobic phase occurs until the waste is sufficiently stabilized, approximately 1–2 years. The cell can then be mined for compost material and other recyclables. Multiple cells will be operated consecutively, so that each cell can be in the composting, mining, or filling phases.

Biocells are designed with the following components: groundwater control system, composite liner, leachate collection system, liquid/leachate injection system, landfill gas collection/air injection system, bio-cap intermediate covers to oxidize methane (CH_4), final cover system, and a monitor sensor system. A schematic of a biocell is illustrated in **Figure 4.1**. The advantages and disadvantages of this options are listed in **Table 4.5**.

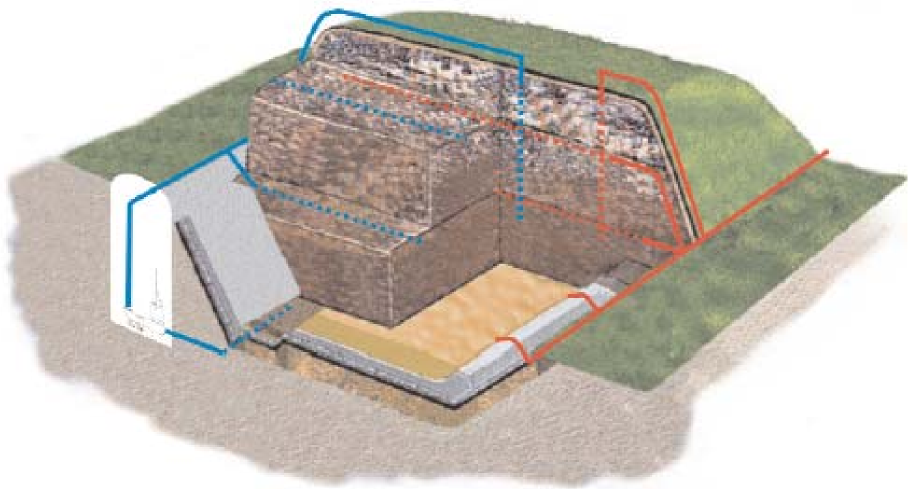

Figure 4.1 – Schematic of Biocell (Stantec, 2006)

Table 4.5 - Advantages and Disadvantages of Biocells receiving only Biosolids

Advantages	Disadvantages
Enhances anaerobic microbial action	New technology with unproven reliability
Smaller footprint	Biosolids structure may inhibit proper circulation of air to aerobic conditions
Production of compost	GHG emissions before completely covered
Increased gas capture	High initial capital costs
Decreased time for waste stabilization to occur	Technological challenge: avoiding sub-surface gas formation
Reusable space and infrastructure	Creating uniform moisture content and accurately measuring moisture
Owned and operated by CRD (not subject to private market)	Organics diversion program at Hartland landfill greatly reduces the potential gas production
No social impact resulting from truck traffic if biosolids facility is located at Hartland landfill	Recovery and reuse of compost post-mining stage is not compatible with CRD policy
	Operational concerns including odour and safety when the compost is extracted

A biocell provides multiple advantages over a traditional landfill system. The system enhances anaerobic microbial action, resulting in increased gas capture and power production. Stabilization of waste occurs in a shorter period of time. Also, compost material and other recyclables that are captured by recycling can be recovered during the “mining” stage. Finally, the space and infrastructure within the reactor is reusable. Some disadvantages include the absence of evidence supporting the reliability of biocells. In addition, use of harvested compost product would not be compatible with current CRD program goals.

Although biocell technology is promising, the claim of zero GHG emissions prior to capping is yet to be substantiated. Methane has 23 times the global warming potential as CO_2. Even a small release of methane can eliminate the GHG benefit from gas capture and use. The BMP recommended that biocells may be a candidate for pilot testing at Hartland landfill to prove complete methane capture during each phase of operation and successful recovery of end products after the aerated phase.

A biocell system could be beneficial as a backup to receive any overflow biosolids when seasonal demand is low or if complications arise in the biosolids dryer. The biocell provides a biosolids disposal option that is independent of fluctuations in the private market. However, for this option to be viable, municipal solid waste and biosolids must be placed in the cell concurrently to maintain proper structure to allow air flow. In addition, the aggressive organics diversion operated by the landfill will greatly decrease the gas producing benefits of the biocell concept during the anaerobic stage. **Tables 4.6** and **4.7** outline the capital cost, the operating cost and the advantages and disadvantages of this option.

Table 4.6 - Capital Costs of Biocell Installation

Biocell Capital Costs	
Direct Construction Costs	One cell
Liner System	$340,500
Internal Piping and Other Structures	$180,150
Instrumentation & CQA	$47,500
Appurtenance Features	$135,800
Design contingency (10% of construction costs)	$66,500
Construction contingency (15% of construction costs)	$99,800
Total Direct Costs	**$870,250**
Indirect Costs	
Engineering (7% of direct costs)	$60,918
Administration (3% of direct costs)	$26,108
Miscellaneous (2% of direct costs)	$17,405
Total Indirect Costs	**$104,430**
Subtotal (Direct + Indirect Costs)	**$974,680**
Interim financing (4% of subtotal)	$15,200
Inflation to midpoint of construction: 2014 (2% per annum)	$49,000
Total Capital Costs (One Cell)	**$1,038,880**
Total Capital Costs (Five Cells)	**$5,194,400**

[1] Biocells will be located at Hartland landfill and constructed over a 10 year interval. Each biocell can accept the entire quantity of biosolids for 2 years prior to capping. Each cell will undergo a 5-6 year anaerobic stage, 1-2 aerobic stage and 1 year mining stage. These are sized to except biosolids: MSW (1:8) as required for proper function

[2] Liner system is geomembrane liner, geocomposite clay liner, sand drainage layer and leachate collection and recovery system

[3] Leachate will flow out of each cell by gravity

[4] Landfill gas will be utilized at the existing LFG Facility

[5] Biocell configuration is based on idealized site, convenient to existing infrastructure

[6] Operation costs not included

Table 4.7 – Operating Costs of Biocell Installation

Biocell Operating Costs[1]	
Direct Operating Costs	One cell
Operating and Maintenance[2]	$75,000
Aeration	$12,366
Annual Operating Costs (One Cell during aeration stage)	**$87,366**
Hauling cost	$36,000
Maximum Annual Operating Costs (Five cells in operation, one in aeration stage)	**$423,000**

[1] Operation of One Biocell during the Aeration Stage, as aeration considered the most expensive stage.

[2] O&M includes air and leachate injection, gas extraction/collection, environmental sampling, and 1 FTE

4.3 Option 2 – Dedicated Land Disposal (DLD)

Application of biosolids at high rates for disposal on dedicated land is practiced at a few wastewater treatment facilities in North America including Calgary. Typically, liquid solids are injected into the soil where they are assimilated. However, application of thermally dried product minimizes odour, potential nuisances and reduces transportation costs. In the latter case, the dried product is mechanically incorporated into the soil. The objective of dedicated land disposal is economical disposal of solids rather than utilization for crop production or soil improvement. Example facilities are located in Colorado Springs, Colorado, and Sacramento, California. At the Sacramento facility, DLD units have been reconstructed with subsurface impermeable liner and under-drain systems in response to concerns about the potential for groundwater contamination. **Table 4.8** outlines the advantages and disadvantages of this option. The capital and operating costs are detailed in **Tables 4.9** and **4.10**.

Table 4.8 - Advantages and Disadvantages of Dedicated Land Disposal (DLD)

Advantages	Disadvantages
Flexibility in managing solids in excess of utilization demand	Potential for groundwater contamination
Minimum land use as application rates are maximized	Approval for special permit due to OMRR, may be difficult to get permit
Not subject to market changes	Limited application season (Summer only)
-	Contamination of a dedicated site
-	Operation of treatment system for leachate
-	High capital cost for an option that may not be utilized
-	Could result in high GHG generation and operational costs for hauling

Table 4.9 – Capital Costs of Dedicated Land Disposal (DLD)

Dedicated Land Disposal Capital Costs	
Direct Capital Costs	
Land Purchase	$825,588
Construction Costs: Liner and Drainage system	$44,432,795
Rolling equipment	$500,000
Construction contingency (5% of construction costs)	$2,287,919
Total Direct Costs	**$48,046,303**
Indirect Costs	
Engineering (7% of direct costs)	$3,363,241
Administration (3% of direct costs)	$1,441,389
Miscellaneous (2% of direct costs)	$960,926
Total Indirect Costs	**$5,765,556**
Subtotal (Direct + Indirect Costs)	**$53,811,859**
Interim financing (4% of subtotal)	$15,200
Inflation to midpoint of construction: 2014 (2% per annum)	$49,000
Total Capital Costs	**$53,876,059**

[1]Land purchase price: $10,000/ha

[2] Liner and Drainage system costs include excavation, stockpile and storage of soil, membrane liner cost and drainage system installation; the system is based on economies of scale ($5/sq.ft for the liner system)

[3]Rolling equipment include tractors and incorporation equipment

[4] Biological treatment system for leachate not included in capital costs

Table 4.10 – Operating Cost of Dedicated Land Disposal (DLD)

Dedicated Land Disposal Operating Costs	
Direct Operating Costs	
Number of operators	3
Total Operating Labor [1]	$180,000
Site Monitoring	$100,000
Maintenance Costs (1% of Capital)[2]	$538,761
Land application cost [3]	$183,600
Hauling Costs [4]	$123,000
Annual Operating Costs	**$1,125,361**

[1] Operating labor is 60,000 per full time employee

[2] Maintenance of liner and drainage system

[3]Land application based on contract cost of $30/DT

[4] Hauling costs based on transfer of 225 loads of biosolids 100 km, 4 hrs per load, $125/hr cost of driver and vehicle, 2.13km/L fuel efficiency and $0.95/L diesel costs.

4.4 Option 3 – Waste-to-Energy Facility for Biosolids Only

The most typical incineration technology for biosolids would be a fluidized bed incinerator (FBI). The technology is described in Section 3.2.4 of the Biosolids Management Plan report dated November 4, 2009 and will not be repeated here. Most of the newer dewatered biosolids combustion facilities are FBIs due to their higher efficiency and combustion stability. This option could be implemented in using dried Class A biosolids with 50% or 95% solids content. A Waste to Energy facility receiving biosolids could actually be considered a primary biosolids strategy but requires additional funding.

Dewatering of the biosolids to a minimum of 50% solids content would be required to insure that the sludge could maintain combustion without the addition of auxiliary fuel. Biosolids have an energy content of 18,000 MJ/tonne of dry solids. Sixty to seventy percent of this energy would be needed to achieve the drying necessary for continued self combustion of the sludge. Alternatively, if the biosolids are dried to 95% solids content and all the energy content is available thus producing more heat that can be recovered.

The heat from combustion is recovered by devices located either in the bed or at the point at which combustion gases exit the chamber of a combination. This heat is used to create superheated steam. The resulting superheated steam is converted to electrical power using a non-condensing steam turbine generator and excess steam is available for other uses. The hot gases from the incinerator would be processed in multiple train heat recovery units. An air emission control train consisting of wet and dry scrubbers as well as electrostatic precipitators prior to discharge through a plume dispersion stack would ensure compliance with air quality requirements.

Alternatively, condensing steam turbine generators are used resulting in a doubling of the electricity production. However, the excess heat is lower and is in the form of hot water instead of stream.

Residual fly ash and bottom ash collection is required from the incinerator and the emission control facilities at an overall rate of 20% to 25% of the raw solids input rate or approximately 3 tonnes/day and includes most of the metals contained in the wastewater sludge. The fly ash requires stabilization and must be disposed in a landfill as a special waste. The bottom ash can be incorporated into construction materials or aggregate.

Capital and O&M Costs

The capital cost of a waste to energy for biosolids only based on fluidized bed technology was described in the BMP report and is estimated at $46.9 million. The estimated annual operating and maintenance cost for this facility is $1.2 million.

Table 4.11- Advantages and Disadvantages of WTE Facility for Biosolids Only

Advantages	Disadvantages
Eliminates management system dependence on markets for biosolids products	High capital cost
The heat produced by the WTE would supply the heating needs for the digesters and the biosolids dryers – reduction in energy cost for the wastewater treatment program	High annual operating and maintenance cost
Potential for materials recovery from ash such as phosphates and metals	Cost of WTE for biosolids only is not included in the project cost for the wastewater management program
Potential for construction aggregate from ash	Loss of carbon offset by not using dried biosolids as fuel in cement kiln
Retains the biogas production from the digesters	No beneficial reuse of biosolids
Minimizes the footprint of biosolids management	Loss of revenues from the sale of dried biosolids to cement kilns
Microconstituents such as pharmaceuticals, personal care products, and endocrine disruptors are destroyed at the high temperatures	-
Approximately 2,330 MW/year of electrical energy can be produced with an annual revenue of $186,000	If the WTE facility is located at Hartland landfill adjacent to the digesters, there would be no market to use the excess heat
Excess steam or hot water is available to adjacent users or for a district energy system	Environmental risks / concerns • The fly ash at about 0.7 tonnes/day collected from the air emission control train concentrates potentially toxic metals and would therefore constitute a special (hazardous) waste requiring disposed in a dedicated landfill • Risk of failure air emission control system failure-perceived potential long term health risks
	• WTE facilities may generate public resistance due to social concerns • Perception of public health impacts - air emissions • Perception of adverse impact of acceleration of global warming because of heated plume emission

Advantages	Disadvantages
	• Siting considerations • Potential impact on adjacent property value reductions and negative impact on future development • Public safety because of fire, explosion, additional truck traffic • Risk of delays • Backup disposal for biosolids still required in the event of process failure

4.5 Option 4 – Fluidized Bed Combustion of Biosolids with no Energy Recovery

This option is similar to Option 3 but does not include the recovery of heat. An example of biosolids disposal in a fluidized bed without energy recovery is the Westside Treatment Plant in Vancouver, Washington. As a result of difficulties associated with finding land disposal sites for biosolids, a dedicated combustion facility was constructed.

Capital and O&M Costs

The capital cost of a FBI for biosolids only and with no energy recovery facility is approximately $37.5 million. The estimated annual operating and maintenance costs for this facility are approximately $1 million. This capital cost estimate is based on approximately 80% of the cost of a FBI with heat recovery and electricity generation capability.

Table 4.12 - Advantages and Disadvantages of WTE Facility for Biosolids Only

Advantages	Disadvantages
Eliminates management system dependence on markets for biosolids products – a reliable biosolids management option	Same as Option 3 plus those below
Potential for materials recovery from ash such as phosphates and metals	No revenues from generation of electricity
Potential for construction aggregate from ash	Difficult to obtain revenues from heat recovery if the facility is located at Hartland landfill
Retains the biogas production from the digesters	
Minimizes the footprint of biosolids management	
Microconstituents such as pharmaceuticals, personal care products, and endocrine disruptors are destroyed at the high temperatures	

4.6 Option 5 – Combined Biosolids / Solid Waste WTE Facility

Background

The Capital Regional District is currently carrying out a feasibility study to review and evaluate the integration opportunities for solid waste and liquid waste. This study includes a review of several options to deal with municipal solid waste, source separate organics (separated from municipal solid waste) and biosolids. The five scenarios under investigation include:

1. Municipal solid waste including household organics and no biosolids to a WTE facility;
2. Municipal solid waste without household organics and no biosolids to a WTE facility;
3. Municipal solid waste including household organics and digested biosolids to a WTE facility;
4. Municipal solid waste without household organics but including digested biosolids to a WTE facility, and
5. Municipal solid waste without household organics and co-digested biosolids and source separated household organics to a WTE facility.

Some of the questions to be addressed in this study include: (1) separate processing of source separated household organics using composting or digestion, (2) combined processing of sludge from the wastewater treatment plant and source separated organics using anaerobic digestion, (3) capital and operating cost of the various options under consideration and (4) handling of ash. This report is scheduled to be completed in July 2010. A decision on the management of household organics is expected in the fall of 2010.

A separate feasibility study on a tri-Regional WTE is also underway. The anticipated output of this study is to determine if a WTE facility would serve the CRD only or three regional districts on southern Vancouver Island: CRD, Cowichan Valley Regional District and Regional District of Nanaimo. This report is also scheduled to be completed in July 2010. Should the construction of such a facility be approved by the CRD, the earliest date that a WTE would be operational is 2017.

Biosolids Management Plan

The option of a combined WTE for municipal solid waste and biosolids using mass burn technology was examined in the December 2009 Biosolids Management Plan. The estimated capital cost for this facility was estimated at $195.4 million and the portion of the capital cost attributable to biosolids was estimated at $18.3 million. This was based on median capital cost of $775 per annual tonne and has a standard deviation of 50%. The annual debt repayment for the sum of $18.3 million is $988,000 based on a 25-year amortization period and an interest rate at 6%. The portion of the annual operating and maintenance cost related to the biosolids is estimated at $800,000.

The total annual cost for the disposal of biosolids is estimated at $836,000 per year. When the annual debt repayment of $988,000 is added to the O&M cost is added, the total annual cost is estimated at $1,824,000. This represents a unit cost of $306 per dry tonne of solids.

Table 4.13 – Estimated Annual Cost for Disposal at a WTE for MSW and Biosolids

Disposal at WTE combined with MSW and Biosolids	
Annual Debt Repayment – share of biosolids	$988,000
O&M cost – share of biosolids	$800,000
Hauling Costs	$36,000
Annual Costs	**$1,824,000**

The above cost estimates were based on a mass-burn facility with a capacity of 210,000 tonnes/year. The portion of the WTE facility attributable to biosolids is based on the ratio of biosolids to MSW. The estimated cost of a WTE facility will be updated as part of the feasibility studies currently under way by the CRD.

The residual ashes represent up to 25% by weight of the solids into the WTE. Potential revenues include electricity, heat (steam or hot water), recyclable metals from the ashes and using a portion of the ash as construction aggregate. Similar to Options 3 and 4, the mass burn WTE for combined municipal solid waste and biosolids would be considered a primary biosolids strategy.

Table 4.14 - Advantages and Disadvantages of Combined Biosolids & MSW WTE

Advantages	Disadvantages
Eliminates management system dependence on markets for biosolids products –i.e. reliable biosolids management option	Same as option 3 plus the following:
Significant capital and operating cost reduction compared to WTE facility for biosolids only	Risk of delays beyond 2017 for the construction of a regional or tri-regional WTE
The heat produced by the WTE would supply the heating needs for the digesters and the biosolids dryers – reduction in energy cost for the wastewater treatment program	Public acceptance of large WTE with respect to siting or resistance to thermal processing
Potential for materials recovery from ash such as phosphates and metals	Risk that the construction of a WTE facility may not go ahead
Potential for construction aggregate from ash	
Retains the biogas production from the digesters	
Potential for tapping into the federal innovative environmental solution “Green”funds because of	

Advantages	Disadvantages
The innovative approach of integrating both biosolids and MSW streams- if this additional source of funds occurs then the portion of capital to be funded by CRD would drop and the payback period would be decreased	

4.7 Option 6 – Haul to Other WTE Facilities in BC

The operators of the following existing waste to energy facilities have been contacted to find out if the dried biosolids from the CRD could be used as a source of fuel.

- Williams Lake Energy Plant, Epcor – This is a large stand alone WTE facility with the capacity to accept 73,000 tonnes per year of wood waste and biomass. The plant produces 70 MW of electricity which is sold to BC Hydro. The plant manager has indicated that this facility is not permitted to accept biosolids and that it is not designed to burn biosolids. It is our understanding that modifications to the air pollution control equipment would be required if biosolids was used a fuel at this facility.
- Burnaby WTE, Metro Vancouver – This waste to energy facility is located in the commercial and industrial area of south Burnaby. It receives waste from Burnaby, New Westminster, and the North Shore, and is responsible for the disposal of over 20% of municipal solid waste from Metro Vancouver. The facility receives 280,000 tonnes of waste per year and produces steam and electricity. The steam is sold to a paper recycling facility and the electricity is sold to BC Hydro. Metro Vancouver has indicated they would not accept dried biosolids from the CRD.
- Mill in Nanaimo – Harmac Pacific was contacted to find out if their mill in Nanaimo had a hog fuel burner or a cogeneration facility that would accept dried biosolids from the CRD. No response has been received.
- The existing cogeneration facility operated by Kelson Canada at Elk Falls in Campbell River is a gas fired facility that produces electricity and sells the process steam to adjacent industrial users such as the Elk Falls mill. This facility does not accept solid fuels such as wood waste or dried biosolids.
- Other facilities at mills in Crofton and Port Alberni – Catalyst Paper was contacted to find out if they have combustion facilities that would accept dried biosolids from the CRD. No response has been received.

Covanta is proposing a waste to energy facility in Gold River to generate thermal electric power from refuse derived fuel. This project would convert approximately 750,000 tonnes of fuel to 97 MW of energy. The proposed technology is mass-burn combustion system. Fuel would be received at the facility by barge, at the existing deep-sea dock facility. Covanta has indicated that the proposed facility could accept biosolids and they would be interested in accepting dried biosolids from the CRD. The current permit does not allow for acceptance of biosolids as feedstock and an amendment to the permit would be required. It is our understanding that the proposed air pollution control system is designed to handle biosolids and an amendment to the permit would be relatively straightforward. The decision to proceed with construction is pending further approvals from the Ministry of the Environment and securing a large source of waste material as feedstock.

At this time, no existing waste to energy facility within BC that could take the dried biosolids has been identified. It is possible that new facilities could be built before the wastewater treatment plant is opened in 2016. Efforts to contact owners and operators of existing and proposed WTE should continue.

4.8 Option 7 – Haul to WTE Facilities in the US: Marion County

Three major waste to energy facilities are in operation in the Pacific Northwest Region of the US. However, only one facility indicated the availability of additional capacity for solids receiving. A facility schematic and brief operational summary for that process is described here.

Marion County:

The Marion County facility, located in Brooks Oregon, is operated by the private company Covanta Inc. The facility has a rated refuse capacity of 550 tons per day of solid waste which is used to generate up to 13.1 MW of renewable energy annually that is sold to Portland General Electric. The Marion Facility uses mass burn technology, dry flue gas scrubbers and filter fabric baghouses to control acid gases and particulates. More specifically, the system is comprised of two waterwall furnaces (275 ton/day) with Martin reverse reciprocating grates and an ash handling system. The process schematic is illustrated in Figure 4.2.

The waste is burned at 2,000°F, generating steam which in turn drives turbines which generate electrical power. The facility receives approximately 90% of the solid waste produced by Marion County. The remaining 10% comprised of construction and demolition waste, food processing waste, and other miscellaneous non-burnables are diverted to the landfill in Salem. Ferrous metals which were not previously separated from the waste and which are processed through the combustion chambers are picked out of the ash with large magnets. This metal is cleaned and taken to markets for recycling. Last year, about 3,356 tons of metal were recycled by the Waste-to-Energy Facility.

The advantages and disadvantages to CRD of hauling sludge to Oregon Washington State are outlined in Table **4.15**. The annual costs are described in Table **4.16**. The Marion County Incinerator has tipping fee of $260/DT biosolids. It is assumed that the biosolids meet combustion requirements. This tipping fee appears to be high but it is in the same range as the annual cost for debt repayment and operating cost for a large mass burn facility for the CRD (see Option 5). The obvious disadvantages are the high hauling cost and the negative public perception of shipping waste to another country and over a long distance.

Table 4.15 - Advantages and Disadvantages of WTE in the US

Advantages	Disadvantages
Reduction in waste volume	Dependency on private company
Production of energy	Expensive tipping fee
Avoid costly capital expenditures when using an already established system	Variable GHG emissions reported in the literature
	Transport of solids over a long distance
	The province of BC is considering the adoption of legislation banning the export of solid waste products to the US

Table 4.16 – Operating Cost of Shipping Biosolids to WTE in Oregon

WTE in United States Operating Costs	
Direct Operating Costs	
Annual Disposal Costs ($260/DT)	$1,591,200
Hauling Costs	$849,800
Annual Operating Costs	**$2,441,000**

[1)]Tipping fee is based on personal communication with a representative from Covanta Inc

[2)] Hauling costs include: ferry trip (Sidney BC to Anacortes) and mileage to Brooks OR based on transfer of 225 loads of biosolids, 24 hrs per load (round trip), $125/hr cost of driver and vehicle, 2.13km/L fuel efficiency and $0.95/L diesel costs.

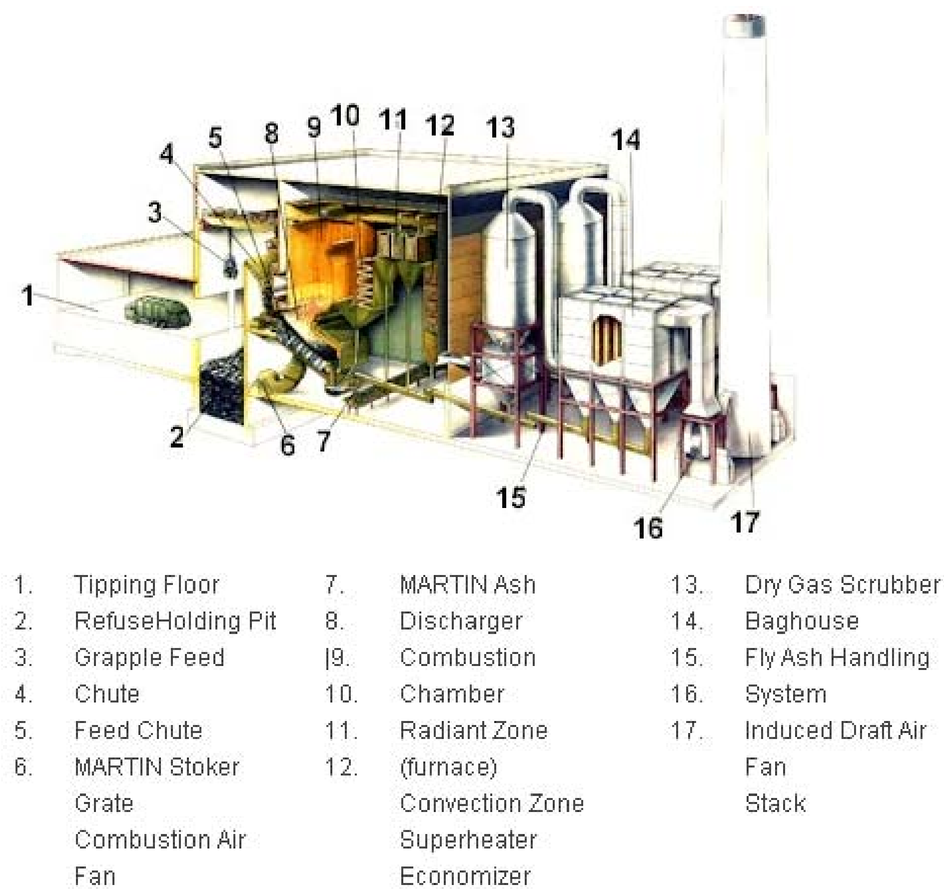

Figure 4.2. Covanta Marion Inc. Solid Waste to Energy Facility Schematic

4.9 Option 8 – Gasification

4.9.1 Existing Facilities

Nexterra

Wood gasification installations supplied by Nexterra Systems Ltd. have been constructed in Victoria (Dockside Green), Kamloops (Tolko) and New Westminster (Kruger). We were advised by Nexterra that these existing installations are not suitable to use biosolids as a source of fuel. Nexterra has indicated that these three plants have been sold, designed and permitted to be run on wood, not biosolids. A switch in fuel from biosolids would require changes to the existing operating and air permits, hardware and controls. As a result of the advice received from the supplier, the option of disposing the biosolids at the existing Nexterra facilities has been eliminated.

4.8.2 Proposed Gasification Facility

International Composting Corporation (ICC Group)

ICC Group is a Victoria based company that is planning the construction of a gasification plant in the Western Communities for the purpose of producing heat. ICC has indicated that construction is scheduled to start in the next 12 months with a planned upgrade in 2013 to produce biodiesel. ICC has indicated this facility would be designed to accept biosolids. No details on the location and size of the proposed facility have been provided. No details on financial arrangement such as the tipping were provided. The option of disposing the biosolids at this proposed facility will not be considered further at this time. However, since the production of biosolids will not start until 2016, further discussions could take place with ICC to follow up on how facility development is proceeding.

4.10 Option 9 – Ship to Third Party Composting Facility on Vancouver Island

There are a number of composting facilities located on Vancouver Island which could potentially accept biosolids.

International Composting Corporation (ICC Group)

ICC Group has been operating a composting facility in Nanaimo since 2004. The facility includes a 2,050 square metre building on a 3.2 hectare site and has a current capacity of 90 tonnes per day. It is currently processing 40 tonnes per day of source separated organic and yard and garden waste. This facility would have the capacity required to accept the dried biosolids from the CRD. ICC has indicated that their acceptance of the dried biosolids is subject to receiving detailed analysis of the dried biosolids including metal contents to ensure that it does not affect the quality and marketability of the final product. It is likely that the current spare capacity of 50 tonnes per day will not be available when biosolids are produced starting in 2016. ICC Group has not provided information on the tipping fee that would be charged for biosolids. The current tipping fee for food waste is $85 per tonne. Further discussions could take place with ICC to follow up on its upgrading plans for their Nanaimo facility.

Fisher Road Recycling

The composting facility located in Cobble Hill is operated by Fisher Road Recycling. This facility has a capacity of 18,000 tonnes/year (49 tonnes/day) including the bulking agent that is used to mix with the wet organics. The net capacity excluding the bulking agent is 10,600 tonnes per year. The facility uses in-vessel composting technology and currently has spare capacity to accept the dried biosolids. The travelling time from Hartland landfill to Fisher Road is estimated at 1 hour and 20 minutes. The total time for each load including loading, unloading and the return trip is 3.5 hours. The operator has indicated that the facility currently has spare capacity. The current tipping fee is $80 per tonne. It is our understanding that a rezoning application has been submitted to allow for further expansion of this facility. Further discussions could take place with Fisher Road Recycling to follow up on its upgrading plans for their Cobble Hill facility.

Coast (V.I.) Environmental Ltd.

This firm is operating a composting facility in Chemainus. It consists of an eight cell in-vessel gore cover composting facility located within a 1740 square metre building. The current tipping fee is $100 per tonne. The operator has indicated that the facility has a capacity of 4,000 tonnes per year based on receiving organic matter with 30% solids contents and is currently operating at capacity. The capacity is below the estimated annual biosolids production of 5,250 tonnes per year. This facility does not have the necessary capacity to accept the biosolids produced by the CRD.

The advantages and disadvantages to CRD of using composting facilities on Vancouver Island are outlined in Table **4.17**. The annual costs are described in Table **4.18**.

Table 4.17 - Advantages and Disadvantages of Composting Facility on Vancouver Island

Advantages	Disadvantages
Some facilities are located close to Victoria	Dependency on small and medium size facilities that may not have the capacity in 2016 or beyond
Production of compost which is useful product	May have to pay extra cost to reserve capacity for future use
Avoid costly capital expenditures when using an already established facility	No guarantee these facilities will be in operation in 2016 and beyond
Moderate tipping fee that is lower than Hartland landfill	Does not meet the policy objective of the CRD or no land application
	Truck traffic will be generated

Table 4.18 – Operating Cost of Hauling to Composting Facility on Vancouver Island

Composting Facility on Vancouver Island Operating Costs	
Direct Operating Costs	
Annual Disposal Costs ($85/tonne)	$478,000
Hauling Costs; 4 hrs return trip, one 30-tonne truck every second day, $140/hr for truck and driver)	$102,000
Annual Operating Costs	**$580,000**

Although this option does not meet the requirements of the CRD policy of no land application of biosolids, as a backup strategy it does produce a product that meets federal and provincial regulations for metal contents and microbiological quality for use as a fertilizer and soil amendment (biosolids growing medium). Also the anaerobic digestion process will remove 80% of the microconstituents such as pharmaceutical and personal care products.

4.11 Option 10 – Ship to Land Application Facilities Outside of Canada

One end-use option is to land-apply the biosolids on private land as a fertilizer and soil conditioner. The agronomic biosolids application rate can be customized to supply the optimal amount of nutrients for the planned cropping system to minimize environmental impacts due to nutrient runoff. Two recommended companies provide land application services in Washington State: Boulder Park, Inc and Natural Selection Farms.

Natural Selection Farms manages more than 35,000 acres (15,000 ha) including irrigated hops, corn, orchards, managed pastureland and canola fields for biofuel production in Central Washington. The amount of land in cultivation has the capacity to receive 50,000 tons of biosolids annually. Currently, they receive approximately half that quantity from utilities in Washington such as King County.

Boulder Park Inc. (BPI) manages the Boulder Park project in Central Washington. The project is comprised of 120 landowners and farmers which grow dryland wheat on more than 50,000 acres (25,000 ha). The advantages and disadvantages to CRD of land application in Washington State are outlined in Table **4.19**. The annual costs are described in **Table 4.20**.

Table 4.19 – Advantages and Disadvantages of Land Application of Biosolids in the US

Advantages	Disadvantages
Offset commercial fertilizer use, expense, and reduce GHG emissions from inorganic fertilizer production	Transporting the solids to a rural land application site (vulnerable to variable fuel costs)
Year round reliable acceptance of biosolids	Hauling is impacted by winter weather road closures and ferry crossing
Competition for contract can drive down costs	Dependent on US biosolids regulations
Proven reliability for King County (Seattle) and other agencies	Land-based biosolids reuse may not be compatible with CRD goals
	Negative public perception of shipping biosolids to another country and over long distances
	Will generate truck traffic

	The province of BC is considered the adoption of legislation banning the export of solid waste product to the US

Table 4.20 – Operating Cost of Hauling to Land Application Site in the US

Land Application in United States Operating Costs	
Direct Operating Costs	
Annual Land Application & Hauling Contract Costs ($40/DT)[1]	$244,800
Standby Fee[2]	$17,000
Ferry Cost Transportation to Seattle[3]	$87,200
Trucking Cost to Seattle (16 hrs return trip, one 30-tonne truck every second day, $140/hr for truck and driver)	$410,000
Annual Operating Costs	**$759,000**

1) Hauling and Land Application costs based on fee King County Biosolids pays to Groat Brothers Hauling and Boulder Park Inc.

2) Standby storage and utilization fee based on current King County contract costs

3) Ferry costs based on Washington State Ferries rate for Sidney BC to Anacortes

4.12 Option 11 – Initial Disposal at Hartland Landfill followed by WTE

Since the potential CRD waste to energy facility for the disposal of municipal solid waste would not be operational until at least 2017, an interim emergency disposal site is required between the time the Core Area wastewater treatment facilities are completed in 2016 and the completion of the WTE facility for municipal solid waste. The WTE facility is at the early planning stage and at this time, there is no guarantee that this project will proceed. Should this WTE project go ahead, the CRD could insure that capacity to handle the biosolids would be included in the sizing of the facility. In this case, the WTE would become the primary disposal alternative for biosolids and there would be no need to ship the biosolids to cement kilns in the lower mainland. An emergency disposal backup plan will have to be implemented in case of failure of the WTE facility. It is likely that the emergency backup plan would be to dispose the municipal solid waste and the biosolids at Hartland landfill. If the mass burn technology is used for the WTE, it is highly reliable since multiple units, at least two, would be utilized and it is highly unlikely that both units would be out of service.

As discussed in Section 5, the portion of the capital and O&M cost attributable to the biosolids may be apportioned on the basis of dry weight. Using this approach, the total annual cost of debt repayment and O&M cost attributable to the biosolids would be in the range of $1.8 million.

Section 5 Preliminary Screening

5.1 Cost Summary

Table 5.1 summarized the capital cost and annual operation cost for most options. The option of using biosolids as cover material at the landfill has been ruled out as impractical and has not been priced. Similarly the option of disposal at existing gasification and waste to energy facilities have not been priced since no existing facility has been identified.

Table 5.1 – Summary of Capital and O&M Costs

Options		Capital Cost	Annual Operating Cost
1	Disposal at Hartland landfill: a) Biosolids mixed with municipal solid waste (MSW) in active landfill b) Using biosolids as cover material c) Biocell at Hartland landfill	0 0 $5,194,000	$583,000 Not a suitable use $423,000
2	Dedicated land disposal and processing facility	$53,876,000	$1,125,000
3	Waste to energy (WTE) for biosolids only	$46,900,000	$1,200,000
4	Fluidized bed combustion (FBC) for biosolids only	$37,520,000	$1,000,000
5	Waste to Energy (WTE) facility with biosolids and MSW combined	$18,300,000 (Portion attributable to biosolids)	$836,000 (Portion attributable to biosolids)
6	Ship to other WTE in BC	0	No facility available at this time
7	Ship to WTE in Marion County, Oregon	0	$2,441,000
8	Gasification a) Existing facility such as Dockside Green b) New facility by third party	0 - If facility constructed by third party	No facility available at this time
9	Ship to a third party composting facility on Vancouver Island	0	$580,000
10	Ship to a third party composting facility outside of Canada	0	$759,000

Options		Capital Cost	Annual Operating Cost
11	Combination of two options: a) Disposal at Hartland landfill initially b) WTE for biosolids and MSW	a) 0 b) To be confirmed by CRD studies under way	a) $583,000 b) To be confirmed by CRD studies under way

5.2 Preliminary Screening

A preliminary screening of options was carried out to eliminate options that cannot provide the required capacity, cannot be implemented by 2016 and that are not using proven technology. This process eliminated Options 1b), 1c), 2, 5 and 8a) from further consideration. Also options that would require a significant capital expenditure that is entirely attributable to the Core Area wastewater treatment program are also eliminated. The overall project budget of $782,000 for the wastewater treatment program has already been approved by the CRD and new significant capital expenditures would need to be added such as Options 3 and 4 which would raise the project cost by $38 to $47 million.

Table 5.2 – Preliminary Screening of Biosolids Emergency Disposal Backup

	Emergency Back-up Candidate Option	Capacity Available at All Times	Can be implemented by 2016	Use of proven technology	Capital cost not included in WWTP project
1a)	Disposal at Hartland Landfill	Pass	Pass	Pass	Pass
1b)	Use as cover material at Hartland landfill	**Fail (1)**	Pass	**Fail (1)**	Pass
1c)	Biocell at Hartland Landfill	Pass	Pass	**Fail**	**Fail**
2	Dedicated land disposal and processing facility	Pass	**Fail**	Pass	**Fail**
3	Waste to energy (WTE) for biosolids only	Pass	Pass	Pass	**Fail**
4	Fluidized bed combustion (FBC) for biosolids only	Pass	Pass	Pass	**Fail**
5	Waste to Energy (WTE) facility with biosolids and MSW combined	Pass	**Fail**	Pass	Pass
6	Ship to other WTE in BC	**Fail - None identified**	**Fail - None identified**	Pass	Pass
7	Ship to other WTE outside	**Fail (3)**	Pass	Pass	Pass

	Emergency Back-up Candidate Option	Capacity Available at All Times	Can be implemented by 2016	Use of proven technology	Capital cost not included in WWTP project
	of Canada				
8a	Gasification – Existing facility such as Dockside Green	**Fail**	**Fail**	**Fail**	Pass
8b)	Gasification – new facility by third party	**Fail - None identified**	**Fail - None identified**	Pass	**Fail**
9	Ship to a third party composting facility on Vancouver Island	**Fail (2)**	Pass	Pass	Pass
10	Ship to a third party Land application facility in the US	**Fail (3)**	Pass	Pass	Pass
11	Combination of two options: Disposal at Hartland landfill initially followed by WTE for biosolids and MSW	Pass	Pass	Pass	Pass – if WTE developed as a stand-alone project with no capital contribution from the wastewater treatment program

(1) Based on pilot studies carried out by the CRD, operational difficulties have been identified. Also the use of biosolids as cover could not be done on a continuous basis
(2) Spare capacity may not be available in 2016 and beyond
(3) Pending provincial legislation may prohibit the export of waste material

Based on the above preliminary screening, the only options that would pass all criteria include disposal at Hartland landfill (Option 1a) and interim disposal at Hartland landfill followed by disposal at a combined WTE facility for biosolids and MSW (Option 11). The two options of shipping waste to facilities in the US (Options 7 and 10) received a "failed" under available capacity at all times because of possible provincial legislation that would prohibit the export of waste material. However because details of the proposed legislation is not available, these options were carried forward for further evaluation in the triple bottom line analysis. The option of hauling to a third party composting facility also received a "fail" under available capacity at all times because there is no guarantee that current spare capacity will be available in the future. However this option was carried forward because of its potential to be a backup alternative in the future. Following preliminary screening the following options are retained for further evaluation in the Triple Bottom Line Analysis:

- Disposal at Hartland landfill – mixed with municipal solid waste (Option 1)
- Ship to a WTE facility in Marion County, Oregon (Option 7)
- Ship to a third party composting facility on Vancouver Island (Option 9)
- Ship to a third party composting facility in central Washington State (Option 10)
- Disposal at Hartland landfill initially followed by future WTE (Option 11)

Section 6 Triple Bottom Line Assessment

The remaining alternatives were evaluated using a modified Triple Bottom Line (TBL) as an analysis tool. Due to the preliminary nature of this investigation, a full analysis was not conducted. Instead the economic, social, and environmental impacts were ranked 1-5 (worst to best) based on predicted impact.

Economic impacts are the direct costs to the public agency that are traditionally associated with an economic analysis. In this case, all backup alternatives that require capital cost were eliminated since these are not included in the approved $782 million budget for the wastewater treatment program. The economic impact is based solely upon the annual operating costs of the remaining alternatives. A summary of the economic costs of the five alternatives under consideration as well as the TBL ranking criteria are outlined in **Table 6.1** below. The option with the lowest cost has the highest ranking of 5 and the option with the highest cost has the lowest ranking of 1.

Table 6.1 – Economic Ranking of Short List of Options

	Options	Economic Costs (Annual Operating Cost)	TBL Ranking Criteria
1	Disposal at Hartland landfill: a) Biosolids mixed with municipal solid waste (MSW) in active landfill	$583,000	5
2	Ship to WTE in Marion County, Oregon	$2,441,000	1
3	Ship to a third party composting facility on Vancouver Island	$580,000 or more depending on location of facility	4
4	Ship to land application in Central Washington	$759,000	3
5	Combination of two options: a) Disposal at Hartland landfill initially b) WTE for biosolids and MSW	$1,824,000 (1) To be confirmed by CRD studies under way	2

1) For the purpose of the TBL analysis, it is assumed that the annual fee charged for the disposal of biosolids at a regional WTE facility includes the debt payment for the upsizing of the facility needed to accept biosolids as per Table 4.13

The most expensive option is ship to WTE in Oregon, while shipping to land application falls within the middle of the range. Disposal at Hartland landfill and ship to a composting facility on Vancouver Island require the lowest operating costs. The combination WTE was assigned a value that assumes that the portion of the capital cost attributable to the biosolids is included in the tipping fee.

Environmental costs are the indirect environmental implications of an agency's actions and were quantified based on the carbon footprint, nonrenewable resource use, beneficial product utilization and regulatory restrictions. The carbon footprint score reflects the alternative's ability to generate carbon debits (emissions) or credits for the utility. Nonrenewable resource use indicates the quantity of fossil fuels required for successful operation of the alternative. Each alternative utilizes the biosolids differently. Beneficial product utilization capitalizes on the fertilizer or energy value of the biosolids. Finally, regulations may be restrictive when shipping biosolids across the border into the United States as well as provincial regulations heavily control biosolids compost production and use. The option with the highest environmental ranking has a score of 5 and the option with lowest ranking has a score of 1.

Table 6.2 – Environmental Ranking of Short List of Options

	Options	Carbon Footprint	Nonrenewable Resource Use	Beneficial Product Utilization	Regulatory Restrictions
1	Disposal at Hartland landfill: a) Biosolids mixed with municipal solid waste (MSW) in active landfill	1	5	1	5
2	Ship to WTE in Marion County, Oregon	3	1	3	1
3	Ship to a third party composting facility on Vancouver Island	5	3	5	3
4	Ship to land application in Central Washington	4	2	5	1
5	Combination of two options: a) Disposal at Hartland landfill initially b) WTE for biosolids and MSW	3	4	2	3

The social costs are related to traffic operations in sensitive areas, public acceptance, and odour potential. The social ranking is shown in **Table 6.3**.

Table 6.3 – Social Ranking of Short List of Options

	Options	Traffic Operations	Public Acceptance	Odour Potential
1	Disposal at Hartland landfill: a) Biosolids mixed with municipal solid waste (MSW) in active landfill	4	5	1
2	Ship to WTE in Marion County, Oregon	1	1	5
3	Ship to a third party composting facility on Vancouver Island	2	1	4
4	Ship to land application in Central Washington	1	1	4
5	Combination of two options: a) Disposal at Hartland landfill initially b) WTE for biosolids and MSW	4	1	2

The summary of the TBL evaluation is presented in **Table 6.4** below.

Table 6.4 – Ranking of Short List of Options

	Options	Economic	Environmental	Social	Total
1	Disposal at Hartland landfill: a) Biosolids mixed with municipal solid waste (MSW) in active landfill	5	12	10	27
2	Ship to WTE in Marion County, Oregon	1	8	7	16
3	Ship to a third party composting facility on Vancouver Island	4	16	7	27
4	Ship to land application in Central Washington	3	12	6	21
5	Combination of two options: a) Disposal at Hartland landfill initially b) WTE for biosolids and MSW	2	12	7	21

Based on the preliminary TBL assessment, the two alternatives with the highest score are disposal at Hartland landfill and ship to a third party composting on Vancouver Island. However as discussed elsewhere in this report, there is no guarantee that third party composting facilities on Vancouver Island will have the reserve capacity in 2016 and beyond to accept the dried biosolids on an emergency basis. Also both of these options would require amending the CRD policy of no land application of biosolids.

The options of shipping biosolids to a land application site in Central Washington and initial disposal at Hartland landfill followed by disposal at a future regional WTE facility are tied for second place. The option of shipping biosolids to the US potentially has the negative public perception of exporting waste to another country. The option of eventual disposal at a regional WTE facility depends on approval of a very large capital expenditure which may not occur. The option of shipping to a WTE facility in Oregon has the lowest rating.

Section 7 Findings and Recommendations

The wastewater treatment processes will produce between 22 and 29 tonnes per day (dry weight) of solids by 2030 depending on the rate of growth. It is proposed to treat these solids in anaerobic digesters that are operated at a temperature of 55^0C with an average retention time of 15 days. Approximately 50% of the solids will be converted to gas consisting mainly of methane (60%) and carbon dioxide (38%). The remaining solids will have undergone treatment that meets the requirement of the BC Organic Matter Recycling Regulation for Class A biosolids. The estimated production of Class A biosolids will be in the range of 14.4 to 16 tonnes of solids per day. In order to increase the production of biogas, it is proposed to add fats, oil and grease (FOG) to the digesters. Assuming a 75% capture rate for FOG, an additional 1.4 tonnes of solids will be produced.

It is proposed that digested biosolids will be dewatered and thermally dried. Dried biosolids (95% dry matter) can be transported to cement kilns in the lower mainland. The dried biosolids are considered a low grade fuel. The use of dried biosolids as fuel will displace coal. It is recommended to have an emergency disposal backup plan for the biosolids in case the cement kilns stop accepting dried biosolids. Several options have been examined and all these options fall into the following three categories:

- Thermal destruction – This can be achieved in a fluidized bed incinerator, a waste to energy facility or a gasification plant (Options 3, 4, 5, 6, 7, 8 and 11);
- Land application – Further processing using composting followed by land application of the composted product (Option 9) or direct land application of biosolids (Option 10); and,
- Landfill – Hartland landfill or a dedicated land disposal facility (Options 1, 2 and 11).

The total project budget for the approved wastewater treatment program for the Core Area is $782 million. This amount does not include the cost of constructing a dedicated combustion facility, a waste to energy or a gasification plant for biosolids disposal. The cost of such a facility is in the range of $37 to $46 million. It would be beyond the scope of the approved project to add such a facility.

Accordingly, the emergency backup disposal alternative should consist of a facility owned and operated by the CRD or a facility owned by a third party and that would accept the biosolids for a fee and have sufficient reserve capacity available at all times. The two potential facilities owned by the CRD include Hartland landfill and a future waste to energy facility for the disposal of municipal solid waste that is currently in the early planning stage. Third party facilities include composting, waste to energy or gasification plants that are owned by other agencies or the private sector.

At this time, no third party waste to energy or gasification plants located in BC and that would accept biosolids have been identified. The supplier of gasification plants in Victoria (Dockside Green), Kamloops and New Westminster has indicated that these facilities are not designed or permitted to accept biosolids. The large WTE facilities in Burnaby (Metro Vancouver) and Williams Lake (Epcor) have indicated they either do not have the capacity or are not permitted to accept biosolids. No response has been received from the operator of the co-generation facilities located at mills on Vancouver Island in Crofton, Port Alberni and Campbell River.

It is possible that existing facilities will accept biosolids following more detailed analysis of the finished product. However, the metal content of the biosolids cannot be confirmed until biosolids are actually produced and this will not occur until 2016. New waste to energy or gasification plants are in the planning stage and it is possible that a facility with sufficient capacity and capability to accept biosolids will be constructed by 2016. However, at this time the option of using a third party waste to energy or gasification facility in BC does not meet the requirement for the emergency disposal of biosolids. The Marion County waste to energy located 50 km south of Portland Oregon is a large facility that would accept the biosolids. However, the tipping fee is high at $260 per tonne and the hauling cost is significant. This option is not recommended.

There are two medium sized composting facilities on Vancouver Island located at Cobble Hill and Nanaimo that currently have the capacity to accept the biosolids. However, there is no guarantee that the capacity will be available in 2016 or beyond. It is difficult for facilities of this size to set aside a portion of their capacity in case the CRD needs it at an undermined future date and period of time. The tipping fee for these two facilities is in the range of $80 to $85 per tonne and the hauling costs are moderate especially if large 30 tonne capacity truck trailers are used in order to minimize the number of truck loads. The annual cost for this option is estimated at approximately $580,000. Because of the uncertainties regarding the availability of spare capacity, this option is not recommended at this time. Also composting does not meet the current objective of avoiding land application since the end product of any composting facility will be applied to land.

There are at least two large land application firms in Central Washington State that offers a highly competitive rate of $40 per tonne for land application including hauling from Seattle. However, land application does not meet the objectives of the CRD and shipping biosolids over such a long distance would consume a lot of diesel fuel. Also there are significant uncertainties in transporting biosolids by ferry and over long distances during the winter months. This option is not recommended.

The waste to energy facility currently under consideration by the CRD would meet all the criteria for an emergency backup plan and would be under the total control of the CRD. However this project is still at the conceptual level and, if approved by the CRD and other parties involved, the earliest start date is 2017. Should this project go ahead, it could become the primary resource recovery option for the dried biosolids.

Disposal of biosolids at Hartland landfill does not meet the current objective of the CRD. However, it could be considered as an interim measure until a regional waste to energy facility is constructed. Option 11 consists of emergency disposal of biosolids at Hartland landfill until a regional facility is operational. With this option, the disposal of biosolids at the landfill may never occur since resource recovery at cement kilns would remain as the primary practice.

Recommendations:

1. Continue to investigate using third party waste to energy and gasification facilities on Vancouver Island or on the lower mainland for the emergency disposal of biosolids. Dried biosolids will not be produced until 2016 and it is possible that by that time, existing facilities will be expanded or new facilities constructed.

2. Should the CRD proceed with the construction of a waste to energy facility for municipal solid waste, this would become the primary disposal method for biosolids.

3. Until a waste to energy facility becomes available, Hartland landfill should be designated as the preferred emergency disposal method.

4. Reconsider the policy objective of avoiding land application of biosolids, using biosolids for the production of soil amendments such as compost and biosolids growing medium and application of dried biosolids for mine reclamation. Land application has been proven as an acceptable disposal option at many locations in North America and British Columbia and it is also considered a viable option under current Provincial Regulations.