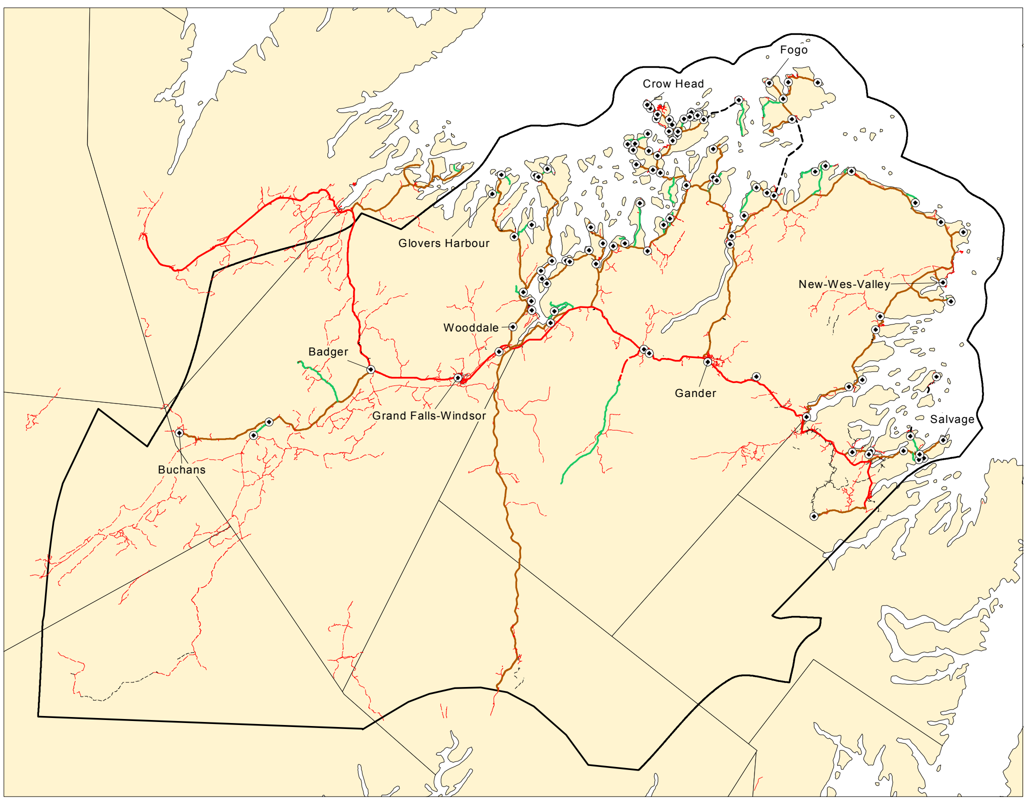
CENTRAL NEWFOUNDLAND SOLID WASTE MANAGEMENT PLAN

Phase II Report

Final Report Submitted to

Central Newfoundland Waste Management Committee

BNG PROJECT # 722021



BAE ♦ NEWPLAN GROUP

CENTRAL NEWFOUNDLAND
SOLID WASTE MANAGEMENT PLAN

Phase II Report
Final Report

<u>Final Report Submitted to:</u>

Central Newfoundland Waste Management Committee
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Project No.: 722021

Title: CENTRAL NEWFOUNDLAND SOLID WASTE MANAGEMENT PLAN

Phase II Report – Final Report

Client: Central Newfoundland Waste Management Committee

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Central Newfoundland Solid Waste Management Plan

Volume 2

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EXECUTIVE SUMARY

The Solid Waste Management Plan has been developed using a very interactive process between the BAE-Newplan Group (BNG) and the Central Newfoundland Solid Waste Management Committee (CNSWMC). The CNSWMC is an umbrella organization made up of representative of the community councils within the Central Region of Newfoundland. In October 2002, BNG submitted Phase I of the Solid Waste Management Plan to the CNSWMC. The Phase 1 Report provided the committee with information on the following topics:

- boundary of the study area;
- waste generation rates;
- population projections;
- waste generation centriod;
- waste characteristics for Central Newfoundland;
- a description of waste collection and transportation;
- local waste management facilities and potential locations throughout the study area;
- a review of comparable waste management systems,
- a review of existing recycling and composting facilities;
- analysis of various recyclable processing options;
- alternatives approaches to engineered landfill;
- cost estimates for local waste management facilities; and
- selection of potential waste management facility.

Based on the findings presented to the CNSWMC in the Phase I Report, the committee decided to adopt a two-stream (wet/dry) waste collection system with local waste management facilities located in Buchan's Junction, Botwood, Virgin Arm - Carter's Cove, Seldom - Little Seldom, Gander Bay South, Indian Bay, and Terra Nova.

The Phase II Report includes an investigation of the location of the Regional Waste Management Facility, landfill alternatives, local waste management facility options, materials recycling facility and composting facility alternatives, construction and demolition alternatives, conceptual design of the Regional Waste Management Facility, and development of the tipping fee and close out requirements for all existing waste disposal sites within the study area.

1.0 INTRODUCTION

1.1 BACKGROUND AND OBJECTIVES

The Province of Newfoundland and Labrador has developed a comprehensive strategy[1] with a goal of 50% diversion of materials currently going to landfills by the year 2010. The strategy includes a reduction in the number of disposal sites, the elimination of open burning, and the phase out of unlined landfills.

The Central Newfoundland Waste Management Committee is an umbrella organization made up of representative of the community councils within the Central Region of Newfoundland. In keeping with the goals of this strategy, the Central Newfoundland Waste Management Committee has undertaken the task to oversee the development of a Solid Waste Management Plan for the Central Newfoundland Region. BAE♦Newplan Group was retained in April 2002 to assist the committee with the development of the plan. The Central Newfoundland Waste Management Committee, under the direction of Allan Scott, has a mandate to:

> "To study and recommend a cost effective, environmentally acceptable solid waste management system for Central Newfoundland."

The guiding principles for this mandate are clearly documented in the Terms of Reference[2] provided to BAE♦Newplan Group by the Central Newfoundland Waste Management Committee. They include:

- Evaluate the solid waste management needs, including recycling programs;
- Identify existing problems and determine the most feasible means of improvement; and
- Provide the region with an acceptable solid waste management plan for a design period of 50 years.

In October, 2002, BAE♦Newplan Group completed Phase I of the Central Newfoundland Solid Waste Management Plan. Based on the findings presented to the CNSWMC in the Phase I Report, the committee decided to adopt a two-stream (wet/dry) waste collection system with local waste management facilities / staging areas located in Buchan's Junction, Botwood, Virgin Arm - Carter's Cove, Seldom - Little Seldom, Gander Bay, Indian Bay, and Terra Nova.

[1] Government of Newfoundland and Labrador, Department of the Environment. *Newfoundland and Labrador Waste Management Strategy.* April 2002.
[2] Terms of Reference, Central Newfoundland Waste Management Study. February 22, 2002.

The objects for the Phase II Report are clearly documented in the Proposal[3] provided to the Central Newfoundland Waste Management Committee by BAE♦Newplan Group in August 2002. Based on BAE♦Newplan Groups' previous experience as well as conducting Phase I of the Solid Waste Management Plan, the Phase II investigation has been broken down into several tasks, which include the following:

- Investigation of Landfill Alternatives;
- Investigation of Local Waste Management Facility Options;
- Investigation of Materials Recycling Facility and Composting Facility Alternatives;
- Construction and Demolition Alternatives;
- Conceptual Design of the Regional Waste Management System;
- Develop Tipping Fee; and
- Determine Close Out Requirements for all Existing Waste Disposal Sites.

[3] Proposal for Central Newfoundland Solid Waste Management Study, Phase II. August, 2002.

2.0 IDENTIFICATION OF POTENTIAL LOCATIONS FOR WASTE MANAGEMENT FACILITY

The following sections provide the results of the phased site selection process. The Terms of Reference required the project team to consider existing sites for future use and, to undertake a site selection process for a new Regional Solid Waste Management Facility.

The phases included in the assessment of site suitability include:
1. Phase 1 - Preliminary Identification (Constraint Mapping)
2. Phase 2 - Site Screening (Ranking)
3. Phase 3 - Financial Investigation
4. Phase 4 - Detailed Investigations

2.1 PRELIMINARY IDENTIFICATION

The optimal landfill location is the one that minimize the total transportation from communities / local waste management facilities to the landfill site. To find the optimal landfill site, the waste generation centroid by road distance was calculated based on the transportation road network and the waste generation data. the waste generation centroid by road distance is defined as a point on the Trans Canada Highway (TCH) of which the waste tonnage-distance from both side of it are same.

The waste generation centroid of the Central Newfoundland Region is found to be 34.7 km west of Gander at the TCH / Lewisporte Bypass junction. The impacts of including Bonavista, South Brook and Baie Verte regions (Figure 2-1) on the landfill location had been investigated as well. The centroids for various scenarios are presented in Table 2-1 and are shown in Figure 2-2.

Table 2-1: Centroid Locations for Various Scenarios.

Regions Served	No. of Communities	Population	Waste Volume (T/Year)	Centroid (km)
All - Central, Bonavista, South Brook and Baie Verte	119	109,290	62,012	36.8
Central, South Brook and Baie Verte	97	92370	53,984	47.1
Central, South Brook	81	85,482	50,715	43.3
Central only	66	76,583	45,493	34.7
Central, Bonavista, South Brook	103	102,402	58,744	22.9
Central, Bonavista	88	93,503	54,521	8.9

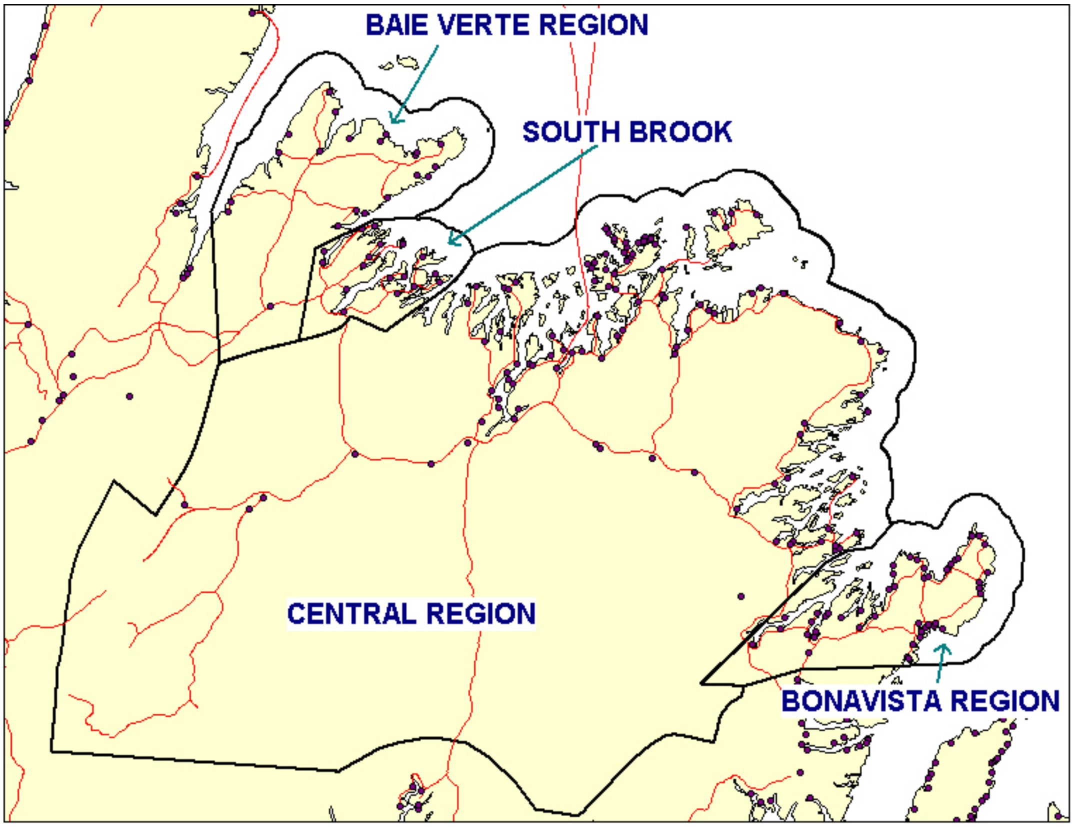

Figure 2-1: Central, Bonavista, South Brook and Baie Verte Regions.

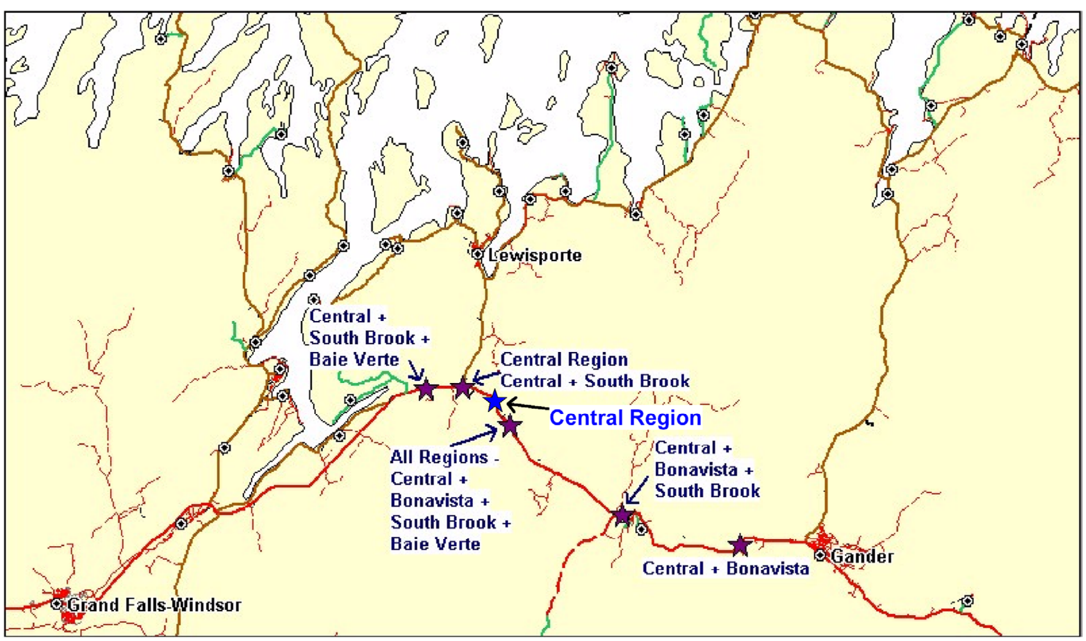

Figure 2-2: Centroid Locations of Various Scenarios.

The analysis shows that including South Brook and Baie Verte will not impact the optimal landfill site location significantly. Bonavista would have a significant impact on the landfill site selection. This impact was reviewed by the CNWMC and the decision was made to consider only the Central Region as per the Terms of Reference.

The sections below are for the Central Region only.

Phase 1 – Preliminary Identification was completed during Phase 1 of the Solid Waste Management Plan. The site selection process applied regulatory and community based constraints to a GIS model. Topographic maps (1:50,000) and the Department of Government Services and Lands provincial land use atlas were used in conjunction with site selection criteria and constraints. Each constraint and criteria were layered on a base map in the GIS model.

Locations that fell within the constraint areas were excluded form the site selection process. Only the areas that fell within the less than 12 percent land slope and soil covered criteria were considered as suitable sites for the waste management facility. This process identified five possible locations where the waste management facility could be located. Figure 2.3 highlights these locations.

Three additional sites were identified during the constraint mapping of the region; one located just east of Eel Pond; and two others in the Shirley Lake Area. However, once the soil cover criteria (2 m – 3 m soil cover) was applied to these sites, the sites were determined to be unsuitable for the development of a landfill facility.

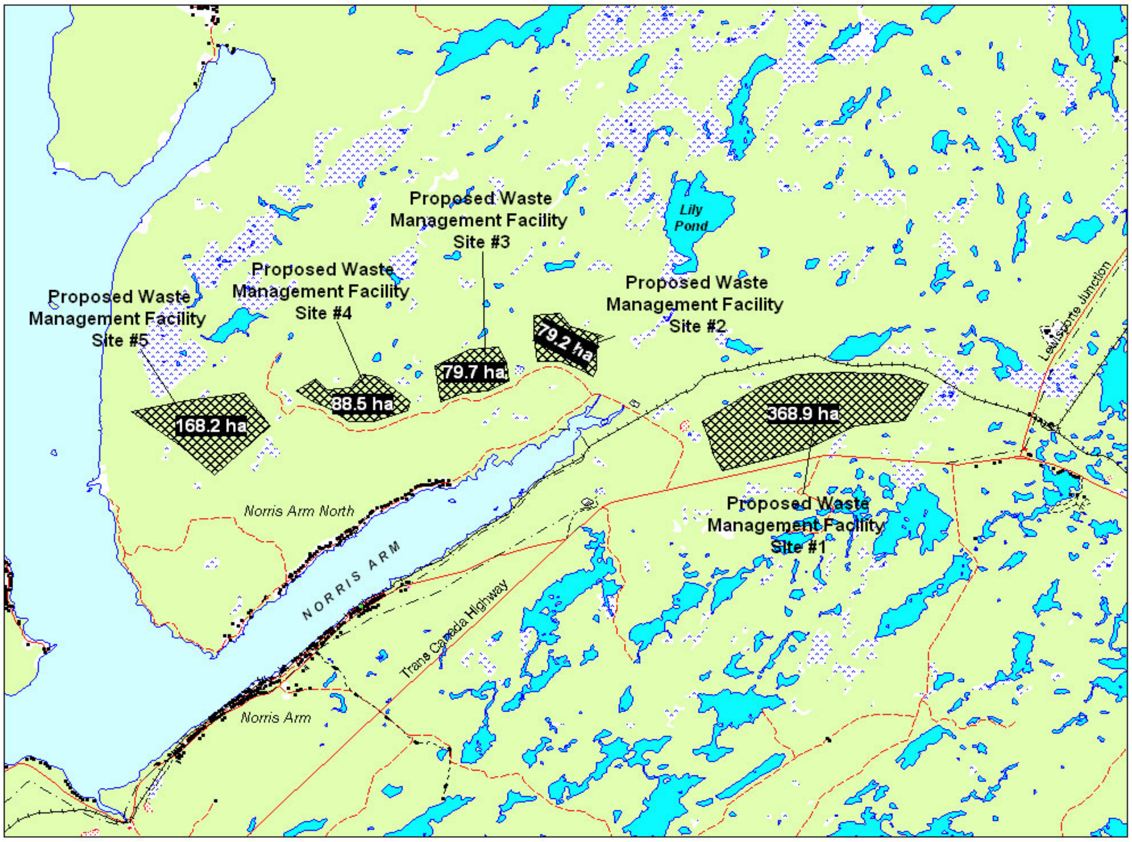

Figure 2.3: Five Proposed Waste Management Facility Locations.

2.2 PHASE 2 - SITE SCREENING - RANKING

A comprehensive set of evaluation criteria has been developed for the site screening process. These evaluation criteria were developed by BAE-Newplan Group in 1996 for the Newfoundland and Labrador Department of Environment in a document titled "Discussion Paper for Preliminary Site Selection of Sanitary Landfills".

Following the identification of the five potential sites, an assessment to rank each location was undertaken. In addition to physical parameters, the ranking system considered the potential impact of a deficiency in the landfill system; for example, impact on water resources. The objective of this phase was to identify, in order of priority, several preferred sites.

Each of the site evaluation factors was assigned a weight based on a scale of 1 to 10. This weight reflects the relative importance of the factor in the development of the site for waste disposal. Each site factor was also designated with a range of scores based on a scale of 1 to 10. The following outline represents the rationale for the weighting and scoring of each site factor. The figures shown for scoring are guidelines, and actual scores may fall between the average scores shown.

2.2.1 FACTORS RELATED TO PUBLIC ACCEPTABILITY & AESTHETICS

Site Visibility (Weight=6)

Ideally, a disposal site should be totally screened from the community, highway, cabins, etc. However, the degree of remoteness and the operating methods lessen the importance of total screening of the site.

Range	Ranking
Not Visible	10
Partially Visible	5
Mostly Visible	1

Forest Coverage (Weight = 3)

Heavy tree cover obviously affects clearing and development costs of the site, and destruction of a forest is not desirable. On the other hand, tree cover surrounding the site can be desirable in reducing visibility, which has advantages from an aesthetic point of view.

Range	Ranking
No Cover	10
Some Cover	5
Heavy Cover	1

Exposure to Climatic Conditions (Weight = 5)

Site exposure requires consideration because the degree of exposure to climatic conditions will affect the efficiency and cleanliness of the operations. To some extent, the degree of exposure can also affect the availability of overburden during winter months. In addition, sites should not be located in areas subject to storm erosion, or sites in close proximity to shoreline features, particularly near bluffs or high shore banks. Also, in-filling of flood plain areas is not acceptable.

Range	Ranking
Sheltered	10
Some Exposure	5
Exposed	1

Prevailing Winds (Weight = 3)

Prevailing winds is an important factor in the selection of a waste disposal site. Many complaints could be expected from residents if prevailing winds are in the direction of populated areas. While this applies more particularly to incineration as opposed to landfill only, potential changes in technologies and long-term methods of disposal at the site require that it be considered in long term planning. The weighting factor would be increased if incineration were included in the waste disposal process.

Range	Ranking
Generally away from developed areas	10
Partially in direction of developed areas	5
Generally in direction of developed areas	1

Conflicting Land Use (Weight = 4)

Present environmental guidelines require that a waste disposal site be at least 1.6 km from existing or proposed developments. This is a very sensitive issue, and increased distance is very desirable when selecting a site that will create minimal impact on adjacent land use. When evaluating this aspect, other conflicting uses such as recreational facilities, cottages, nature parks, etc. must be given consideration.

Range	Ranking
Greater than 2 km	10
Between 1.6 km to 2 km	5
Less than 1.6 km	1

End Use Potential (Weight = 2)

It is being increasingly recognized that selecting, planning and designing a landfill in a manner that would prove compatible with, and be beneficial to its intended end use, is the most cost effective method of preparing the land for future development. For example, closed landfill sites have been converted into municipal golf courses, baseball diamonds, soccer fields, parks, ski and sled runs, etc. An assessment of the end use potential of a site is therefore a consideration.

Range	Ranking
Defined Potential Use	10
Possible Use	5
No potential Use	1

2.2.2 Factors related to Cost of Development, Operations & Long Term Site Flexibility

Haul Distance (Weight = 8)

Realizing the financial restraints of most municipalities in this province, haul distance to the site is very important. Haulage distances should be as time and cost efficient as possible. Sites were pro-rated based on distance from the waste generation centroid.

Range	Ranking
Closest	10
Furthest	1

Site Access (Weight = 6)

The difficulty of constructing an access to the site has a great effect of the capital costs required in initial site construction. The available route and its exposure also affect the maintenance and upkeep of the road, especially during the winter months.

Range	Ranking
Good	10
Fair	5
Difficult	1

Availability of Suitable Cover Material (Weight = 10)

The depth and availability of suitable cover material is of great importance in the selection of a landfill site. Depth of material is a determining factor in calculating the space requirements of the site, and plays a major role in capital and operating cost.

Range	Ranking
Greater than 3 m	10
Between 1.5 m to 3 m	5
Less than 1.5 m	1

Life Expectancy (Weight = 10)

Care must be taken in the selection of a waste disposal site to ensure that sufficient area is available for long-term usage. Estimates of cumulative waste volumes would be necessary to ensure adequate land area is available.

Range	Ranking
50 years	10
20 years	5
5 years or less	1

Land Ownership (Weight = 8)

Ownership of lands being considered for a waste disposal site and those within a 1.6 km radius may introduce significant development costs. Land value and extent of private ownership requires assessment. Preferable, sufficient crown or municipal lands can be sourced to meet long-term needs.

Range	Ranking
Crown/Municipal Lands	10
Partial Private Lands	5
Majority Private Land of High Value	1

Fire Protection (Weight = 4)

Ideally, the site should be accessible to a small stream or pond to facilitate possible fire fighting which may be required. The proximity to water must be carefully weighed in conjunction with the environmental factors, and the ideal situation would be to have a water body that is higher in elevation than the disposal area.

Range	Ranking
Good	10
Fair	5
Poor	1

Slope (Weight =10)

Average slopes across the land area are an important factor when considering the proper development and management of a sanitary landfill site. Excessive slopes greater than 10% – 12% would cause drainage and erosion problems and make control of any leachates difficult. Also, steep slopes can increase operational and visual problems.

Range	Ranking
1% to 6%	10
6% to 12 %	5
Over 12%	1

Site Drainage Considerations (Weight = 10)

Minimizing and controlling leachates must be a high priority in the selection and operation of a site. Precipitation provides the major transport phase for leachate and contaminant migration from a landfill site. Although some moisture may be derived from the wastes that are being handled, the primary precursor to leachate formation is the infiltration from rainfall or snowmelt. Therefore, controlling the amount of infiltration into the refuse has the greatest effect on leachate production. Controlling surface drainage can control by carefully selecting cover material, cover slope, final cover and vegetation, and infiltration. The degree of compaction also affects leachate generation. However, it is imperative that off-site surface water be diverted away from the site.

Range	Ranking
Good Diversion of Off-Site Drainage	10
Somewhat Difficult Diversion of Off-Site Drainage	5
Difficult Diversion of Off-Site Drainage	1

2.2.3 RESULTS OF THE SITE SCREENING

Tables 2-2 to 2-6 on the following pages, provide the resulting scores for the five (5) sites under consideration. Table 2-7 provides an overall summary comparison and ranking of all six potential sites. Proposed sites 1, 2, and 4 scored the highest at 736, 634 and 605, respectively. Based on these scores it is recommended that these three sites warrant financial investigation to determine which site is most cost effective.

Table 2-2: Proposed Waste Management Facility Site # 1

CRITERIA	DESCRIPTION	SCORE
Visibility	Site may be partially visible from the Trans Canada Highway.	5
Forest Coverage	A review of the aerial photography revealed that approximately 70% of the site is forested.	3
Exposure	Forest coverage in areas. Partially sheltered.	7
Prevailing Winds	Prevailing winds in South West direction. Blowing away from the communities of Norris Arm and Norris Arm North. Winds blowing toward Lewisporte which is approximately 10 km away. Limited problem.	10
Conflicting Land Use	Located approximately 4 km from Norris Arm North.	10
End Use Potential	Due to the remoteness of the site, there is limited potential for future development of the decommissioned landfill.	1
Haul Distance	Haul distance from the centroid was weighted for all five site. This site was deemed to be ranked 1 out of 5, therefore received a score of 10.	10
Site Access	The site can be accessed by the construction of a 0.5 km access road from an existing Norris Arm North road.	10
Cover Material	2.0 – 3.0 m.	5
Life Expectancy	50 years.	10
Land Ownership	The site is located on crown lands.	10
Fire Protection	There is a pond available slightly downgrade of the site.	5
Slope	The overall slope of the site is between 1% to 6%.	10
Drainage	Offsite drainage is generally away from the site. Most drainage is intercepted by the Trans Canada Highway.	10
	TOTAL	**736**

Table 2-3: Proposed Waste Management Facility Site # 2

CRITERIA	DESCRIPTION	SCORE
Visibility	Site maybe partially visible from the existing Norris Arm North Road.	1
Forest Coverage	A review of the aerial photography revealed that approximately 80% of the site is forested.	2
Exposure	Mostly forested. Mainly sheltered.	8
Prevailing Winds	Prevailing winds in South West direction. Blowing away from the communities of Norris Arm and Norris Arm North. Winds blowing toward Lewisporte which is approximately 14 km away. Limited problem.	10
Conflicting Land Use	Located approximately 3.2 km from Norris Arm North.	10
End Use Potential	Due to the remoteness of the site, there is limited potential for future development of the decommissioned landfill.	1
Haul Distance	Haul distance from the centroid was weighted for all five site. This site was deemed to be ranked 2 out of 5, therefore received a score of 8.	8
Site Access	The site can be accessed by the construction of a 0.2 km access road from an existing 0.5 km gravel road and a 2.5 km paved road.	10
Cover Material	2.0 – 3.0 m.	5
Life Expectancy	50 years.	9
Land Ownership	The site is located on crown lands.	10
Fire Protection	There is a stream available slightly downgrade of the site.	4
Slope	The overall slope of the site is between 1% to 6%.	10
Drainage	The site is located on the side of a hill. Some drainage through the site.	5
	TOTAL	**634**

Table 2-4: Proposed Waste Management Facility Site # 3

CRITERIA	DESCRIPTION	SCORE
Visibility	Site not visible from the existing Norris Arm North Road. Norris Arm North approximately 2.0 km from site.	4
Forest Coverage	A review of the aerial photography revealed that approximately 80% of the site is forested.	2
Exposure	Mostly forested. Mainly sheltered.	8
Prevailing Winds	Prevailing winds in South West direction. Blowing away from the communities of Norris Arm and Norris Arm North. Winds blowing toward Lewisporte which is approximately 14 km away. Limited problem.	10
Conflicting Land Use	Located approximately 2 km from Norris Arm North.	5
End Use Potential	Due to the remoteness of the site, there is limited potential for future development of the decommissioned landfill.	1
Haul Distance	Haul distance from the centroid was weighted for all five site. This site was deemed to be ranked 3 out of 5, therefore received a score of 6.	6
Site Access	The site can be accessed by the construction of a 0.15 km access road from an existing 2.8 km gravel road and a 2.5 m paved road. The 2.8 km gravel road would require some upgrade construction.	6
Cover Material	2.0 – 3.0 m.	5
Life Expectancy	50 years.	9
Land Ownership	The site is located on crown lands.	10
Fire Protection	There are some small ponds available at the same elevation.	7
Slope	The overall slope of the site is between 1% to 6%.	10
Drainage	The site is located on the side of a hill. Drainage would be through the site.	4
	TOTAL	**594**

Table 2-5: Proposed Waste Management Facility Site # 4

CRITERIA	DESCRIPTION	SCORE
Visibility	Site not visible from the existing Norris Arm North Road. Norris Arm North approximately 2.0 km from site.	3
Forest Coverage	A review of the aerial photography revealed that approximately 75% of the site is forested.	3
Exposure	Mostly forested. Mainly sheltered.	8
Prevailing Winds	Prevailing winds in South West direction. Blowing away from the communities of Norris Arm and Norris Arm North. Winds blowing toward Lewisporte which is approximately 16.5 km away. Limited problem.	10
Conflicting Land Use	Located approximately 2 km from Norris Arm North.	5
End Use Potential	Due to the remoteness of the site, there is limited potential for future development of the decommissioned landfill.	1
Haul Distance	Haul distance from the centroid was weighted for all five site. This site was deemed to be ranked 4 out of 5, therefore received a rank of 4.	4
Site Access	The site can be accessed by the construction of a 0.23 km access road from an existing 3.5 km gravel road and 2.5 m paved road. The 3.5 km gravel road would require some upgrade construction.	4
Cover Material	2.0 – 3.0 m.	5
Life Expectancy	50 years.	8
Land Ownership	The site is located on crown lands.	10
Fire Protection	There are several small ponds available at a slightly lower elevation.	5
Slope	The overall slope of the site is between 1% to 6%.	10
Drainage	Offsite drainage is generally away from the site.	10
	TOTAL	**605**

Table 2-6: Proposed Waste Management Facility Site # 5

CRITERIA	DESCRIPTION	SCORE
Visibility	Site not visible from the existing Norris Arm North Road. Norris Arm North approximately 2.2 km from site.	2
Forest Coverage	A review of the aerial photography revealed that approximately 80% of the site is forested.	2
Exposure	Mostly forested. Mainly sheltered.	8
Prevailing Winds	Prevailing winds in South West direction. Blowing away from the communities of Norris Arm and Norris Arm North. Winds blowing toward Lewisporte which is approximately 19 km away. Limited problem.	10
Conflicting Land Use	Located greater the 2 km from Norris Arm North.	10
End Use Potential	Due to the remoteness of the site, there is limited potential for future development of the decommissioned landfill.	1
Haul Distance	Haul distance from the centroid was weighted for all five site. This site was deemed to be ranked 5 out of 5, therefore received a score of 2.	2
Site Access	Furthest site from the Trans Canada Highway. Would require upgrade of 4.5 km of gravel road and construction of 0.5 km of road.	2
Cover Material	2.0 – 3.0 m.	5
Life Expectancy	50 years.	8
Land Ownership	The site is located on crown lands.	10
Fire Protection	Nearest source of water is approximately 1 km downgrade of the site.	5
Slope	The overall slope of the site is between 1% to 6%.	10
Drainage	Offsite drainage is generally away from the site.	8
	TOTAL	**568**

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Table 2-7: Preliminary Site Screening of Potential Landfill Sites

Factors		Weight	Site # 1		Site # 2		Site # 3		Site # 4		Site # 5	
			Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score
Related to Public Acceptability and Aesthetics												
1	Visibility	6	5	30	1	6	4	24	3	18	2	12
2	Forest Coverage	3	3	9	2	6	2	6	3	9	2	6
3	Exposure	5	7	35	8	40	8	40	8	40	8	40
4	Prevailing Winds	3	10	30	10	30	10	30	10	30	10	30
5	Conflicting Land Use	4	10	40	10	40	5	20	5	20	10	40
6	End Use Potential	2	1	2	1	2	1	2	1	2	1	2
Related to Cost of Development, Operations and Long Term Site Flexibility												
7	Haul Distance	8	10	80	8	64	6	48	4	32	2	16
8	Site Access	6	10	60	10	60	6	36	4	24	2	12
9	Cover Material	10	5	50	5	50	5	50	5	50	5	50
10	Life Expectancy	10	10	100	9	90	9	90	8	80	8	80
11	Land Ownership	8	10	80	10	80	10	80	10	80	10	80
12	Fire Protection	4	5	20	4	16	7	28	5	20	5	20
13	Slope	10	10	100	10	100	10	100	10	100	10	100
14	Drainage	10	10	100	5	50	4	40	10	100	8	80
	TOTAL SCORES			736		634		594		605		568
		SITE RANKING	1		2		4		3		5	

Example: Evaluation of Site #3 for haul distance indicates a score of 6 on a scale of 1 to 10. Since haul distance was assigned a weight of 8 on a scale of 1 to 10 the weighted score of the Site #3 for haul distance is 6 x 8 = 48. The weighted score for each factor is added to obtain the total weighted score for each site.

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2.3 PHASE 3 – PRELIMINARY FINANCIAL INVESTIGATION

Based on the results of the preliminary site ranking, it is recommended that proposed sites 1, 2, and 4 warrant financial investigation to determine which sites are most cost effective. The objective of this phase is to identify the two most feasible sites for the location of the waste management facility.

A comprehensive set of evaluation criteria has been developed for the financial site screening process. Following the identification of the three potential sites, an assessment to rank the feasibility of each location was undertaken. The financial ranking system considered such criteria as the costs associated with the construction of the access road, stream crossings, drainage diversion, connecting site to three-phased power and telephone lines, pump house and waterlines required for fire protection, and etc. Infrastructure costs associated with the construction of the landfill cells, public drop-off areas, composting facility, materials recovery facility and etc. were not included as part of the financial investigation. These costs were considered to be equal for all three proposed sites.

2.3.1 PROPOSED SITE # 1

Proposed site #1 is located approximately 2.0 km east of Norris Arm Harbour and covers an area of 368.9 ha. It was ranked the highest during the Phase II ranking process with a score of 736. Table 2-8 provides the results of the financial analysis for site #1.

Table 2-8: Financial Analysis for Proposed Waste Management Facility Site #1.

CRITERIA	DESCRIPTION	ESTIMATED COST
Site Access Road	The site can be accessed by the construction of a 0.5 km access road from an existing 0.750 km Norris Arm North paved road. It was assumed that the cost of constructing and paving of the access road is $100,000/km.	$50,000
Stream Crossings	A review of topographic maps and aerial photographs revealed that there are no streams in the vicinity of the proposed access road.	$0
Tree Clearing	A review of the aerial photography revealed that approximately 70% of the site is forested. It was assumed that the size of the WMF will be approximately 50 ha and the cost of tree clearing will be $2,500/ha. Since approximately 70% of the site is considered to be tree covered, 35 ha will need to be cleared.	$87,500
Three-Phase Power	Three-phased power is available at Norris Arm North at a distance of 2.42 km from the site. The cost estimate is based on a 20 KW Load.	$99,000

CRITERIA	DESCRIPTION	ESTIMATED COST
Telephone Lines	Aliant Telecom was contacted to provide an estimate of providing telephone services to the site. The cheapest alternative was to provide the service from the Lewisporte Junction Region. The quote was based on a distance of 5 km from the nearest telephone connection.	$53,300
Fire Protection (Pump House and Waterline)	There is a pond available slightly downgrade (1.3 km) of the site. The site will likely require a pump house and approximately 1.5 km of waterline to provide adequate water for fire protection. It is assumed that the cost of the pump house will be approximately $350,000 and the waterline $250/m.	$675,000
Drainage Diversion	Offsite drainage is generally away from the site. Most drainage is intercepted by the Trans Canada Highway. To prevent onsite drainage, the site will require approximately 1.15 km of drainage channels at a estimated cost of 100,000/km.	$115,000
Annual Transportation Cost	The cost provided includes the total transportation cost of transporting waste from the local waste management facilities to the WMF using **53 ft trailers.** Costs comparisons of using roll-off bins, transtor bins, and 53 ft trailers, are provided in Section 5.2.	$414,186
	Total	**$1,493,986**

2.3.2 PROPOSED SITE # 2

Proposed site #2 is located approximately 1.0 km north of Norris Arm Harbour and covers an area of 79.2 ha. It was ranked second highest during the Phase II ranking process with a score of 634. Table 2-9 provides the results of the financial analysis for site #2.

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Table 2-9: Financial Analysis for Proposed Waste Management Facility Site #2.

CRITERIA	DESCRIPTION	ESTIMATED COST
Site Access Road	The site can be accessed by the construction of a 0.2 km access road from an existing 0.5 km gravel road and 2.5 km paved road. It was assumed that the cost of constructing and paving of the access road is $100,000/km and the cost of upgrading and paving the existing gravel road is $75,000/km.	$57,500
Stream Crossings	A review of topographic maps and aerial photographs revealed that there are no streams in the vicinity of the proposed access road.	$0
Tree Clearing	A review of the aerial photography revealed that approximately 80% of the site is forested. It was assumed that the size of the WMF will be approximately 50 ha and the cost of tree clearing will be $2,500/ha. Since approximately 80% of the site is considered to be tree covered, 40 ha will need to be cleared.	$100,000
Three-Phase Power	Three-phased power is available at Norris Arm North at a distance of 2.34 km from the site. The cost estimate is based on a 20 KW Load.	$95,000
Telephone Lines	Aliant Telecom was contacted to provide an estimate of providing telephone services to the site. The cheapest alternative was to provide the service from the Lewisporte Junction Region. The quote was based on a distance of 7 km from the nearest telephone connection.	$125,000
Fire Protection (Pump House and Waterline)	The site is located 1 km upgrade of Norris Arm Harbour. The site will require a pump house and approximately 1 km of stainless steel waterline to provide adequate water for fire protection. It is assumed that the cost of the pump house will be approximately $350,000 and the waterline $270,000/km.	$620,000
Drainage Diversion	The site is located on the side of a hill. There is some drainage through the site. To prevent onsite drainage, the site will require approximately 1.2 km of drainage channels at a estimated cost of 100,000/km.	$120,000
Annual Transportation Cost	The cost provided includes the total transportation cost of transporting waste from the local waste management facilities to the WMF using **53 ft trailers.** Costs comparisons of using roll-off bins, transtor bins, and 53 ft trailers, are provided in Section 5.2.	$423,650
	Total	**$1,541,150**

2.3.3 PROPOSED SITE # 4

Proposed site #4 is located approximately 2.0 km north of Norris Arm Harbour and covers an area of 88.5 ha. It was ranked third highest during the Phase II ranking process with a score of 605. Table 2-10 provides the results of the financial analysis for site #4.

Table 2-10: Financial Analysis for Proposed Waste Management Facility Site #4.

CRITERIA	DESCRIPTION	ESTIMATED COST
Site Access Road	The site can be accessed by the construction of a 0.23 km access road from an existing 3.5 km gravel road and 2.5 km paved road. It was assumed that the cost of constructing and paving of the access road is $100,000/km and the cost of upgrading and paving the existing gravel road is $75,000/km.	$285,500
Stream Crossings	A review of topographic maps and aerial photographs revealed that there are no streams in the vicinity of the proposed access road.	$0
Tree Clearing	A review of the aerial photography revealed that approximately 75% of the site is forested. It was assumed that the size of the WMF will be approximately 50 ha and the cost of tree clearing will be $2,500/ha. Since approximately 75% of the site is considered to be tree covered, 37.5 ha will need to be cleared.	$93,750
Three-Phase Power	Three-phased power is available at Norris Arm North at a distance of 1.55 km from the site. The cost estimate is based on a 20 KW Load.	$64,000
Telephone Lines	Aliant Telecom was contacted to provide an estimate of providing telephone services to the site. The cheapest alternative was to provide the service from the Lewisporte Junction Region. The quote was based on a distance of 9 km from the nearest connection.	$160,000
Fire Protection (Pump House and Waterline)	There are several small ponds available slightly downgrade (0.8 km) from the site. The site will require a pump house and approximately 0.8 km of waterline to provide adequate water for fire protection. It is assumed that the cost of the pump house will be approximately $350,000 and the waterline $250,000/km.	$550,000
Drainage Diversion	Drainage is generally away from the site with little onsite drainage. To prevent onsite drainage, the site will require approximately 1.2 km of drainage channels at a estimated cost of 100,000/km.	$120,000

CRITERIA	DESCRIPTION	ESTIMATED COST
Annual Transportation Cost	The cost provided includes the total transportation cost of transporting waste from the local waste management facilities to the WMF using **53 ft trailers.** Costs comparisons of using roll-off bins, transtor bins, and 53 ft trailers, are provided in Section 5.2.	$438,356
	Total	**$1,711,606**

<u>Summary of Preliminary Financial Investigation</u>:

- Site #1 = **$1,493,986**
- Site #2 = **$1,541,150**
- Site #3 = **$1,711,150**

2.4 PHASE 4 – DETAILED INVESTIGATION

Based on the results of the site screening and preliminary financial investigation, Site #1 was selected for further detailed investigations. The investigation included a multi-discipline investigation of the site. The objective of the investigation was to augment the data generated at the site screening stage of the study, and to collect sufficient additional data to allow a feasibility assessment the site. The objective of the detailed investigations will be to identify any physical or ecological factors that may preclude the site from further consideration and support the selection of a preferred site. The components of the investigation are listed below:

- Site Development Concept;
- Land Use Conflicts;
- Archaeological;
- Receiving Water;
- Geotechnical; and
- Hydrogeology.

This investigation also included the confirmation of information collected during the site screening and ranking process, and review the information gathered from published sources on regional characteristics. Discussions with municipal and provincial representatives was undertaken to gather information on site development issues and land use. Other information will be collected from mapping and provincial databases, and the intrusive sampling of site soils and waters.

The intrusive investigation included site visits to confirm physical characteristics, habitat types, and sites of archaeological significance or interest. A biological survey was completed to determine the presence/absence of rare and/or endangered species.

The assessment of soil depths and characteristics was carried out by the construction of test pits. The geo-technical report prepared by Newfoundland Geosciences Limited, is provided in Volume 2, Appendix A.

2.4.1 Terrestrial and Aquatic Environment

The survey was conducted on September 12, 2003. The Biological Reconnaissance Survey report prepared by Jacques Whitford Environment Limited, is provided in Volume 2, Appendix B.

The site comprised a mix of forest and wetland areas that are flat and gently sloping in a northern direction. The site has been extensively disturbed by past forest harvesting activity. The most recent cutovers on the western end of the site are estimated to be in the order of five years old; older cutting activity, on the eastern end of site, may be upwards of 80 years old. With the removal of the conifers, the remaining hardwoods have developed into healthy stands of white birch and red maple. Generally, the softwoods have not extensively regenerated, although extensive alder beds have developed in some areas.

Interspersed among the forested areas are wetland features that are predominantly sloped fens. Compared to bog, fens are relatively nutrient-rich due to inputs of surface water draining from upland areas. Fens tend to support a higher proportion of grasses and sedges rather than sphagnum mosses that are generally associated with more nutrient-poor bogs.

Three small streams that are not shown on 1:50,000-scale topographic mapping were found. All three are very small (i.e., < 1 metre wide) and flowed in a northward direction through areas of fen or alders.

The area is used extensively by moose as the combination of cutovers and fens provide suitable habitat for this species. Moose beds (i.e., sites where an individual moose bedded down for the night) were found along the edges of several fens. Moose droppings and trails were found throughout the site. Other evidence of wildlife included fox and snowshoe hare scat and red squirrel were seen and heard.

Birds observed included boreal chickadee, American crow and common flicker. The history of forest harvesting and the relative diversity of the site combine to create a variety of habitats (i.e., hardwood stands, residual softwood, alder beds). During the breeding season, these habitats may support bird species that would otherwise not be found in a typical black spruce forest. This could only be confirmed by conducting surveys at the appropriate time of year (early June).

In summary:

1. There may be an issue with the small streams observed on the site. DFO will want to know if they are fish habitat in reference to their no net loss guiding principle for habitat conservation. Based on our observations, the streams are suitable habitat for brook trout, but none were observed and it has not been determined if any are present. Water Resources Management Division of DOE will also require permitting for any work within 15 m of a water body or wetland, so further delineation of these features may be required.

2. There were no obvious issues with wildlife or avifauna determined from the site visit.

3. The vegetation types are typical of cut-over areas, and no issues were identified in that respect.

2.4.2 Site Geology

The fieldwork for this investigation was completed during the period of September 25-29, 2003. A total of thirty eight test pits were completed at location shown on the site location plan (Drawing No. NFS09711-GE-01) located in Volume 2, Appendix C.

The test pits were completed using a Hitachi EX200LC excavator, supplied by A and B Construction Limited, to depths ranging from 2.0 to 5.5 m below ground surface. The field work was conducted under the supervision of an engineering geologist who maintained detailed logs and obtained representative samples of the various strata encountered. All soil samples were stored in moisture proof containers.

Test pit locations were selected and established in the field, based on maximum, evenly spaced coverage for a four to five day work program. The locations and elevations were provided with the aid of a Garmin 12XL GPS, aerial photographs, and topographic maps. The GPS elevation and coordinate information is referenced to North American Datum 1983 (NAD 83), UTM Zone 21, and location information has a probable accuracy of +/- 25 m. Elevation data provided on the Test Pit Records may vary significantly from actual elevations.

Organics/Sand/Silt

A thin layer of dark brown to black, soft compressible peat and rootmat was encountered at the surface at all test pit locations. The stratum ranged in thickness from 0.1 m (thin rootmat) to 1.2 m (peat/bog).

At most test pit locations a variable layer of silt, sand and organic matter was encountered beneath surficial peat, rootmat, and bog. This stratum was noted to vary in colour (orange-brown, brown, grey), and contain occasional to some cobbles and boulders. The thickness of these materials ranged from 0.3 – 1.3 m at the test pit locations, and based on direct inspection was classified as loose to compact.

Till

A layer of silty sand to silty sand with gravel glacial till, with occasional cobbles and boulders was found at all test pit locations, and noted to extend to depths of 5.5 m. Based on direct inspection in the test pits the relative density of this stratum is classed as compact to dense, with occasional very dense sections.

Gradation analysis completed on ten representative samples of the till material obtained during this investigation indicated the following average group percentages: 17.4% gravel (range 0.9 to 39.9%); 47.7% sand (range 32.8 to 59.4%); and 34.8% silt/clay (range 20.5 to 59.4%). Atterburg Limits determinations completed on four samples indicate the fines portion of the material non-plastic (high silt content). The average moisture content of the samples tested was approximately 10.9 %.

Bedrock

Inferred bedrock was found at 20 of the 38 test pit sites at depths ranging from 0.6 to 5.2 m below surface. Bedrock was inferred by excavation refusal, no coring of the bedrock was completed. The bedrock is comprised of sandstone, siltstone and conglomerate of the Badger Group. IN general, excavation of small surficial pieces of bedrock was possible, however at test pit TP3, excavation of the bedrock was possible to approximately 1.8 m below the bedrock surface. Based on limited visual inspection within the test pit excavations, the bedrock was observed to be severely fractured to moderately jointed.

Groundwater

Groundwater was encountered at 31 of the 38 test pit locations at depths ranging from 0.4 to 4.4 m below ground surface. Test pits were not left open long enough for groundwater to stabilize. Groundwater levels may fluctuate seasonally and in response to precipitation events.

2.4.3 Hydrogeological Characteristics

Jacques Whitford Environmental Limited (JWEL) was retained by BAE Newplan Group Limited in October 2003, to conduct a Hydrogeological Assessment at the proposed Waste Management Facility located east of Norris Arm, Newfoundland and Labrador (NL). The main objective of the study was to evaluate the hydrogeological conditions underlying the proposed site, and assess the potential for impacts on local groundwater resources resulting from the proposed development.

The results of the study indicated that, based on the available data concerning the underlying soil and groundwater conditions, the area immediately surrounding the proposed waste management facility had a moderate to high susceptibility for impacts from the operation of the facility. However, the community of Norris Arm North is located approximately 4 km west of the proposed site (Site #1) and is located on the opposite side of the catchment area. Groundwater flow in the area surrounding the community of Norris Arm North would be characterized by recharge fro m the topographic high to the north and would not be influenced by the area surrounding the proposed waste management facility. Refer to Volume 2, Appendix D for more details.

2.4.4 Sites of Archaeological or Special Interest

Jacques Whitford Environmental Limited (JWEL) was retained by BAE Newplan Group Limited in August 2003, to conduct a Historical Resources Assessment at the proposed Waste Management Facility located east of Norris Arm, Newfoundland and Labrador (NL).

JWEL completed the field component of the Stage 1 Historical Resources Overview Assessment (HROA) on September 5 and 6, 2003. Field work included archaeological surveys and subsurface testing. The study team was composed of Yves Labreche, archaeologist and permit holder, and archaeologist Roy Skanes, field co-researcher.

As discussed with the proponent, the study area for this work included the western part of a proposed Waste Management Facility (Site # 1), or approximately 100 hectares of land. The area is located east of the community of Norris Arm, between the Trans Canada Highway (south) and an abandoned railway track now concerted into a trail (north). The western boundary of the study area includes an existing borrow pit.

Fieldwork involved three task:

1. Discussion with selected residents about land use and the natural environment;
2. A ground survey and surface inspection of the entire area; and
3. Close surface inspection and subsurface testing, where appropriate.

Physical attributes of the study area such as vegetation cover, wildlife, landforms, soil, and evidence of land use were noted and several photographs were taken. UTM coordinates were recorded with a GPS (Geographic Positioning System) hand-held unit at 19 survey and subsurface testing locations. A total of six test pits were excavated and the level of effort for this program was considered to be adequate.

No historic resources were discovered during the assessment and it is concluded that the historic resources potential of the study area is low.

Based on the findings of the historic resource study, it is recommended that the proponent should be allowed to proceed with the development of the waste management facility. See Volume 2, Appendix E for further details.

2.4.5 PROVINCIAL LAND USE RESTRICTIONS

The site screening investigation also included a search of potential provincial land-use restrictions that may apply to proposed Sites #1 and #2. The following stakeholders were contacted and their comments are summarized below and provided in Volume 2, Appendix F of this report:

- **Robert Wight, Department of Pollution Prevention**
  It appears that Site #2 slightly overlaps the boundaries of the area proposed watershed area of the Local Service District of Norris Arm North. Recommendation of Site #1 over Site #2.

- **Wayne E. Ricks, P.Eng., Department of Works Services and Transportation**
  The proposal has been reviewed by the Department and from a roads point of view, there are no objections.

- **Charlie Butler, Department of Forest Resources and Agrifoods**
  There are no concerns identified for either site from a Agrifoods perspective. However, from a forestry perspective, both sites contain merchantable timber. Both areas are within domestic cutting zones and the area chosen would result in and equivalent loss to the domestic cutters. There is also a small plantation bordering Site #1, therefore should be excluded from the proposed site. Also, approximately half of Site #1 contains timber licensed to Corner Brook Pulp and Paper. The company should be contacted regarding this proposal.

2.5 SUMMARY OF SITE SUITABILITY AND SELECTION OF PREFERRED SITE

Site #1 has undergone both a screening level and intermediate level site investigation to collect sufficient data to assess the site for potential use as a regional waste management facility. The collective results of these studies support an informed opinion on the suitability of the site. A brief discussion of the results of the assessment is provided below.

The subject property meets the size and location criteria established by the committee for development of regional facility. The site has a sufficient buffer zone from residential wells. The site access alternatives appear feasible and will not interfere with planned development in the area.

There were no unique habitats identified on the site and the wetland areas are not considered to be restrictive. Small streams (< 1m) were identified on the site which may be suitable habitat for brook trout, but none were observed. Further investigation may be required to ascertain if these are fish bearing streams. However, this does not preclude development as fish bearing habitat can be created elsewhere to meet the DFO no net loss principle for habitat conservation. There were no rare or endangered plants or animal species identified during the investigation that would represent a constraint to development.

The overburden strata consists primarily of organic soils and silty sands overlying sandy glacial till and bedrock. Bedrock was encountered between 0.6 and 5.2 metres below grade. Bedrock was observed to be sandstone, siltstone, and conglomerate of the Badger Group. Also, was observed to be severely fractured to moderately jointed. Groundwater was observed between 0.4 and 4.4 metres below grade. The geologic and hydrologic conditions do not preclude development, however the high groundwater table and bedrock outcrops will require considerable site grading and drainage to facilitate the construction of a liner and leachate management system.

The site investigation did not reveal any potential archaeological or heritage features. The site screening investigation has revealed some provincial land-use restrictions with regards to forest resources, but due to the mass size of the site, it is likely that these land-use restrictions can be avoided.

In general, the investigations indicate that the biophysical features of the site will not restrict development for a regional waste management facility. The geologic and hydrologic conditions will require additional engineering and capital costs to be incurred. The investigation has established that Site #1 meets all of the technical criteria required for further consideration as the preferred site of the regional waste management facility.

3.0 ALTERNATIVE APPROACHES TO ENGINEERED LANDFILL

This section includes a discussion on alternative approaches to an engineered landfill including such factors as: amount of land needed for a 50 year capacity, high water table, cover material, bale fill or in-cell compaction, and other designs, construction and operational parameters. Supporting information gathered from suppliers and manufacturers on technologies being applied to landfill operations is provided in Volume 2, Appendix G.

3.1 LANDFILL DESIGN ALTERNATIVES

Landfills are designed to maximize the disposal volume and minimize the landfill area. Increasing the density of the refuse, minimizing the cover systems, and optimizing the design of the landfill to utilize site-specific topographic conditions achieve maximizing disposal volume. Conventional fill and cover landfills are the most common approaches. The compaction of refuse may be achieved by the normal traffic over the site, or by mechanical compaction equipment designed for this purpose. Compaction equipment includes rollers fitted with sheep foot or pad compactors. Mechanical compaction is effective and typically increases refuse density to approximately 700 kg/cubic meter[4].

Bale-fill systems, daily cover alternatives, and the size of individual cells can provide reduction of volume in engineered landfills. These options also offer other potential benefits such as reduced transportation costs, easier handling and storage, reduction of leachate and landfill gas generation, and reduction of odour and vector problems. The following sections provide a summary of landfill design alternatives.

3.2 BALE-FILL LANDFILLING

Conventional landfills require large land areas to accommodate the volume requirements associated with uncompacted waste. In addition, these landfills have historically been associated with odour problems, fire risk, and unacceptable environmental conditions. Bale-fill landfills can reduce and/or eliminate many of these problems.

Bale-filling systems can be used for both inorganic and organic wastes. Bale filling reduces the volume of wastes by compaction. The reduced waste volume and the uniform brick shape of the bales allows for the greater utilization of landfill space, which translates into potential cost savings. In a typical bale system, the waste is compressed mechanically in a processing building into airtight bales and then wrapped with stretch plastic film. The

[4] Per. Com. Otter Lake Landfill Operations.

film lowers oxygen and water intake into solid waste, thereby reducing the potential for leachate production within the landfill from fermentation and degradation. Other operational advantages of bale-fill landfills include:

- Preservation of waste material properties;
- Reduction of odour and landfill gas;
- Less fire risk;
- Reduction of landfill leachate generation;
- Easy handling and storage; and
- No landfill compaction equipment required.

Other potential financial benefits arising from the use of a bale-fill system include:

- Savings in waste grading and compaction costs;
- Reduction in overall land requirements;
- Possible elimination of daily cover requirement if plastic wrap is used;
- More efficient development of the working face; and
- Reduction in traffic vector problems.

Disadvantages of the system include:

- Higher capital cost, when compared to traditional in-place compaction;
- Does not offer significant volume savings;
- An on-site building would be required to accommodate the processing unit;
- Individual bales accommodate approximately 1 tonne of waste, this requires transportation and storage of 250-300 bails/day;
- Although vehicle compaction equipment would not be required, the purchase of a specialized landfill equipment would be needed to store the bails within landfill cells; and
- Lifespan of baler is approximately 10-15 years.

Bale fill systems offer the greatest potential benefit where land area is at a premium and where transportation and storage are high priorities. According to industry sources (Machinex Recycling Technologies), the greatest volume reduction is achieved in wastes with high organic content, a bale fill system is not expected to offer significant volume savings (when compared to compaction values in a conventional landfill) after the organic content of the MSW is removed. Bale fill technologies also require higher capital investment compared to fill and cover systems; conversely, bale fill operational costs are typically lower.

Where land is available at a reasonable cost, research and practical experience supports a conclusion that the marginal volume reduction offered by bale fill technologies would not translate into a significant capital cost savings over the 50-year life of the landfill. Information received from Machinex Recycling Technologies is presented in Appendix F.

3.3 ALTERNATIVE DAILY COVER SYSTEMS

Alternative cover systems offer significant volume reduction compared to conventional soil cover. These systems increase the available disposal volume, extending the life of the landfill, and offer potential cost savings. Typical alternative cover systems include: synthetic covers, stabilized organic waste, lime and organic slurries, and various tarping options.

Synthetic Covers

Synthetic materials such as polystyrene and polymer plastics similar in nature to typical household plastic food wraps, have been used successfully as a daily cover on municipal landfills. Synthetic covers are manufactured specifically for this purpose. The synthetic covers are typically manufactured from recycled plastics and degrade readily in the landfill. The synthetic covers are available in bulk roles that are applied by special rollers attached to the compaction equipment. The synthetic covers are designed as a temporary daily cover and are not suitable for material segregation, hydraulic barriers, or for long-term exposed cover. Synthetic covers are prone to puncture by sharp waste materials are easily breached by vectors. Synthetic covers are most useful where landfill volumes are at a premium, where active cells are small, and where final landfill grading includes a soil liner.

Stabilized Organic Waste

The utilization of stabilized organic waste (compost) for landfill cover has proven successful at several large municipal facilities. The Otter Lake facility in Nova Scotia (Halifax Regional Municipality) uses stabilized organic municipal waste as cover material. The organic waste is separated from the general municipal garbage and composted on-site. In Nova Scotia, the separated organic waste material is considered a recycled material and counts towards waste diversion objectives. The stabilized organic material is a very poor quality compost but has little odour and does not attract vectors. The material serves as an excellent cover material, effectively reducing odours, wind blown garbage, and provided very good erosion control. Factors influencing the selection of a stabilized organic landfill cover include the availability and cost of suitable soil cover materials, and the overall benefit of increasing waste diversion. Information from Halifax suggests a direct waste diversion of 15-30% is possible from organic separation and composting.

Lime and Organic Slurry Systems

Lime slurry has been used at municipal landfills to reduce odours and encapsulate waste materials. In those cases studied the slurry itself was a waste product from industrial processes. The application of a lime or other slurry with pozzolanic characteristics would require dedicated mixing and application equipment. The slurry would be applied hydrated and dry to form a barrier over the waste. It is not suitable for daily cover. The cost is expected to be higher than synthetic barrier systems but may be an option in areas where suitable industrial wastes are available.

Organic slurries are typically composed of cellulose fibre mulch and form a cementous binder when applied as a daily cover. Typically, the slurry is water-based and applied with a portable hydro-mulch vehicle. Many slurry systems include odour and dust control materials while offering a reduction in infiltration.

Although the initial capital cost of implementing a slurry system involves the purchase of a specialized truck, slurries offer savings from a reduction in labour costs due to a fast application rate. Slurries eliminate the transportation and fuel costs associated with soil borrow; however, the unit cost of slurry mix tends to be higher than soil borrow, which is assumed to be available at the site.

Tarping systems utilize self-contained tarping units, which attaches to heavy machinery such as the blades of bulldozers. The tarping unit unrolls and retrieves the synthetic fabric, which is used to cover solid waste and reduce infiltration. The associated tarp is weighted with cable pockets and/or ballast chains to prevent dislodgement.

Tarping Systems

Tarping systems would typically have the lowest labour costs. Material costs are estimated to be the same magnitude as the slurry system. These systems offer the best reduction of infiltration of all conventional methods investigated, as well as minimizing cover volume. The tarps offer superior erosion control than other methods, degrade within the landfill, and allow for free movement of leachate and landfill gas.

However, these systems, which are randomly anchored by ballasts, tend to be vulnerable to inclement weather conditions such as high wind. They have the potential to tear and are prone to abrasion through shifting. These systems will reduce but not prevent rodents and birds from direct contact with the waste cells. Waste condensation may cause tarp damage over time.

The use of synthetic tarps warrants serious consideration at locations where natural cover material limited and/or where space is at a premium.

3.4 CELL LIFE

Experience at traditional fill and cover landfills suggests that a cell designed to accommodate two years of waste provides the greatest flexibility from an operational perspective. The feasibility of designing individual landfill cells with a 2-year life expectancy was investigated. Based on preliminary calculations, the overall cost of a 2 year cell design criteria is greater than developing individual cells with a life expectancy of 5 years. Costs to develop berms to accommodate the projected waste volumes over 50 years with 25 individual cells would increase by approximately 25-30% due to the increase in soil borrow and labour required to development the intermediate berms shared by adjacent cells. For example, a 2-year individual cell configuration over a 50-year life would require 24 intermediate berms, as compared to 9 intermediate berms in a 5-year individual cell configuration. Subsequently, these increases in soil borrow also increases the footprint required to contain the waste by a similar magnitude.

The primary advantage of a 2-year cell is that the active footprint of the landfill would be reduced. In addition, erosion and leachate volumes would decrease from this configuration. Leachate treatment costs would subsequently decrease; however, the collection network would be more costly to develop as a result of additional piping connections and grading requirements. Further minimization of erosion and leachate generation is not seen to be a cost effective when compared to the implications on overall capital cost. Design parameters, such as a leachate treatment plant and interceptor ditches must be constructed to accommodate the maximum flow volumes. These mitigative measures can easily be implemented into the footprint of both the 2-year and 5 year landfill options.

Reduction of capital cost can most easily be achieved by consideration of additional height to the landfill. By keeping both length and width constant, the additional height would present an opportunity for additional waste containment. At a particular height, the landfill design will experience the law of diminishing return. At this height, the cost of developing a structurally sound containment berm out ways the resulting increases in capacity. It should be noted that this type of detailed engineering analysis was not part of the scope of work in this phase of the project.

Operational and maintenance costs are expected to be of the same magnitude for both options, therefore, their evaluation will not impact the overall feasibility of the analysis. Also, the analysis assumes similar landfill equipment with a 10-year replacement cost. Salvage values were not taken into account.

3.5 LINER SYSTEMS

A containment landfill will be required for the Central Newfoundland Region. A containment landfill is designed to control the discharge of effluent. The design requires the installation of one or more impermeable liners. The design of the liner system is an engineering function. The liner system may be designed with leachate collection, a leak detection layer, and a second liner to serve as a contingency against failure. The cost of the liner system will vary depending upon the topography of the site, site hydrology, and hydraulic complexity, and the risk management factors built into the system.

Site conditions will impact engineering designs. A containment landfill requires the collection and management of leachate. The leachate will be collected in a piping network and directed to a treatment system. There are no alternatives to leachate collection, however there are alternatives in the methods used to collect leachate.

The Newfoundland and Labrador Department of Environment are currently in the process of developing technical requirements for landfill liner systems, compost facilities, close out of existing landfills. The standards are to be released in the near future.

3.6 HERHOF – DRY STABILAT METHOD

The Herhof (Dry-Stabilat) Method is an alternative to landfill and incineration that enabled effective and efficient separation of waste for recycling and fuel production. This method fully meets the statutory requirements for maximizing waste recycling while at the same time conserving natural resources. Metals, mineral and glass fractions are reused as substitutes for natural raw materials. Plastics can also be separated out, dispensing with separate collection and recycled to new products. The fuel product (Stabilat), a bi-product of the system can be substituted for fossil fuels. The method is safe, clean, environmentally friendly, and may result in disposal sites become a relic of the past.

The system, which only commenced production in 1997, has rapidly gained widespread acceptance and will, by Spring 2001, be treating the waste of approximately 2 million people in Germany and Italy. It is believed that the Herhof (Dry-Stabilat) Method can make a vital contribution to Ireland's waste problem in a way that is environmentally friendly and economically sound. It will enable Ireland to substantially reduce its dependence on landfill without having to introduce municipal waste incineration. The Herhof (Dry Stabilat) Method offers Ireland the opportunity to lead Europe in the introduction of a system of Waste Management, which maximizes recycling possibilities and transforms waste from being a problem for the community into valuable products. The basic idea has been copied from nature. The result is a 100% material recycling or closed loop system. All waste products are re-used in the Economic Process either as raw material or fuel - no landfill.

For more information on the Herhof (Dry-Stabilat) Method, see information in Volume 2, Appendix H of this report.

3.7 NATURAL ATTENUATION

Natural attenuation is a naturally-occurring process in soil and groundwater environments that acts without human intervention to reduce the mass, toxicity, volume, or concentration of contaminants. Natural attenuation processes are classified as destructive or non-destructive. Destructive processes include chemical and biological degradation reactions. Non-destructive processes include adsorption, dispersion, dilution, and volatilization. Natural attenuation is a non-intrusive process that allows continuing use of infrastructure during remediation. It is not subject to the limitations of mechanical equipment, and is often less costly since no energy source is required. Natural attenuation processes are subject to natural changes in local conditions, such as groundwater velocity and pH. The time frame for remediation is usually longer than other technologies.

The Newfoundland and Labrador Waste Management Strategy (2002) provides minimum requirements for new facilities. All landfill sites require a properly designed and constructed impermeable liner system with a leachate collection system, and an approved leachate (disposal or treatment) system. Therefore, natural attenuation is not a viable option.

4.0 LOCAL WASTE MANAGEMENT FACILITIES

The project team developed detailed collection and transportation model that allowed the Committee an opportunity to study the advantages and disadvantages of several potential local waste management facility options and location. The preferred system was selected based upon the objectives of the waste management strategy, the convenience to the users, and the overall cost. The model can be used in the future to optimize the collection and transportation routes. It may also be used to calculate the specific capital and operating costs of the individual local waste management facility sites.

4.1 LOCAL WASTE MANAGEMENT FACILITY LOCATIONS

The assessment of the collection and transportation requirements of the new system has resulted in selecting a collection and local waste management facility system that includes the following locations:

- Buchan's Junction Waste Management Facility (524 tonnes / year)
- Point Leamington Waste Management Facility (1,282 tonnes / year)
- Virgin Arm – Carter's Cove Waste Management Facility (3,638 tonnes / year)
- Fogo Island Waste Management Facility (1,429 tonnes / year)
- Gander Bay Waste Management Facility (2,727 tonnes / year)
- Indian Bay Waste Management Facility (3,396 tonnes / year)
- Terra Nova Regional Waste Management Facility (3,040 tonnes / year)

In accordance with the objectives of the Terms of Reference the preferred collection and transportation system has been selected to minimize the impact on the existing collection system (see Figure 4-1 for Proposed Local Waste Management Facility Locations). The two-stream (wet/dry) collection system will also allow municipalities to continue to use current collection contractors. Provided below is a summary of the preferred collection system. Table 4-1 provides information on the population and projected waste volumes for the preferred collection and transportation system.

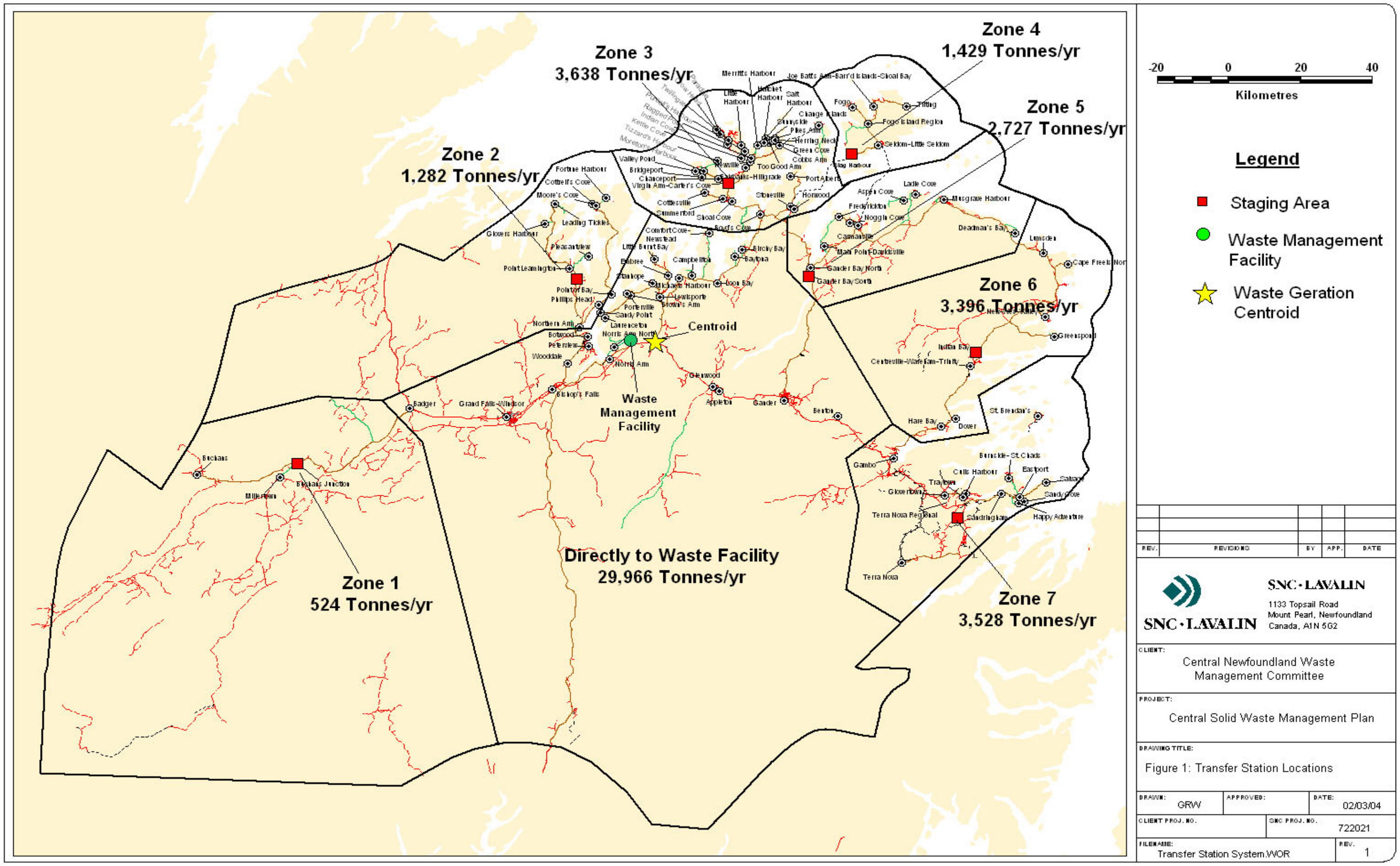

Figure 4-1: Proposed Local Waste Management Facility Locations for Central Newfoundland.

Table 4-1: Tonnages for Seven Waste Management Facility System.

Proposed Waste Management Facility Location	Zone	Population Served		Estimated Amount of Waste per Zone (Tonnes)	
		2001	2052	2001	2052
Buchan's Junction	1	1,105	962	524	456
Point Leamington	2	2,702	2,352	1,282	1,116
Virgin Arm – Carter's Cove	3	7,660	6,655	3,638	3,158
Fogo Island	4	3,018	2,626	1,429	1,246
Gander Bay	5	5,748	4,992	2,727	2,369
Indian Bay	6	7,158	6,223	3,396	2,953
Terra Nova*	7	7,448	6,616	3,528	3,139
Directly to Landfill		41,754	36,251	29,966	26,012
Total		**76,593**	**66,677**	**46,490**	**40,449**

* An estimated population for the Terra Nova National Park was determined based on the annual amount of solid waste generated at the park divided by 1.3 kg/person/day.

* The estimated population for the Terra Nova National Park was assumed to stay constant over the 50 yr period.

Each of the local waste management facilities will be designed to cost effectively accommodate the current and projected waste volumes from the collection area. The facilities have been sited to provide a convenient and visible local waste management facility location. Concept designs for the local waste management facilities are provided in Volume Appendix I.

4.2 NEWFOUNDLAND AND LABRADOR ENVIRONMENTAL STANDARDS FOR MRFS

In September 2003, the Newfoundland Department of Environment issued "*Environmental Standards Waste Transfer Stations – Final Draft*" that establish criteria and procedures for the development of all waste transfer stations in the province. These standards are provided in Appendix J and significant sections are discussed below. These standards apply to the development of all waste transfer stations which receive and transfer municipal solid waste. The standards do not apply to the haulage of such materials from the transfer stations to the points of final disposal. The standards apply to all waste transfer stations developed in the province regardless of ownership. Waste transfer stations are also subject to registration in accordance with the *Environmental Protection Act* and as detailed in the *Environmental Assessment Regulations.*

4.2.1 CONSIDERATIONS

Table 4-2: General siting criteria for Waste Transfer Stations in Newfoundland and Labrador

<table>
<tr><th>Siting Requirement</th><th colspan="2">Criteria</th></tr>
<tr><td>Size and Capacity</td><td colspan="2">Suitable to meet current and estimated future was generation rates of the communities served.</td></tr>
<tr><td>Land Use</td><td colspan="2">Zoned appropriately, typically as industrial or heavy commercial.</td></tr>
<tr><td>Access and Road Restrictions</td><td colspan="2">Access roads shall be accessible year round by the weight and type of vehicles anticipated.

The access roadway shall be a two lane roadway or equivalent.

The intersection of any access road with a public street or road shall be designed in accordance to the requirements of the provincial Department of Work, Services and Transportation.</td></tr>
<tr><td>Airport</td><td colspan="2">Consult Transport Canada if within 20 km of a licensed airport.</td></tr>
<tr><td rowspan="6">Separation Distances</td><td rowspan="2">Property Type</td><td>Minimum Separation Distances from active compost areas (m).</td></tr>
<tr><td>In-vessel</td></tr>
<tr><td>Property Boundary</td><td>25</td></tr>
<tr><td>Residential, Industrial, Commercial, and Institutional Properties</td><td>25</td></tr>
<tr><td>Water Courses, Rivers, and Lakes</td><td>100</td></tr>
<tr><td>Water Supply</td><td>100</td></tr>
</table>

4.2.2 DESIGN REQUIREMENTS

Access Requirements – designed to handle the types and volumes of traffic anticipated;

Buildings – Buildings shall be properly sized and designed for the application.

Receiving, Storage and Transfer Areas –The receiving area and tipping floor must be inside a building. The tipping area shall be of a suitable size to accommodate trucks, heavy equipment, and provide suitable storage capacity for waste awaiting placemen in a transfer vehicle.

Storage – The tipping floor shall be of suitable size to accommodate two full days waste on the tipping floor without impeding vehicle or equipment movement or creating a safety hazard. Mix municipal waste shall not be stored outside.

Fencing – Adequate fencing and gates to prevent pedestrian and vehicular traffic from entering the facility during non-operational hours.

Water Supply – Adequate supply of clean water is required.

4.2.3 OPERATIONS

The operation will be conducted in a fashion which protects public health and safety, minimizes fire hazard, does not create a nuisance to adjacent areas, and will not contaminate ground or surface waters off-site.

Receiving Waste – All vehicles delivering waste to the site shall be screened to make sure they are carrying acceptable materials and if required, weighed to determine waste quantities for accounting purposes.

Site Access – Public access to the site is to be controlled so that the general public does not have direct access to the facility unless accompanied by staff members.

Hazardous Waste – Any hazardous waste received at the site shall be properly segregated and stored, and removed from the site on a regular basis by an approved licensed contractor.

Contingency Plans – Up-to-date contingency plan must be in place to effectively handle the effects of fire, odour, flood, power outage, spill, delivery of hazardous waste, or any other issue which could cause a disruption to proper facility operation.

Animal, Rodent, and Vector Control Program –An active vector and rodent control program is required.

Litter Control Program – Includes the requirement for tarping of loads and regular litter collection.

Dust Control Program – Roads shall be properly maintained and dust control programs implemented as required.

Fire Safety Program – Develop fire safety program in consultation with the local fire department and, where required, the Department of Forest Resources and Agri-Foods.

Groundwater / Surface Water Monitoring Program – Monitoring programs need to be developed which assess the impacts of site operations on groundwater and surface water.

Reporting Requirements – An annual report summarising the operation of the site is required.

4.3 PREFERRED LOCAL WASTE MANAGEMENT FACILITY SYSTEM

Based on previous consultation with the Central Newfoundland Waste Management Committee, all local waste management facilities will have the following components:

- Municipal solid waste will be collected and transported to the regional facility using a 53 ft trailer;
- Enclosed loading area (pre-engineered structure);
- Grade separated tipping floor;
- Upgraded gravel access road;
- Onsite paving is required;
- 12.2 m weigh scale is required;
- Large volumes of water are not required, therefore water storage is not included in the costing;
- C&D Storage and C&D Landfill Facility;
- Household Hazardous Waste Depot;
- White Goods Storage Area, and;
- Car Wreck Storage Area.

4.4 CAPITAL AND OPERATING, COSTS

4.4.1 BUCHAN'S JUNCTION WASTE MANAGEMENT FACILITY

Approximately 524 metric tonnes of solid waste will be delivered to the Buchan's Junction Waste Management Facility on a yearly basis. Of the 524 metric tonnes of waste delivered, 344 T will be dry waste and 180 T will be wet waste.

Table 4-3 provides the capital cost and Table 4-4 provides the operational cost for the Buchan's Junction Waste Management Facility.

Table 4-3: Capital Cost for Buchan's Junction Waste Management Facility

Item	Cost ($)
Land Purchase - Assumed Central Newfoundland Solid Waste Management Commission would not have to purchase land.	$0
Site Preparation - Site grading, excavation, clearing, grubbing, etc. Assumed size of site would be 145 m x 165 m. Assumed an average of 1.0 m excavation and backfill for the site at $10/ m^3$.	$239,250
Pre-Engineered Building - To accommodate a 53 foot compaction trailer it was assumed the building would have to be approximately 20 m x 15 m. The unit cost of the metal pre-engineered building including concrete bi-level is $800/m^2$. The building would also include an office and washroom.	$240,000
53 ft Transfer Trailer	$80,000
38 m^3 Open Top Bin - Bulk Waste Storage	$6,000
HHW Depot - Includes building, concrete platform, and isolated drainage system	$62,563
C&D Storage Area - Development cost included in site preparation	$0
C&D Disposal Area - Development cost included in site preparation	$0
White Goods / Car Wreck Area - Development cost included in site preparation	$0
Access Road - Site is located on a 500 m gravel access road. It was assumed the access road would require some upgrading (no paving), at an assumed cost of $25/m.	$12,500
On-site Access Roads - Development cost included in site preparation	$0
Onsite Paving - Assumed 500 m2 of paving at a cost of $20/m2 .	$10,000
Weigh Scales - Inbound 40 ft weigh scales	$50,000
Water Supply – A water supply will be needed for employee use, washroom facilities, and facility washdown. It was assumed you don't need large volumes of water and therefore do not require storage. Due to the location of the current landfill, an artesian well is proposed. The cost of drilling an artesian well is $100/m to a depth of 100m.	$10,000
Power Supply - It was assumed that the nearest power supply is approximately 500 m from the site on the main road. The cost to extend the power supply was assumed at $25/m. Onsite electrical distribution was assumed to a lump sum of $2000.	$14,500
Septic Tank and Tile Field	$5,000
Fencing and Gates - 3m fence around perimeter of site (approx. 620 m perimeter) at $55/m. $2000 was assumed for the cost of gates and $500 was assumed for signage.	$36,600
Groundwater monitoring	$30,000
Landscaping	$5,000
Sub-Total	$801,413
Contingency (10%)	$80,141
Engineering (15%)	$120,212
TOTAL	$1,001,766

Table 4-4: Operational Cost for Buchan's Junction Waste Management Facility

ITEM	COST ($/year)
Staffing – 10 hours per week @ $15/hour + 35% payroll burden	$10,530
Loader (Rented) - 5hr/week @ 52 weeks/year @ $40/hr	$10,400
Bulldozer (Rented) - 2hr/month @ 12 months/year @ $100/hr	$2,400
Chemical Testing Equipment	$500
Transportation and Disposal Cost (HHW) - Approx. 1.5 T @ $500/T	$750
Power Lighting, misc	$10,000
TOTAL	$34,580

4.4.2 POINT LEAMINGTON WASTE MANAGEMENT FACILITY

Approximately 1,282 metric tonnes of solid waste will be delivered to the Point Leamington Waste Management Facility on a yearly basis. Of the 1,282 metric tonnes of waste delivered, 840 T will be dry waste and 442 T will be wet waste.

Table 4-5 provides the capital cost and Table 4-6 provides the operational cost for the Point Leamington Waste Management Facility.

Table 4-5: Capital Cost for Point Leamington Waste Management Facility

Item	Cost ($)
Land Purchase - Assumed Central Newfoundland Solid Waste Management Commission would not have to purchase land.	$0
Site Preparation - Site grading, excavation, clearing, grubbing, etc. Assumed size of site would be 165 m x 165 m. Assumed an average of 1.0 m excavation and backfill for the site at $10/ m^3.	$272,250
Pre-Engineered Building - To accommodate a 53 foot compaction trailer it was assumed the building would have to be approximately 20 m x 15 m. The unit cost of the metal pre-engineered building including concrete bi-level is $800/m^2. The building would also include an office and washroom.	$240,000
53 ft Transfer Trailer	$80,000
38 m^3 Open Top Bin - Bulk Waste Storage	$6,000
HHW Depot - Includes building, concrete platform, and isolated drainage system	$62,563
C&D Storage Area - Development cost included in site preparation	$0
C&D Disposal Area - Development cost included in site preparation	$0
White Goods / Car Wreck Area - Development cost included in site preparation	$0
Access Road - Site is located on a 500 m gravel access road. It was assumed the access road would require some upgrading (no paving), at an assumed cost of $25/m.	$12,500
On-site Access Roads - Development cost included in site preparation	$0
Onsite Paving - Assumed 500 m^2 of paving at a cost of $20/m2 .	$10,000
Weigh Scales - Inbound 40 ft weigh scales	$50,000
Water Supply – A water supply will be needed for employee use, washroom facilities, and facility washdown. It was assumed you don't need large volumes of water and therefore do not require storage. Due to the location of the current landfill, an artesian well is proposed. The cost of drilling an artesian well is $100/m to a depth of 100m.	$10,000

Item	Cost ($)
Power Supply - It was assumed that the nearest power supply is approximately 500 m from the site on the main road. The cost to extend the power supply was assumed at $25/m. Onsite electrical distribution was assumed to a lump sum of $2000.	$14,500
Septic Tank and Tile Field	$5,000
Fencing and Gates - 3m fence around perimeter of site (approx. 660 m perimeter) at $55/m. $2000 was assumed for the cost of gates and $500 was assumed for signage.	$38,800
Groundwater monitoring	$30,000
Landscaping	$5,000
Sub-Total	$836,613
Contingency (10%)	$83,661
Engineering (15%)	$125,492
TOTAL	$1,045,766

Table 4-6: Operational Cost for Point Leamington Waste Management Facility

ITEM	COST ($/year)
Staffing – 15 hr per week @ $15/hour + 35% payroll burden	$15,795
Loader (Rented) - 8 hr/week @ 52 weeks/year @ $40/hr	$16,640
Bulldozer (Rented) - 5 hr/month @ 12 months/year @ $100/hr	$6,000
Chemical Testing Equipment (HHW)	$1,000
Transportation and Disposal Cost (HHW) - Approx. 3.8 T @ $500/T	$1,900
Power Lighting, misc	$12,000
TOTAL	$53,335

4.4.3 FOGO WASTE MANAGEMENT FACILITY

Approximately 1,429 metric tonnes of solid waste will be delivered to the Fogo Waste Management Facility on a yearly basis. Of the 1,429 metric tonnes of waste delivered, 937 T will be dry waste and 492 T will be wet waste.

Table 4-7 provides the capital cost and Table 4-8 provides the operational cost for the Fogo Waste Management Facility.

Table 4-7: Capital Cost for Fogo Waste Management Facility

Item	Cost ($)
Land Purchase - Assumed Central Newfoundland Solid Waste Management Commission would not have to purchase land.	$0
Site Preparation - Site grading, excavation, clearing, grubbing, etc. Assumed size of site would be 165 m x 170 m. Assumed an average of 1.0 m excavation and backfill for the site at $10/ m^3.	$280,500
Pre-Engineered Building - To accommodate a 53 foot compaction trailer it was assumed the building would have to be approximately 20 m x 15 m. The unit cost of the metal pre-engineered building including concrete bi-level is $800/ m^2. The building would also include an office and washroom.	$240,000
53 ft Transfer Trailer	$80,000
38 m^3 Open Top Bin - Bulk Waste Storage	$6,000

Item	Cost ($)
HHW Depot - Includes building, concrete platform, and isolated drainage system	$62,563
C&D Storage Area - Development cost included in site preparation	$0
C&D Disposal Area - Development cost included in site preparation	$0
White Goods / Car Wreck Area - Development cost included in site preparation	$0
Access Road - Site is located on a 500 m gravel access road. It was assumed the access road would require some upgrading (no paving), at an assumed cost of $25/m.	$12,500
On-site Access Roads - Development cost included in site preparation	$0
Onsite Paving - Assumed 500 m^2 of paving at a cost of $20/m2 .	$10,000
Weigh Scales - Inbound 40 ft weigh scales	$50,000
Water Supply – A water supply will be needed for employee use, washroom facilities, and facility washdown. It was assumed you don't need large volumes of water and therefore do not require storage. Due to the location of the current landfill, an artesian well is proposed. The cost of drilling an artesian well is $100/m to a depth of 100m.	$10,000
Power Supply - It was assumed that the nearest power supply is approximately 500 m from the site on the main road. The cost to extend the power supply was assumed at $25/m. Onsite electrical distribution was assumed to a lump sum of $2000.	$14,500
Septic Tank and Tile Field	$5,000
Fencing and Gates - 3m fence around perimeter of site (approx. 670 m perimeter) at $55/m. $2000 was assumed for the cost of gates and $500 was assumed for signage.	$39,350
Groundwater monitoring	$30,000
Landscaping	$5,000
Sub-Total	$845,413
Contingency (10%)	$84,541
Engineering (15%)	$126,812
TOTAL	$1,056,766

Table 4-8: Operational Cost for Fogo Local Waste Management Facility

ITEM	COST ($/year)
Staffing – 15 hr per week @ $15/hour + 35% payroll burden	$15,795
Loader (Rented) - 8 hr/week @ 52 weeks/year @ $40/hr	$16,640
Bulldozer (Rented) - 5 hr/month @ 12 months/year @ $100/hr	$6,000
Chemical Testing Equipment (HHW)	$1,000
Transportation and Disposal Cost (HHW) - Approx. 4.7 T @ $500/T	$2,350
Power Lighting, misc	$12,000
TOTAL	$53,785

4.4.4 GANDER BAY WASTE MANAGEMENT FACILITY

Approximately 2,727 metric tonnes of solid waste will be delivered to the Gander Bay South Waste Management Facility on a yearly basis. Of the 2,727 metric tonnes of waste delivered, 1,788 T will be dry waste and 939 T will be wet waste.

Table 4-9 provides the capital cost and Table 4-10 provides the operational cost for the Gander Bay Waste Management Facility.

Table 4-9: Capital Cost for Gander Bay Waste Management Facility

Item	Cost ($)
Land Purchase - Assumed Central Newfoundland Solid Waste Management Commission would not have to purchase land.	$0
Site Preparation - Site grading, excavation, clearing, grubbing, etc. Assumed size of site would be 175 m x 190 m. Assumed an average of 1.0 m excavation and backfill for the site at $10/ m^3$.	$332,500
Pre-Engineered Building - To accommodate a 53 foot compaction trailer it was assumed the building would have to be approximately 20 m x 15 m. The unit cost of the metal pre-engineered building including concrete bi-level is $800/m^2$. The building would also include an office and washroom.	$240,000
53 ft Transfer Trailer	$80,000
38 m^3 Open Top Bin - Bulk Waste Storage	$6,000
HHW Depot - Includes building, concrete platform, and isolated drainage system	$62,563
C&D Storage Area - Development cost included in site preparation	$0
C&D Disposal Area - Development cost included in site preparation	$0
White Goods / Car Wreck Area - Development cost included in site preparation	$0
Access Road - Site is located on a 500 m gravel access road. It was assumed the access road would require some upgrading (no paving), at an assumed cost of $25/m.	$12,500
On-site Access Roads - - Development cost included in site preparation	$0
Onsite Paving - Assumed 500 m^2 of paving at a cost of $20/m2 .	$10,000
Weigh Scales - Inbound 40 ft weigh scales	$50,000
Water Supply – A water supply will be needed for employee use, washroom facilities, and facility washdown. It was assumed you don't need large volumes of water and therefore do not require storage. Due to the location of the current landfill, an artesian well is proposed. The cost of drilling an artesian well is $100/m to a depth of 100m.	$10,000
Power Supply - It was assumed that the nearest power supply is approximately 500 m from the site on the main road. The cost to extend the power supply was assumed at $25/m. Onsite electrical distribution was assumed to a lump sum of $2000.	$14,500
Septic Tank and Tile Field	$5,000
Fencing and Gates - 3m fence around perimeter of site (approx. 730 m perimeter) at $55/m. $2000 was assumed for the cost of gates and $500 was assumed for signage.	$42,650
Groundwater monitoring	$30,000
Landscaping	$5,000
Sub-Total	$900,713
Contingency (10%)	$90,071
Engineering (15%)	$135,107
TOTAL	$1,125,891

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Table 4-10: Operational Cost for Gander Bay Waste Management Facility

ITEM	COST ($/year)
Staffing – 25 hr per week @ $15/hour + 35% payroll burden	$26,325
Loader (Rented) - 10 hr/week @ 52 weeks/year @ $40/hr	$20,800
Bulldozer (Rented) - 8 hr/month @ 12 months/year @ $100/hr	$9,600
Chemical Testing Equipment	$1,000
Transportation and Disposal Cost - Approx. 8 T @ $500/T	$4,000
Power Lighting, misc	$12,000
TOTAL	$73,725

4.4.5 INDIAN BAY WASTE MANAGEMENT FACILITY

Approximately 3,396 metric tonnes of solid waste will be delivered to the Indian Bay Waste Management Facility on a yearly basis. Of the 3,396 metric tonnes of waste delivered, 2,226 T will be dry waste and 1,170 T will be wet waste.

Table 4-11 provides the capital cost and Table 4-12 provides the operational cost for the Indian Bay Waste Management Facility.

Table 4-11: Capital Cost for Indian Bay Waste Management Facility

Item	Cost ($)
Land Purchase - Assumed Central Newfoundland Solid Waste Management Commission would not have to purchase land.	$0
Site Preparation - Site grading, excavation, clearing, grubbing, etc. Assumed size of site would be 175 m x 205 m. Assumed an average of 1.0 m excavation and backfill for the site at $10/ m^3$.	$358,750
Pre-Engineered Building - To accommodate a 53 foot compaction trailer it was assumed the building would have to be approximately 20 m x 15 m. The unit cost of the metal pre-engineered building including concrete bi-level is $800/m^2$. The building would also include an office and washroom.	$240,000
53 ft Transfer Trailer	$80,000
38 m^3 Open Top Bin - Bulk Waste Storage	$6,000
HHW Depot - Includes building, concrete platform, and isolated drainage system	$62,563
C&D Storage Area - Development cost included in site preparation	$0
C&D Disposal Area - Development cost included in site preparation	$0
White Goods / Car Wreck Area - Development cost included in site preparation	$0
Access Road - Site is located on a 3 km gravel access road. It was assumed the access road would require some upgrading (no paving), at an assumed cost of $25/m.	$75,000
On-site Access Roads - Development cost included in site preparation	$0
Onsite Paving - Assumed 500 m^2 of paving at a cost of $20/m^2 .	$10,000
Weigh Scales - Inbound 40 ft weigh scales	$50,000
Water Supply – A water supply will be needed for employee use, washroom facilities, and facility washdown. It was assumed you don't need large volumes of water and therefore do not require storage. Due to the location of the current landfill, an artesian well is proposed. The cost of drilling an artesian well is $100/m to a depth of 100m.	$10,000

Item	Cost ($)
Power Supply - It was assumed that the nearest power supply is approximately 3 km from the site on the main road. The cost to extend the power supply was assumed at $25/m. Onsite electrical distribution was assumed to a lump sum of $2000.	$77,000
Septic Tank and Tile Field	$5,000
Fencing and Gates - 3m fence around perimeter of site (approx. 760 m perimeter) at $55/m. $2000 was assumed for the cost of gates and $500 was assumed for signage.	$44,300
Groundwater monitoring	$30,000
Landscaping	$5,000
Sub-Total	$1,053,613
Contingency (10%)	$105,361
Engineering (15%)	$158,042
TOTAL	$1,317,016

Table 4-12: Operational Cost for Indian Bay Waste Management Facility

ITEM	COST ($/year)
Staffing – 25 hr @ $15/hour + 35% payroll burden	$26,325
Loader (Rented) - 10 hr/week @ 52 weeks/year @ $40/hr	$20,800
Bulldozer (Rented) - 8 hr/month @ 12 months/year @ $100/hr	$9,600
Chemical Testing Equipment	$1,000
Transportation and Disposal Cost - Approx. 10 T @ $500/T	$5,000
Power Lighting, misc	$15,000
TOTAL	$77,725

4.4.6 TERRA NOVA WASTE MANAGEMENT FACILITY

Approximately 3,528 metric tonnes of solid waste will be delivered to the Terra Nova Waste Management Facility on a yearly basis. Of the 3,528 metric tonnes of waste delivered, 2,313 T will be dry waste and 1,215 T will be wet waste.

Table 4-13 provides the capital cost and Table 4-14 provides the operational cost for the Terra Nova Waste Management Facility.

Table 4-13: Capital Cost for Terra Nova Waste Management Facility

Item	Cost ($)
Land Purchase - Assumed Central Newfoundland Solid Waste Management Commission would not have to purchase land.	$0
Site Preparation - Site grading, excavation, clearing, grubbing, etc. Assumed size of site would be 175 m x 205 m. Assumed an average of 1.0 m excavation and backfill for the site at $10/ m^3.	$358,750
Pre-Engineered Building - To accommodate a 53 foot compaction trailer it was assumed the building would have to be approximately 20 m x 15 m. The unit cost of the metal pre-engineered building including concrete bi-level is $800/ m^2. The building would also include an office and washroom.	$240,000
53 ft Transfer Trailer	$80,000

Item	Cost ($)
38 m^3 Open Top Bin - Bulk Waste Storage	$6,000
HHW Depot - Includes building, concrete platform, and isolated drainage system	$62,563
C&D Storage Area - Development cost included in site preparation	$0
C&D Disposal Area - Development cost included in site preparation	$0
White Goods / Car Wreck Area - Development cost included in site preparation	$0
Access Road - Site is located on a 200 m gravel access road. It was assumed the access road would require some upgrading (no paving), at an assumed cost of $25/m.	$5,000
On-site Access Roads - Development cost included in site preparation	$12,500
Onsite Paving - Assumed 500 m^2 of paving at a cost of $20/$m^2$.	$10,000
Weigh Scales - Inbound 40 ft weigh scales	$50,000
Water Supply – A water supply will be needed for employee use, washroom facilities, and facility washdown. It was assumed you don't need large volumes of water and therefore do not require storage. Due to the location of the current landfill, an artesian well is proposed. The cost of drilling an artesian well is $100/m to a depth of 100m.	$10,000
Power Supply - It was assumed that the nearest power supply is approximately 200 m from the site on the main road. The cost to extend the power supply was assumed at $25/m. Onsite electrical distribution was assumed to a lump sum of $2000.	$7,000
Septic Tank and Tile Field	$5,000
Fencing and Gates - 3m fence around perimeter of site (approx. 760 m perimeter) at $55/m. $2000 was assumed for the cost of gates and $500 was assumed for signage.	$44,300
Groundwater monitoring	$30,000
Landscaping	$5,000
Sub-Total	$926,113
Contingency (10%)	$92,611
Engineering (15%)	$138,917
TOTAL	$1,157,641

Table 4-14: Operational Cost for Terra Nova Waste Management Facility

ITEM	COST ($/year)
Staffing – 25 hr @ $15/hour + 35% payroll burden	$26,325
Loader (Rented) - 10 hr/week @ 52 weeks/year @ $40/hr	$20,800
Bulldozer (Rented) - 8 hr/month @ 12 weeks/year @ $100/hr	$9,600
Chemical Testing Equipment	$1,000
Transportation and Disposal Cost - Approx. 10.4 T @ $500/T	$5,200
Power Lighting, misc	$15,000
TOTAL	$77,925

4.4.7 Virgin Arm – Carter's Cove Waste Management Facility

Approximately 3,638 metric ones of solid waste will be delivered to the Virgin Arm – Carter's Cove Waste Management Facility on a yearly basis. Of the 3,638 metric ones of waste delivered, 2,385 T will be dry waste and 1,253 T will be wet waste.

Table 4-15 provides the capital cost and Table 4-16 provides the operational cost for the Virgin Arm – Carter's Cove Waste Management Facility.

Table 4-15: Capital Cost for Virgin Arm – Carter's Cove Waste Management Facility

Item	Cost ($)
Land Purchase – Assumed Central Newfoundland Solid Waste Management Commission would not have to purchase land.	$0
Site Preparation – Site grading, excavation, clearing, grubbing, etc. Assumed size of site would be 175 m x 205 m. Assumed an average of 1.0 m excavation and backfill for the site at $10/ m^3$.	$358,750
Pre-Engineered Building – To accommodate a 53 foot compaction trailer it was assumed the building would have to be approximately 20 m x 15 m. The unit cost of the metal pre-engineered building including concrete bi-level is $800/m^2$. The building would also include an office and washroom.	$240,000
53 ft Transfer Trailer	$80,000
38 m^3 Open Top Bin – Bulk Waste Storage	$6,000
HHW Depot - Includes building, concrete platform, and isolated drainage system	$62,563
C&D Storage Area - Development cost included in site preparation	$0
C&D Disposal Area - Development cost included in site preparation	$0
White Goods / Car Wreck Area - Development cost included in site preparation	$0
Access Road - Site is located on a 700 m gravel access road. It was assumed the access road would require some upgrading (no paving), at an assumed cost of $25/m.	$17,500
On-site Access Roads - Development cost included in site preparation	$0
Onsite Paving - Assumed 500 m^2 of paving at a cost of $20/m^2$.	$10,000
Weigh Scales - Inbound 40 ft weigh scales	$50,000
Water Supply – A water supply will be needed for employee use, washroom facilities, and facility washdown. It was assumed you don't need large volumes of water and therefore do not require storage. Due to the location of the current landfill, an artesian well is proposed. The cost of drilling an artesian well is $100/m to a depth of 100m.	$10,000
Power Supply - It was assumed that the nearest power supply is approximately 700 m from the site on the main road. The cost to extend the power supply was assumed at $25/m. Onsite electrical distribution was assumed to a lump sum of $2000.	$19,500
Septic Tank and Tile Field	$5,000
Fencing and Gates - 3m fence around perimeter of site (approx. 760 m perimeter) at $55/m. $2000 was assumed for the cost of gates and $500 was assumed for signage.	$44,300
Groundwater monitoring	$30,000
Landscaping	$5,000
Sub-Total	$938,613
Contingency (10%)	$93,861
Engineering (15%)	$140,792
TOTAL	$1,173,266

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Table 4-16: Operational Cost for Virgin Arm – Carter's Cove Waste Management Facility

ITEM	COST ($/year)
Staffing – 35 hr @ $15/hour + 35% payroll burden	$36,855
Loader (Rented) – 12 hr/week @ 52 weeks/year @ $40/hr	$24,960
Bulldozer (Rented) –10 hr/month @ 12 months/year @ $100/hr	$12,000
Chemical Testing Equipment	$750
Transportation and Disposal Cost – Approx. 10.2 T @ $500/T	$5,100
Power Lighting, misc	$15,000
TOTAL	$94,665

4.5 TRANSPORTATION COSTS FOR LOCAL WASTE MANAGEMENT FACILITIES

Results of the Transportation Cost Investigation (several options were previously reported) for the proposed local waste management facility locations revealed that the most cost-effective method of transporting waste to the Regional Waste Management Facility is via 53 ft trailers. Table 4-17 provides a summary of the transportation cost via a 53-foot trailer.

Table 4-17: Transportation Cost using 53ft Trailers

Local Waste Management Facility I.D.	Cost
Buchan's Junction	$30,227
Point Leamington	$22,262
Virgin Arm – Carter's Cove	$74,449
Fogo	$53,662
Gander Bay South	$48,288
Indian Bay	$104,386
Terra Nova	$80,912
Total	**$414,186**

4.6 SUMMARY OF COSTING

Table 4-18 provides a summary of all cost for each local waste management facility.

Table 4-18: Summary of Cost for each Local Waste Management Facility

Local waste management facility	Capital Cost	Operating Cost	Transportation Cost	Total Operational & Transportation Cost	Annual Cost Per Tonne
Buchan's Junction	$1,000,125	$42,580	$30,227	$72,807	$138.95
Point Leamington	$1,044,125	$73,335	$22,262	$95,597	$74.57
Fogo	$1,055,125	$73,785	$53,662	$127,447	$89.17
Gander Bay South	$1,124,250	$105,725	$48,288	$154,013	$56.48
Indian Bay	$1,315,375	$109,725	$104,386	$214,111	$63.05
Terra Nova	$1,156,000	$109,925	$80,912	$190,837	$62.76
Virgin Arm – Carter's Cove	$1,171,625	$134,665	$74,449	$209,114	$57.48

NOTE: Operational and transfer cost are only for the first year.

5.0 A REVIEW OF COMPARABLE MUNICIPAL WASTE SYSTEMS

It is inherently difficult to compare solid waste management systems of different municipalities. Each of the facilities used within the various systems may use a significantly different process than its counterpart in another municipality. For instance, one facility may favour mechanical rather than manual sorting to a greater degree than another or may accept a greater amount of IC&I waste. Also, the local economic climate may contribute to the disparity between process costs; the cost of labour, materials and utilities may be more or less expensive in certain municipalities, and the markets for recyclable materials may be more or less lucrative. There are many variables at play.

Another significant challenge in comparing waste management systems is the inconsistency in how cost and process information is reported. A thorough accounting of the cost and process data would be required to ensure that the costs reported are categorized and defined similarly across the systems. Such an analysis would be lengthy and involve a high level of cooperation from the municipal waste managers whose systems are being studied. This level of research analysis is beyond the scope of this report.

The analysis presented in this report is based on the best data available to the study group. The information used in this study has been gathered from the literature and, where possible, through direct discussion with municipal waste managers. It is intended that the process cost per units may be helpful in estimating cost ranges for comparable potential waste systems in the Central Newfoundland Region. However, it is stressed that these can only be ballpark estimates and would be based on municipal systems, whose local conditions may or may not be similar to that of the Central Newfoundland.

Three examples have been used for each system. Examples of wet/dry systems used are from Guelph (Ontario), Edmonton (Alberta), and Northumberland (Ontario). The three/four stream systems examined are from Colchester County, the Annapolis Valley, and Halifax Regional Municipality (HRM). All four stream systems from Nova Scotia.

The observations from the analysis are incorporated in six tables. Table 5-1 presents an overview of the waste systems reviewed. Table 5-2 presents a summary of the quantities of waste processed at the municipal waste facilities. Tables 5-3 and 5-4 reviews the processing abilities and costs of the municipal recycling and composting facilities. Table 5-5 examines collection costs and Table 5-6 provides a summary of the total system costs.

5.1 The City of Guelph

Guelph was the first municipality to collect and process all waste in a Wet/Dry system. The program has achieved significant diversion from its inception, and has proven to be both effective and economical. As can be seen, Guelph's system costs are low compared to other municipalities. An important factor in this low system cost is the amount of revenue that the municipality receives from the sale of recyclable materials that are delivered, pre-sorted, to the plant by the IC&I sector. Requiring no processing, this material is a source of significant revenue, offsetting the costs of processing the entire residential waste stream.

Guelph's approach to the IC&I sector is something that should be considered by all municipalities. However, this approach may not be possible in municipalities where private recyclers already exist. Established private sector recyclers would be very upset to find themselves in competition with a tax-funded municipal recycling program.

5.2 The City of Edmonton

Edmonton has a collection program that resembles a Wet/Dry program, but differs significantly. Edmonton collects recyclables ONLY in its dry stream, and everything else in its wet stream. In fact, Edmonton simply pulls non-compostable material out of its garbage stream and composts the rest. The system also composts significant amounts of sewage sludge.

The Edmonton program addresses only the residential waste stream. At a capital cost of $99 million, Edmonton's program stands out not only for its 70% residential diversion rate, but also for its cost.

5.3 Northumberland County

Although Northumberland collects their waste in a Wet/Dry stream, they do not compost the organic portion. To date, the composting facility has not been built.

5.4 Halifax Regional Municipality

Halifax's system includes a four-stream collection system. Recyclables are collected in two separate streams: fibre and containers. Organics are collected separately and the fourth stream is the garbage that is left.

Halifax, as well as all other Nova Scotia Municipalities, benefits from the fact that their program is mandatory. Residences and businesses alike must separate their waste. Recyclable and compostable material is banned from disposal in Nova Scotia.

Halifax's recycling numbers appear to be lower than others. That is primarily because of the many private recyclers that provide collection and recycling services to businesses. The municipality handles very little commercial recyclables at the recycling plant. The City has made a decision not to compete with private recyclers.

5.5 The Municipality of Colchester

Colchester's Waste Management Program has benefited from economies of scale. When designing their facility, Colchester decided to build excess capacity to be able to process recyclables from other municipalities. They import recyclable material collected in the Annapolis Valley and other jurisdictions and recycle it for a per tonne fee. The bottom-line benefits from having the tipping fee from the Valley, as well as the revenue from the sale of the recyclable materials. In fact, the Colchester facility operates at a profit, which is unheard of in municipal recycling circles.

5.6 Annapolis Valley

The Annapolis Valley system is unique in that they do not have a recycling facility or a composting facility. Instead of building such facilities, the Valley sends its source-separated materials to other municipalities for processing. The Valley has built two transfer stations where the collected material is gathered before being sent off for processing.

5.7 Analysis of Comparable Municipal Systems

Tables 5-1 to 5-6 provide an analysis of the processing options under consideration for the Central Newfoundland Region.

Table 5-1: Municipal Waste Systems Reviewed

System Type	**Wet/Dry**			**Four Stream**		
Municipality	**Guelph, ON**	**Edmonton, AB**	**Northumberland, ON**	**HRM, NS**	**Colchester, NS**	**Annapolis Valley, NS**
Population	157,405	650,000	79,120	367,502	51,025	84,565
# of Households	44,000	257,000	33,141	119,000	16,987	32,329
Diversion Rate (%)	43% (2001 total historical diversion relative to 1987) 51.5% (1999 GAP historic res. diversion relative to 1987) 39.4% (1999 GAP res. flow diversion)	70% (residential waste stream).	38% (1999 GAP res. flow diversion)	57% (2001 total diversion) 56.6% (1999 GAP residential diversion)	36.7% (2001 diversion of recyclables and organics from disposal for municipal facility)	50% (total diversion)

<u>Analysis</u>

One of the main challenges in comparing diversion rates between municipalities is that they are often measured differently, and thus have different meanings. For instance, it is common knowledge that municipalities within Nova Scotia have achieved the target of diverting more than 50% of their waste from disposal. In the table above, the Halifax Regional Municipality and the Annapolis Valley are reporting diversion rates of 57% and 50%, respectively. Many have also heard that the City of Edmonton is now diverting 70% of its solid waste. Initially, it appears that Edmonton has surpassed the Nova Scotia municipalities by 13% and 20%. However, Edmonton's diversion rate deals only with residential municipal solid waste, while the HRM and Annapolis Valley rates include the diversion and disposal of IC&I waste.

When comparing diversion rates, it is important to consider the methodologies used in their calculations. Some points to consider include:

- Does the diversion rate include materials not handled by the municipality, such as some IC&I waste or backyard composted organics?
- Is the diversion rate calculated using per capita waste generation amounts or total tonnage?
- Is the diversion rate calculated relative to a baseline year or is it a direct comparison of refuse to diverted materials?

Given these differences, caution must be employed when comparing one diversion rate with another. However, when used with understanding, diversion rates can be helpful in evaluating the success and the opportunities for improvement in any waste management program.

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Table 5-2: Waste Quantities Processed

		Wet/Dry			**Four Stream**		
	Municipality	**Guelph, ON (2000)**	**Edmonton, AB (2001)**	**Northumberland, ON (1999)**	**HRM, NS (2001)**	**Colchester, NS (2001)**	**Annapolis Valley, NS (2001)**
Residential	Organics Processed (tonnes/year)	10,200	180,000*	0✚	28,500	2,400	4,500
	Organics Processed (kg/capita/year)	65	280*	0✚	80	50	50
	Recyclables Processed (tonnes/year)	29,000	40,000	9,700	14,200	9,800	2,800
	Recyclables Processed (kg/capita/year)	180	60	120	40	190	30
	Refuse Disposed (tonnes/year)	15,700	90,000	13,700	55,500	6,100	23,500
	Refuse Disposed (kg/capita/year)	100	300	170	150	10	280
IC&I	Organics Processed (tonnes/year)	1,200✚✚	0**	0✚	13,700✚✚	1,000✚✚	2,400
	Organics Processed (kg/capita/year)	8✚✚	0**	0✚	40✚✚	20✚✚	30
	Recyclables Processed (tonnes/year)	7,200✚✚	0**	3,200✚✚	3,400✚✚	620✚✚	1,500✚✚
	Recyclables Processed (kg/capita/year)	46✚✚	0**	40✚✚	10✚✚	10✚✚	20✚✚
	Refuse Disposed (tonnes/year)	113,000	Unknown**	No data available. About 23% of the IC&I dry stream is sent to disposal.	164,000✚✚ ✚	14,700★	Information not available
	Refuse Disposed (kg/capita/year)	720	Unknown**	Unable to calculate.	440	290	Unable to calculate.
Total	Organics Processed (tonnes/year)	12,200	Unknown	0✚	42,200	3,500	6,900
	Organics Processed (kg/capita/year)	78	Unknown	0✚	120	70	80
	Recyclables Processed (tonnes/year)	36,200	Unknown	12,800	17,500	10,400	4,400
	Recyclables Processed (kg/capita/year)	230	Unknown	160	50	200	50
	Refuse Disposed (tonnes/year)	129,000	Unknown	Unable to calculate.	127,000	20,900	23,500
	Refuse Disposed (kg/capita/year)	820	Unknown	Unable to calculate.	340	410	280
Total Annual System Tonnage (Recovery and Disposal)		157,000	Unknown	Unknown	204,000	41,500	37,300

The figures in Table 2 indicate the amount of waste and recoverable material that is handled by the selected municipalities. In many cases, IC&I organics or recyclables may be processed through private recyclers or composters. For instance, the Halifax Regional Municipality estimates that in fiscal year 2000-2001, about 118,000 tonnes of IC&I solid waste was recycled through the private sector. However, because most of the landfills in this study are municipally owned, the final disposition of most IC&I refuse is handled - and therefore documented - by the municipalities. It is expected that the amount of materials received for processing at a dry-stream MRF will be higher per capita than it will be with a three/four stream MRF. This is because the dry-stream MRF is required to process a proportion of the refuse stream that is commingled with the recyclables.

Table 5-3: Recyclables Processing Facilities

	Wet/Dry			Four Stream		
Municipality	**Guelph, ON (1999)**	**Edmonton, AB (2001)**	**Northumberland, ON (1999)**	**HRM, NS (2001)**	**Colchester, NS (2001)**	**Annapolis Valley, NS✚✚✚ (2001)**
Annual Capacity (tonnes)	91,000	40,000	30,000	28,000	12,000	
Annual Capacity per Person (kg)	580	60	380	76	235	
Capital Costs	$12,100,000	$12,000,000	$6,800,000	$4,500,000**	$4,746,000✚	$816,000★
Capital Costs per Capacity	$132	$300	$230	$160	$395	
Capital Costs per Person	$77	$18	$86	$12	93	$10
Annual Gross Operating Costs✓	$3,760,000 (2000: $4,879,215)		$2,110,000	$2,410,000	$843,000	$465,000
Annual Tonnage Received		40,000	12,800	17,500	10,400	4,400
Annual Gross Operating Costs per Tonne	$130 (2000: $165)		$165	$138	$81	$107
Annual Revenues	$2,112,000		$892,000*	$1,349,000***	$1,611,000✚✚	$142,000
Annual Net Operating Costs✓✓	$1,648,000		$1,219,000	$1,062,000	-$768,000	$323,000
Annual Net Operating Cost per Tonne	$57	$100	$95	$61	-$74	$73
Annual Net Operating Cost per Person	$11		$15	$3	-$15	$4

Table 3 illustrates how the addition of high-value, pre-sorted ICI recyclables into the recyclable processing stream can decrease the MRF per tonne operating costs. In Guelph, the cost per tonne of processing residential dry waste in 1999 was $130 (including administration). Introducing source-separated old corrugated cardboard, newsprint, fine paper, commingled containers, and mixed recycling material reduced the processing cost to $57 per tonne.

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Table 5-4: Organics Processing Facilities

	Wet/Dry			Four Stream		
Municipality	**Guelph, ON (1999)**	**Edmonton, AB* (2001)**	**Northumberland, ON**	**HRM, NS (2001)**	**Colchester, NS (2001)**	**Annapolis Valley, NS✓✓ (2001)**
Annual Capacity (tonnes)	44,000	300,000	The Northumberland Wet/Dry program currently does not compost its Wet waste stream. The organics composted at the Canada Composting Inc. facility in Newmarket, Ontario for the County's organics composting trials are not included in these calculations.	50,000 (25,000 per facility)	6,000	
Annual Capacity per Person (kg)	280	460		140	120	
Capital Costs	$7,000,000	$97,000,000**		Data not available✚	$1,939,000 ✚✚✚	$1,293,000✓✓✓
Capital Costs per Capacity	$159	$323			$323	
Capital Costs per Person	$44	$149			$38	$15
Annual Gross Operating Costs ☒	$1,313,000 (2000: $1,398,000)			$3,499,000✚	$185,000	$661,000
Annual Tonnage Received	12,300 (2000: 10,700)	180,000		42,200	3,500	6,900
Annual Gross Operating Costs per Tonne	$107 (2000: $131)	MSW: $60 (projected)*** Sewage biosolids: $183 (projected)***		$83	$53	$96
Annual Revenues	$60,400			$1,028,000✚✚	$48,000✓	$300,000
Annual Net Operating Costs ☒☒	$1,252,000			$2,471,000	$137,000	$361,000
Annual Net Operating Cost per Tonne	$102	$85		$59	$39	$52
Annual Net Operating Cost per Person	$8			$7	$3	$4

In this review, the costs of processing the compostable waste streams (organics in a three/four stream system or wet in a wet/dry system) are shown to be considerably less expensive per tonne in the three/four stream system than in the wet/dry system. This is likely because the wet stream is processing refuse in addition to compostables; thus, the compostables are highly contaminated and will require extra processing, in particular pre-sorting and screening.

Table 5-5: Collection Summary

	Wet/Dry			Four Stream		
Municipality	**Guelph, ON (2000)**	**Edmonton, AB (2001)**	**Northumberland, ON (2001)**	**HRM, NS (2001)**	**Colchester, NS (2001)**	**Annapolis Valley, NS (2001)**
Methodology	Weekly co-collection of wet and dry wastes.	Waste is collected weekly April to October and bi-weekly November to March.	Co-collection of wet (refuse) and dry wastes.	Bi-weekly collection of refuse and organics on alternating weeks. Recyclables collected weekly in urban, bi-weekly in rural.	Bi-weekly collection. Refuse and organics collected one week; paper and container recyclables are collected the next.	Bi-weekly, single pass 4-stream collection.
Number of stops			30,300	155,000	17,000	35,300
Annual Cost	$2,556,000		$1,389,000	$8,620,000*	$1,500,000 **	$1,719,000***
Annual Cost per Tonne	$50 - $55	$60	$82	$42		
Annual Cost per Person	$16		$18	$23	$29	$20
Annual Cost per Stop	$58 per household		$46	$56	$88	$49

Table 5-6: System Summary

	Wet/Dry			Four Stream		
Municipality	**Guelph, ON (2000)**	**Edmonton, AB (2001)**	**Northumberland , ON (1999)**	**HRM, NS (2001)**	**Colchester, NS (2001)**	**Annapolis Valley, NS (2001)**
Total System Annual Gross Cost (not including revenues or tipping fees)	$11,199,000	$31,000,000	Data not available	$35,236,000	$5,404,000	$7,927,000
Total System Annual Gross Cost per Tonne	$71	$160		$172	$130	$213
Total System Annual Gross Cost per Person	$71	$48		$96	$106	$94
Total System Annual Gross Cost per Household	$255	$120		$296	$318	$245
Annual Revenues (including sales and tip fees)	$8,000,000	3,300,000		$11,655,000	$2,706,000	$2,781,000
Annual Revenues per Person	$51	$5		$32	$53	$32
Annual Revenues per Tonne	$51	$17		$57	$65	$75
Annual Revenues per Household	$182	$13		$98	$159	$86
Net System Annual Costs (after revenues)	$3,000,000	27,500,000	$3,188,000	$23,484,000	$2,697,000	$5,145,000
Net System Annual Costs per Tonne	$19	$139	Data not available	$115	$65	$138
Net System Annual Costs per Person	$19	$42	$40	$64	$53	$61
Net System Annual Costs per Household	$68	$107	$96	$152	$159	$159

6.0 MATERIALS RECOVERY FACILITY (MRF)

Material recovery facilities (MRFs) provide an intermediate sorting and processing step between collection programs and end-user markets for recyclable materials. A MRF accepts dry materials, whether source separated or mixed, and separates, processes and stores them for later use as raw materials for remanufacturing and reprocessing. The main function of the MRF is to maximize the quantity of recyclables processed, while producing materials that will generate the highest possible revenues in the market[5].

In a MRF, glass, steel and aluminium cans, unsorted plastics, paper, etc. are separated and undergo various levels of processing in order to prepare them for shipment to end-user markets or remanufacturing plants. Glass is generally sorted by colour and crushed. Plastics are sorted by resin type, ground or crushed, and baled. Aluminium is separated from steel cans and crushed and baled. Cardboard and newsprint are sorted and baled. Processing and condensing materials reduces transportation costs and increases the value of materials in the marketplace.

The amount and types of mechanized equipment used in sorting and processing recyclables at a MRF varies from one facility to another. Hand sorting or picking along conveyor lines is common at smaller facilities. The number of mechanized facilities is growing in response to the growth in municipal curbside collection programs, facilities are using the more advanced technologies because they are becoming more reliable and efficient in separating and processing the recyclables.

There are trade-offs between the simpler, manual sort MRF's and the ones with more high technology equipment. The main trade-off is capital cost vs. operating costs. Manual operations can process about six (6) tonnes of recyclables per worker per day. In mechanical systems, the rate climbs to 10 tonnes per worker/day. However, the capital costs for the equipment in the mechanical systems are reportedly 75 to 100% higher than for the manual system.

There are several benefits to developing a MRF. First, if the recycling program is voluntary, more residents may participate in a program that does not require their cans, bottles and jars, and newspapers to be put into separate containers at the curb. Higher participation means higher volumes of recyclables collected. Second, with a MRF, collection trucks do not need to have separate bins or compartments. Only 2 compartments are needed rather than 4 to 6. Also, collection time and costs can be

[5] Dubanowitz, A. J., 2000. Design of a Materials Recovery Facility (MRF) for Processing the Recyclable Materials of New York City's Municipal Solid Waste. Columbia University.

reduced because less time is taken at the curb sorting materials or emptying several containers. Third, because of the large volumes of materials collected at a MRF and the increased processing, the recyclables are more marketable. The processing facilities are specifically designed to meet the specifications of the end use markets.

MRF's provide flexibility to a recycling program. As the waste stream and the markets for recyclables change, new items can easily be added or subtracted from a recycling program that uses a MRF. When a MRF is designed to accommodate new items, then all that is needed to start recycling the new item is to announce it to the media. Without the flexibility provided by a MRF, the residents have to be educated on how to recycle (separate) new items and the hauler has to add new collection equipment.

6.1 RECYCLABLE MATERIALS

General items collected both through residential curbside collections and community drop-off centres include clear, brown and green glass, aluminum cans, steel and tin cans, plastic bottles, magazines, junk mail, cardboard, paperboard, and newspaper. Materials to be accepted at the MRF will include the following:

Beverage Containers

- Plastic bottles & containers;
- Plastic bags;
- Glass bottles and jars;
- Steel & aluminum cans;
- Clean foil pie plates; and
- Paper milk cartons, Mini Sips & Tetra Juice Packs

Paper Based Materials

- Dry and clean paper;
- Newspapers, flyers, glossy magazines, catalogues;
- Envelopes;
- Paper egg cartons;
- Paperbacks & phone books; and
- Corrugated cardboard.

6.2 PROCESSING TECHNOLOGIES

Many automated technologies can be used to process recyclables and are described in Table 6-1.

Table 6-1: Recycling Facility Technologies

Technology	Function	Description
Bag Breaker: slitters	Open bags	Bags are forced between cutting blades that rotate in opposite directions. As the bags are ripped open, the materials spill onto a conveyor belt below. The plastic bag residue is removed manually along the conveyor line.
Bag Breakers: augers	Open bags	Bags are moved through a cylinder that contains a rotating screw auger. The auger rips the bags open against the inside of the cylinder wall. Plastic bag residue is removed manually.
Bag Breakers: trommels	Open bags	Bag-breaking trommels are specially equipped with triangular cutters or spikes on the inside of the rotating drum. The cutters tear open the bags as they are tumbled in the drum, and the recyclable materials then come out. Plastic bag residue is removed manually later in the process.
Air Classifiers: blowers	Separate materials based on weight	Lighter materials (e.g. aluminium) are separated from heavier materials (e.g. steel cans) by using forced air. The lighter materials are blown to another conveyor, while the heavier materials remain.
Air Classifiers: suction	Separate materials based on weight	A vacuum above a mixed container stream on a conveyor picks up the lighter material, which is then deposited on another conveyor. Vacuum pressure can be adjusted to assist in sorting materials of different weight.
Inclined Conveyors	Separate materials based on weight	Light containers are directed along the conveyor and discharged off the end. Heavier containers slide down the slope of the conveyor and onto a second conveyor, which then moves the heavier containers to another sorting area. Inclined conveyors can also use a series of chain curtains moving in the same direction as the conveyor to improve the sorting.
Trommel Screens	Separate materials based on size	Trommel screens are long, rotating drums that are inclined to help move materials along the drum. The drum is covered in holes of various diameters, which are used to separate containers and debris based on their size. As the drum rotates, the materials tumble in the drum and exit through the holes. Larger materials work their way down toward the end of the drum.

Technology	Function	Description
Trommel-Magnets	Remove ferrous materials	A magnet can be added to a trommel screen to separate ferrous materials from the others. A stainless steel tube is welded on one end of the trommel. The tube is magnetized to attract the ferrous materials. As the trommel rotates, the tube brings the materials to the top of the trommel. The magnetic field is then weakened, and the ferrous materials are dropped into a chute or onto a conveyor.
Star/Disc Screens	Separate materials based on size	The star/disc screens consist of a number of rotating axles, and each have a number of star-shaped discs spaced along them. The spacing between the axles and the stars is adjustable to accommodate the sorting function, as is the diameter of the discs. The materials are directed over the discs so that oversized material is passed over the screen while smaller materials are able to fall through the spaces.
Colour Glass Sorters	Separate glass based on colour	Mechanical glass sorters that differentiate using colours are a new technology. The sorters air-classify the bottoms of the glass containers and then optically sorts the glass into clear, opaque, and two coloured glasses.
Plastics Sorters: transmission	Separate plastics based on resins and colours	The colours or resin-types of plastics are detected with transmission identification sensors (using x-rays or visible light). This is best used where there are low levels of contaminants in the stream.
Plastics Sorters: reflective	Separate plastics based on resins and colours	Reflective near infra-red (NIR) sensors are used to detect the colours of resin-types of plastics. The NIR sensors can be used in ‘dirty’ MRF’s where the stream is mixed.
Eddy Current Separators	Separate aluminium cans using conductivity	An oscillating magnetic field is used to separate conductive but non-ferrous materials from the waste stream. The field moves the materials (typically aluminium cans) onto another conveyor or into a chute. The separators work best when the stream has already received some sorting and the conductive material is the dominant item in the stream. This prevents other items from being moved with, or preventing the movement of, the conductive materials.

The selection of the appropriate processing technology will depend upon the collection system selected, the desired recovery rate, equipment and servicing availability, cost and finally, from experience with similar systems.

6.3 DESIGN

Once the unit operations to process the materials are selected, the equipment needed to carry out the operations must be chosen and installed. The capabilities, reliability, maintenance requirements, flexibility, safety, efficiency, environmental effects, market specifications, and costs of the various alternatives will govern the selection of equipment for the facility.

Although there are many possible combinations for grouping the separation processes within the facility, the operations should follow certain guidelines[6]:

- Pathways should be as straight as possible;
- The system should be designed to encounter changes in the feed stream;
- Conveyance and free fall to move material should be maximized;
- The adjustability of the system should be maximized; and
- The independence of devices should be maximized.

These guidelines allow the entire operation to continue functioning if there are any equipment failures or unexpected materials in the stream. Equipment redundancy and easy maintenance are other factors that will help prevent the need to ever shut down operations, but will add to the overall costs of the facility.

The facility layout will include a unloading area for the delivered materials, pre-sorting area, area requirements for the unit separation operations, storage and transporting areas, sizing for the parking and traffic flow patterns for the facility, and additional buffer space. Scales at the entrance to the Regional Waste Management Facility will be utilized to weigh both incoming and outgoing materials. According to the "*Environmental Standards for Material Recovery Facilities - Final Draft*" released by the Newfoundland and Labrador Department of Environment in September 2003, the unloading area will be large enough to accommodate a two days worth of material delivery in case problems occur within the facility. Large volumes of materials may need to be stored to gain better leverage in the market or during periods when the markets are poor (optional).

The interior of the facility will be large enough to allow changes in interior layout and the addition of new equipment to accommodate increases in population and the possibility for program expansion. There should be a minimum number of interior columns to allow maximum flexibility for equipment placement and the possibility to rearrange the layout in

[6] Dubanowitz, A. J., 2000. Design of a Materials Recovery Facility (MRF) for Processing the Recyclable Materials of New York City's Municipal Solid Waste. Columbia University.

the future. The ceiling should be high enough to accommodate equipment specification. Conveyor lines, air classifiers, shredders and other processing equipment can be as tall as forty feet in larger MRF's. The design of the facility will also include space for employee facilities and possible touring and meeting areas.

The facility will be enclosed to control noise. Since shredding, baling and screening are dust-producing operations, dust collection systems and fans will be incorporated into the facility design. To combat the odours that result within the enclosed facility, a filtered ventilation system will be installed. Air emissions controls will be installed to prevent any pollution that could negatively impact the environment. Automatic sprinklers and control devices will be installed throughout the facility to suppress and prevent fires from spreading within the facility. Facility workers will be required to use hearing protection, hard hats, and dust masks for their protection.

6.4 MECHANICAL VS. MANUAL OPERATIONS

A major issue concerning the operation of the MRF is the choice between mechanical or manual separation techniques. Older, traditional MRF's rely heavily on manual sorting, which is both very expensive and time consuming when handling large volumes of materials. Labour represents one of the highest cost components of the MRF. There are trade-offs between operating and capital costs when considering whether to employ manual or mechanical separation processes. Despite these trade-offs, because of the high nature of labour costs, most long-term cost analyses will typically show that automated processing is usually more cost effective than manual processing[7].

Manual sorting can potentially produce higher quality material recovery, but is inefficient because of relatively low processing rates. Manual sorting also yields more rejected materials and misses a considerable portion of the HDPE and PET plastics in the waste stream due to the inability to target certain container shapes. If a plastic resin cannot be distinguished with the naked eye, it cannot be efficiently manually sorted and will therefore not be targeted. It is extremely difficult for a manual sorter to distinguish between PVC and PET plastics, but these resins can be separated quickly and accurately using automated systems.

In comparison to manual sorting, automated sorting usually results in lower labour costs, greater material recovery, and faster processing rates. Automation also has the advantages of reducing the health and safety risks that result from workers handling

[7] Dubanowitz, A. J., 2000. Design of a Materials Recovery Facility (MRF) for Processing the Recyclable Materials of New York City's Municipal Solid Waste. Columbia University.

wastes directly. Furthermore, machines can usually be adjusted to target new materials by just adding new sensors, and can consequently take more from the waste stream as new markets develop. However, despite all the advantages lists above, it may not be feasible to have a fully automated MRF, since there are certain automated unit operations that are not well proven and may still be unreliable. For example, there are available automated paper sorting technologies, but manual sorting remains the most reliable way to ensure quality separation. It is important to provide flexibility within the MRF to eventually allow automated technologies to replace manual operations and be integrated into the operation system.

The preferred MRF system for the Central Newfoundland Solid Waste Management Plan is a combination of mechanical and manual operations in the processing of recyclable materials. The system is described in more detail in the section below.

6.5 NEWFOUNDLAND AND LABRADOR ENVIRONMENTAL STANDARDS FOR MRFS

In September 2003, the Newfoundland Department of Environment issued "*Environmental Standards for Material Recovery Facilities – Final Draft*" that establish criteria and procedures for the recycling of dry materials in the province. These standards are provided in Appendix J and significant sections are discussed below. These standards apply to the development of facilities that receive dry waste materials for the purpose of recycling. These standards apply to all MRFs developed in the province regardless of ownership. These do not apply to depots for the return of beverage containers. MRFs are also subject to registration in accordance with the *Environmental Protection Act* and as detailed in the *Environmental Assessment Regulations.*

6.5.1 SITING

- The MRFs shall be sized appropriately for the anticipated quantities and types of material to be received;
- MRFs are not to be located in an area near land occupies by, or zoned for residential or commercial development;
- MRFs shall not be developed in parks, nature reserves, areas where there may be endangered species of plants and animals, wildlife migration corridors, areas with historical significance, bogs, marshes, wetlands or areas with unique physical features;
- RWMA's shall either own or hold a long term lease on the site;
- Facilities shall be accessible year round on all weather roads that can accommodate the weigh and types of vehicles used; and

- Outdoor storage areas shall be located no closer than 25 m from the property boundary.

6.5.2 DESIGN REQUIREMENTS

Receiving Area - The receiving area is to be within a building and the tipping floor made of an impermeable material such as concrete. The receiving area shall be appropriately sized to provide storage for a minimum of two days worth of material delivery, without restricting truck or equipment movement.

Leachate and Surface Water Management System – Adequate ditching shall be place on the site to control storm drainage, according to local municipal requirements.

Odour Control Systems and Protocols – The building ventilation system shall be designed to maintain negative air pressure in the building when the doors are closed.
General Site Infrastructure

- *Access Requirements* – designed to handle the types and volumes of traffic anticipated;
- *Buildings* – Buildings shall be properly sized and designed for the application.
- *Fencing* – Adequate fencing and gates to prevent pedestrian and vehicular traffic from entering the facility during non-operational hours;
- *Water supply* – Adequate supply of clean water is required.

6.5.3 OPERATIONS

The operation will be conducted in a fashion which protects public health and safety, minimizes fire hazard, does not create a nuisance to adjacent areas, and will not contaminate ground or surface waters off-site.

Receiving Waste – Procedures must be in place to ensure only acceptable waste is accepted at the facility and if required, weight to determine quantities for accounting purposes. The source, type and amount of materials delivered to the site shall be properly documented and details made available foe inspection.

Acceptable Waste – The facility may accept only dry recyclable materials as defines in the certification of approval.

Site Access – Public access to the site is to be controlled so that the general public does not have direct access to the facility unless accompanied by staff members.

Hazardous Waste – Any hazardous waste received at the site shall be properly segregated and stored, and removed from the site on a regular basis by an approved licensed contractor.

Contingency Plans – Up-to-date contingency plan must be in place to effectively handle the effects of fire, odour, flood, power outage, spill, delivery of hazardous waste, or any other issue which could cause a disruption to proper facility operation.

Animal, Rodent, and Vector Control Program –An active vector and rodent control program is required.

Litter Control Program – Includes the requirement for tarping of loads and regular litter collection.

Dust Control Program – Roads shall be properly maintained and dust control programs implemented as required.

Fire Safety Program – Develop fire safety program in consultation with the local fire department and, where required, the Department of Forest Resources and Agri-Foods.

Groundwater / Surface Water Monitoring Program – Monitoring programs need to be developed which assess the impacts of site operations on groundwater and surface water.

Reporting Requirements – An annual report summarising the operation of the site is required.

6.6 PREFERRED SYSTEM

6.6.1 PROCESS OVERVIEW

With Wet-Dry collection, waste is separated into two categories: Wet materials (yard trimming, food scraps, soiled paper, animal waste) and Dry materials (glass containers, tin and steel cans, plastics). Since the Dry materials are kept separate from the Wet materials, recyclables are kept relatively uncontaminated increasing their marketability. The Wet material is directed to a compost facility while the Dry material would be delivered to the MRF for sorting.

Since the material would arrive at the MRF completely commingled in a single bag the materials would be sorted using a single conveyor system. A two conveyor system is typically used when materials arrive at the facility pre-sorted into fibres (cardboard, newsprint, etc.) and containers (pop cans, plastic bottles, etc.). It is assumed that the material will arrive at the MRF during on 8 hour shift and be sorted during two shifts per day, five days per week. Based on a work year of 250 days resulting in a theoretical throughput of 66 tonnes per day.

The two options for the single conveyor system are a "U" shaped line or a straight process line. The advantages and disadvantages of each process line is described in Table 6-2.

Table 6-2: Recycling Facility Technologies

Advantage/Disadvantage	"U" shape Process Line	Straight Process Line
1	multiple conveyors	simple conveyor system
2	conveyor can be upgraded to accommodate a two bag - dry collection system	conveyor cannot be upgraded to process a two bag - dry collection system
3	short baler feed conveyor	baler fed conveyor is as long as the process line
4	material can be pushed onto the baler feed conveyor from bunkers on both sides	material can only be pushed onto the baler feed from bunkers on one side
5	standard pre-engineered building	customized pre engineered building (long, narrow building would be required)

Based on the above a "U" shaped process system has the most flexibility for the long term operation of the facility and is recommended.

6.6.2 LANT LAYOUT

The building would consist of three separate areas, a tipping floor, process floor and bale storage . The building would be a pre-engineered "conventional" steel framing (beams and columns) building with open web steel joists spanning the building width to create a column free floor area. The exterior walls of the plant would be pre-finished metal siding with metal building insulation. The roof of the plant would be a prefinished metal standing seam system.

The tipping area would be uninsulated with reinforced concrete push walls to a height of 3.65 m. The tipping floor would accommodate the storage of two days worth of material delivery in case problems occur within the facility.

The process room has been sized for the necessary sorting and baling equipment. The area would be insulated but unheated. A loading dock area has been provided for loading of bales into trucks for delivery to market.

The bale storage room would provide storage for baled material. The bale storage room should be capable of storing approximately one full trailer load of each commodity. Excess bales can also be stored along the south wall of the process room if necessary. An asphalted trailer storage area would be provided outside the north wall of the plant next to the truck loading area. Figure 6-1 schematically outlines the building components.

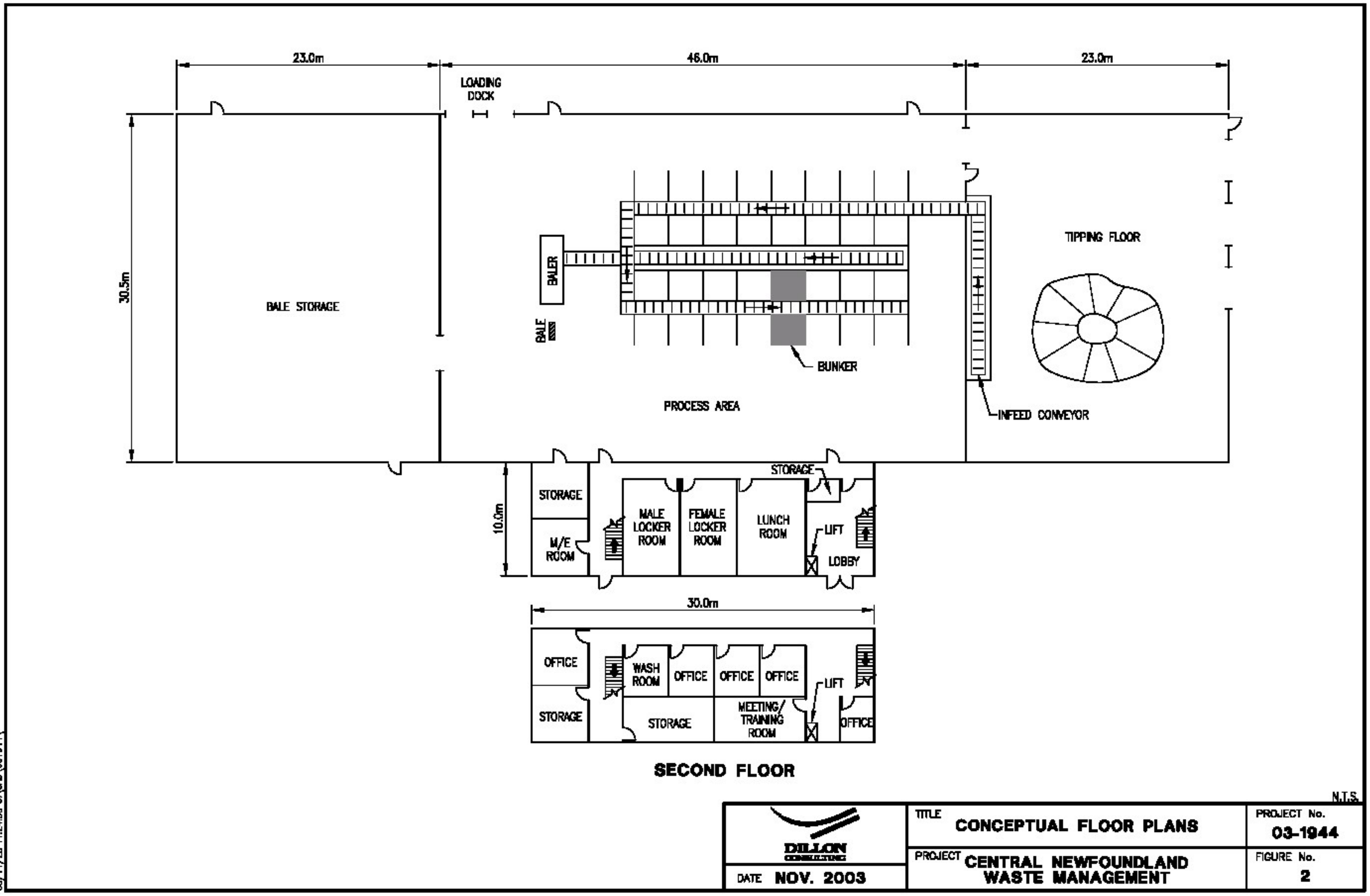

Figure 6-1: Concept Floor Plan for Material Recovery Facility.

6.6.3 PROCESS LAYOUT

The receiving process begins as a material delivery vehicle enters the facility and proceeds to the weigh scale station. An employee registers the vehicle, weighs it, and directs it to the receiving area/tipping floor. Vehicles back into the building and deposit their loads directly onto the concrete tipping floor.

Delivery vehicles would be directed by a staff person to place the material on the floor of the tipping room in a designated area where it would be visually inspected for contaminants, and then moved by a loader into the appropriate stockpile or directly onto the infeed conveyor. Contaminants would be removed and placed into containers for approved disposal. Staff people would be properly trained to recognize hazardous materials and how to handle them. Hazardous materials would be segregated and stored for off site disposal.

After discharging their material, vehicles then proceed back to the weigh scales to have the empty weight registered before leaving the site.

After the material has been inspected by a staff person approved material is pushed onto the process line infeed conveyor by a front end loader or skid steer loader. This conveyor is located along the wall that separates the tipping floor and process area. By having this conveyor run parallel to this wall the area for material storage and vehicle and equipment manoeuvring is maximized.

The infeed conveyor (rubber belted with steel cleats) would carry material to an inclined conveyor which raises the material to the height of the sorting station platform, approximately 4.5 metres.

Since the material on the conveyor consists of commingled fibres and containers automatic pre-screening would be required to remove large pieces of OCC and other material from the material stream that may hinder the sorting of other items and prevent bridging of the bag opener.

An automatic drum style bag opener would open any bags still in the material stream.

The material would then enter the sorting stations. Sorting stations would be enclosed for heating and ventilation purposes. This would provide a more comfortable and safe atmosphere for the employee. It also allow for heating of a small work area instead of the entire process room.

A schematic breakdown of the process is shown in Figure 6-2. All stations would be manual sort stations with the exception of the magnetic separator. Material is manually picked off the conveyor line and deposited into a drop chute where it falls into a collection bunker. The height of the sorting platform is a function of the volume of material to be stored in a bunker and the ability of the equipment to manoeuver under the platform and push material out of the bunker.

Sorted material would be pushed from the collection bunkers onto the baler conveyer by a small loader. Completed bales would be transferred by a forklift and stored in a dedicated area of the building. For safety reasons it is assumed that the bales would only be stored a maximum of three high and that the storage area would be separated from the process area by a fire proof partition. The bales would be stored until there is enough to fill a minimum of one trailer load and then shipped to market. Non-ferrous aluminum would be compacted by a densifier separate from the baler. Sorted glass would fall into individual containers and be stored and shipped in the same containers.

The final bunker, larger that the bunkers for recyclable materials, provides storage for negatively sorted residue. This material would be loaded into trucks for disposal at the landfill.

To accommodate for the varying types and volumes of materials that will be processed the conveyors would be equipped with would have variable speed control to allow the process line to be slowed or accelerated as the material type and volume changes.

6.6.4 OFFICE LAYOUT

The office component would be a two-storey structure of conventional steel frame construction. The roof structure would consist of open web steel joists supporting a metal deck. Interior partitions would be of gypsum board metal stud construction.

The ground floor would provide support to the process line employees and include a lunch room and lockers rooms with washroom facilities. The building would have a general entrance into a lobby and a separate employee entrance. Storage has been included with access from the plant building for storage of baling wire and other materials necessary for the operation of the plant.

The second floor would contain office space for administrative staff and plant supervisors for both the MRF and for the landfill. To facilitate the viewing of the process operation the wall that separates the office area from the process area would be glassed along its entire length. This would allow visitors/staff to view the entire process line as well as direct tours

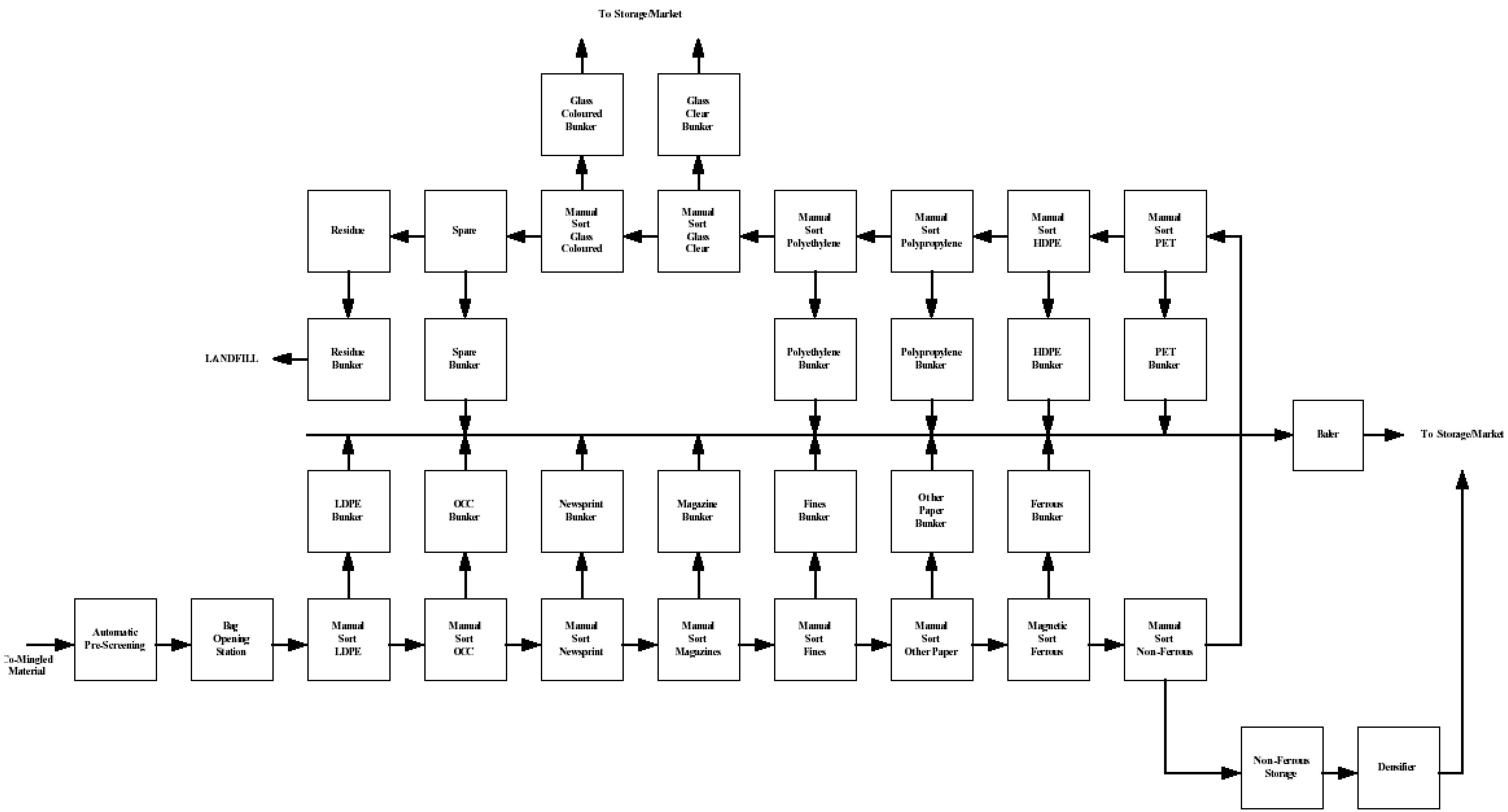

Figure 6-2: Flow Chart of Processing for the Material Recovery Facility.

without having to enter the plant building. Both floors would be designed for handicapped accessibility. A meeting/training room has been provided on the second for training of staff, public meetings and as an education room. A layout of the office space can be seen on Figure 7-1.

6.6.5 SITE DEVELOPMENT

Access to the facility would be via a two-way asphalted all season access road between the facility and the Norris Arm North Side access road. This road would also serve as access to the landfill. Signs stating the hours of operation, site rules, owner/operator, and permitted material types for the landfill and the MRF would be posted at the entrance to the facility. The entrance area would be landscaped.

Since the MRF may have different operational hours than the landfill and to control unauthorized access the entrance to the access road for the material delivery vehicles and employee parking would be equipped with a lockable gate. A system of TV cameras and intercoms would be positioned to view and record and communicate with the incoming traffic. Security fencing would be constructed on each side of the gate to prevent illegal entry onto the access road. For safety a fence would be installed around the fire pond. A general layout of the site building area is given in Figure 6-3.

The scale house would be a heated wood frame building with no washroom facilities. The inbound and outbound (optional if required) scales would have a 100 ton capacity. Since the scales will also serve the landfill radiation detectors would be positioned on the inbound scale. The detectors are very sensitive and are positioned on vertical post on each side of the scale. The purpose of the detectors are to detect materials that are not allowed to be landfilled.

Employee/visitor parking is provided including space for handicap parking and bus parking to allow for groups to visit the facility. A separate entrance/exit is provided for employees and material delivery vehicles.

With the landfill located a short distance away there is the potential for landfill gas to migrate to the vicinity of the MRF. For safety an active methane ventilation system would be installed under all buildings to prevent accumulation of methane gas.

Well(s) would be drilled on site to provide a potable water supply. The well(s) would be integrated into the groundwater monitoring network.

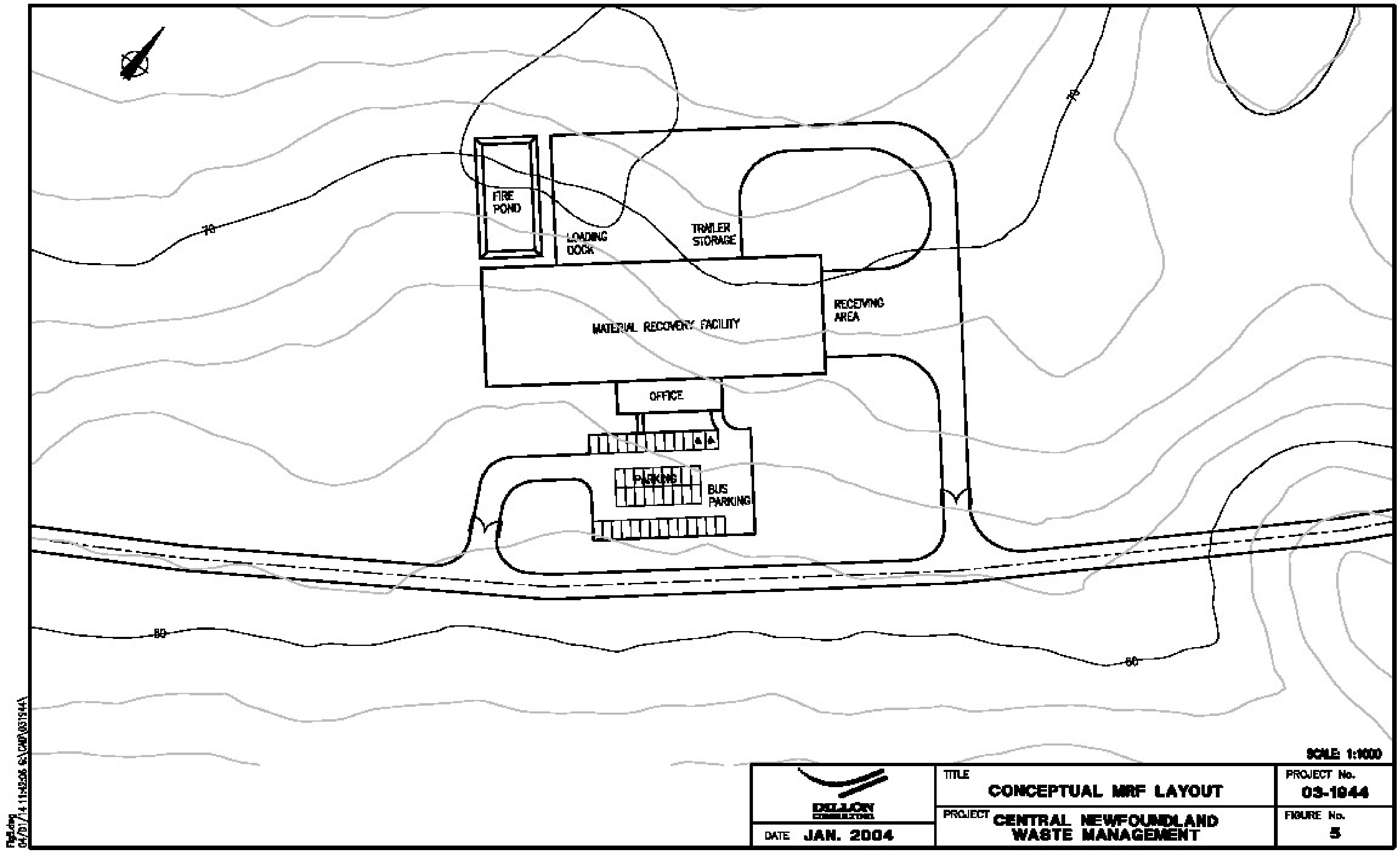

Figure 6-3: Layout of Materials Recovery Facility.

It has been assumed that the MRF would require a sprinkler system for fire protection. The water supply would be provided by a fire pond located near the MRF. If there is sufficient groundwater flow, groundwater could be used to recharge the fire pond. If groundwater is unavailable, stormwater from the MRF roof would be directed to the fire pond to aid in recharge.

Wastewater and sewerage from the MRF would be in sanitary sewer to a septic tank. Effluent from the septic tank would drain into a disposal field. The tank and disposal field would be sized to meet all applicable regulations.

The site would be serviced by 3 phase power and telephone lines which would be brought in along the site access road or along an alternate route chosen by the Newfoundland and Labrador Hydro. All site buildings would be serviced with electrical power and have telephones.

Lighting would be provide for all buildings and major site works. Flood lights would illuminate the scales, employee parking facilities and receiving areas.

Efforts would be made to preserve the existing landscape at the site where possible. Borrow, stockpile, and fill areas would alter the landscape and, efforts would be undertaken to try to blend theses features into the existing landscape. Tree planting would be undertaken on-site to enhance visual screening if required.

6.6.6 CONCEPTUAL COSTING

Capital Cost

Preliminary capital costing was developed based available prices for material recovery equipment and site development. The capital costs included:

- Site Work
- Buildings
- Utilities (excluding off site works)
- Roads
- Process Equipment
- Mobile Equipment
- Engineering

A summary of conceptual capital cost is provided in Table 6-3.

Table 6-3: Conceptual Capital Cost for Materials Recycling Facility.

Item	Cost ($)
Land Purchase - Assumed Solid Waste Management Commission would not have to purchase land.	$0
Building	$1,932,000
Concrete - Slab, Footings, and Bunkers.	$595,000
Mechanical	$400,000
Electrical	$450,000
Roadworks	$75,400
Fire Pond and Pump – Pond , Pumphouse, Generator, and Fuel Tank.	$115,000
Site Works – Fill material, Fencing, Signage, and Landscaping.	$136,000
Water and Sanitary – Water Well and Septic System.	$35,000
Process Equipment and Sort Lines – Conveyors and Controls, Bag Opener, Platforms and Enclosures, Magnetic Separator, Baler, Densifier, and Freight/Installation.	$2,100,000
Mobile Equipment – Tool carrier, Loader, and Forklift.	$240,000
Miscellaneous Site Works	$10,000
Sedimentation Control	$15,000
Sub-Total	$6,103,400
Contingency (10%)	$610,340
Engineering (15%)	$915,510
TOTAL	**$7,629,250**

Operating Cost

Operational cost were developed from existing operational costs for a MRF's and from other facilities and include:

- Wages and Benefits
- Fuel
- Maintenance
- Repairs
- Electricity
- Administration

A summary of conceptual operating cost is provided in Table 6-4.

Table 6-4: Conceptual Operating Cost for Materials Recycling Facility.

ITEM	COST ($/year)
Employee Salaries (20 Sorters, 2 Operators, 3 Administration)	$475,000
Employee Benefits	$95,000
Administration	$40,000
Electricity	$75,000
Heat	$10,000
Telephone	$10,000
Bailing Wire	$50,000
Equipment Maintenance	$25,000
Site Maintenance	$15,000
Vehicle Maintenance	$15,000
Vehicle Fuel	$10,000
Insurance	$75,000
Training	$15,000
Other	$10,000
TOTAL	$920,000
Contingency (20%)	$184,000
Proposed Annual Operating Budget	**$1,104,000**

7.0 COMPOST FACILITY

The processing of the organic (wet) materials is separate from the recyclable (dry) materials sorting line. Wet materials includes all organic materials, none recyclable paper, contaminated recyclables and normal garbage. Wet materials processing requires a separate sorting line, ventilated enclosed processing area, and a covered compost facility.

The Compost Facility will receive all wet waste. When wet waste arrives at the Organic Waste Processing Facility, it will be unloaded onto the tipping floor and inspected for non-processable materials. An in-floor conveyor will transfer waste through a bag breaker, where bags will be shredded and waste will be size-reduced. Next, a trommel screen removes over-sized materials and plastic film. Residual materials removed in the trommel screen will be sent to landfill. Remaining organic wastes pass under a magnet to remove all iron and steel materials. The waste will be then mixed with woodchips[8] and conveyed to the composter.

The following sections further describe the composing process, alternatives for composing, list of compostable materials, various available technologies, and the preferred composing option for the Central Newfoundland Region.

7.1 BACKGROUND INFORMATION

Composting is the enhanced degradation of organic matter by micro and other organisms. In order to ensure the destruction of pathogens efficient composting requires temperatures in excess of 55°C to be maintained for three consecutive days (in in-vessel systems). There are two fundamentally distinct methods of composting: aerobic and anaerobic. Aerobic composting occurs in the presence of oxygen while the anaerobic process in undertaken in the absence of oxygen. The two processes utilize different organisms for the degradation of organic matter. Anaerobic decomposition is generally a slow process and often generates foul odours as a result of the bio-chemical activity taking place within the organic material. Aerobic decomposition, by contrast, is typically much quicker and does not generate foul odours.

Considerable research has been undertaken in recent years into the application of anaerobic processes to organic waste; one advantage of these processes is the generation of methane that can be recovered for use as an energy source. However, the application of anaerobic composting as a waste management strategy and a commercial

[8] Woodchips are used in most compost operations to provide a bulking agent.

opportunity has generally not been successful and for this reason this document focuses on aerobic systems.

The following factors control the aerobic composting process:

- Nutrient balance
- Moisture content;
- Aeration;
- Temperature;
- Particle size;
- pH; and
- Extent of mixing.

7.1.1 NUTRIENT BALANCE

The balance of nutrients within the material to be composted is essential for effective composting activity and is typically expressed in terms as the ratio of one nutrient to another.

The carbon:nitrogen (C:N) ratio is one of the most important parameters to manage for successful composting. To support the microbiological activity that results in compost activity, compost feedstock must be blended to achieve a C:N ratio in the range of 20:1 to 30:1. Ratios lower than 20:1 imply that compost feedstock is too nitrogen rich, which can result in the creation of unpleasant odours. Ratios higher than 30:1 imply that compost feedstock contains insufficient nitrogen to support optimum microbial activity; this results in a slowing of the rate of decomposition. It is important to note that the carbon in the C:N ratio is only the decomposable carbon, not total carbon.

Different types of organic materials contain different levels of both carbon and nitrogen. The C:N ratio of wood wastes may be in the range of 400-700:1, municipal solid wastes 40-100:1, and manure 15-20:1. Wood and cellulose material tends to have a high C:N ratio, while green leafy/vegetable material and animal wastes have lower ratio. As green leafy/vegetable matter dies, however, the C:N ratio rises.

Other nutrients required for effective composting includes phosphorus, potassium, calcium, cobalt, manganese, magnesium, and copper. Generally, these are available within compost feedstock in quantities that do not limit the effectiveness of composting activity.

7.1.2 Moisture Content

A moisture content of 50 – 60 % by weight of the material to be composted is conducive to rapid decomposition. Greater amounts of moisture increase compaction within the material to be composted, thereby creating a denser mass of material that restricts the flow of oxygen. This slows the rate of decomposition and may cause the material to become anaerobic. In addition, the generation of large amounts of leachate will require control at additional cost.

Too little moisture slows composting, as it causes the relative desiccation for the microorganisms that results in decomposition.

7.1.3 Aeration

As indicated above, aerobic composting requires the presence of oxygen to support microorganisms, which metabolize oxygen as a function of living. It is therefore essential that the material be composted be sufficiently porous to allow the flow of air through the material mass. Too little oxygen slows aerobic decomposition processes. On the other hand, too much oxygen may imply too much porosity in the compost pile, which results in too great a release of the heat generated by microbial activity. The porosity of the compost pile is dependent on the moisture content of the pile and the particle size of the pile.

7.1.4 Temperature

The generation of heat is a function of microbial activity within a mass of composted material to be composted. As decomposition takes place, heat generation associated with microbial activity occurs. The rise in temperature within the compost pile is conducive to more rapid microbial activity, which in turn results in increased heating of the mass. As a result of this process, the internal temperature of a composting mass may rise as high as 80 ^{o}C before the population of microorganisms start to exceed the supply of nutrients. At this point, the rate of decomposition begins to decline and temperature within the composting material also declines.

Maintaining thermophilic temperatures (i.e. temperatures above 50oC) within the compost for a period of several days ensures the destruction of any pathogens in the compost feedstock and renders any seeds inactive. Failure to achieve thermophilic temperatures indicates some operational inadequacy that is inhibiting effective composting, such as incorrect moisture levels, an inadequate C:N ratio, improper aeration or some other factor.

7.1.5 PARTICLE SIZE

The particle size of the feedstock affects the composting process. The size of feedstock materials entering the composting process can vary significantly. In general, the smaller the shreds of composting feedstock, the higher the composting rate. Smaller feedstock materials have greater surface areas in comparison to their volumes. This means that more of the particle surface is exposed to direct microbial action and decomposition in the initial stages of composting. Smaller particles within the composting pile also result in a more homogeneous mixture and improve insulation. Increased insulation capacity helps maintain optimum temperatures in the composting pile. At the same time, however, the particles should not be so small as to compact too much, thus excluding oxygen from the void spaces

Compost feedstock particle sizes that range between 1.3 to 7.6 cm (O. 5 to 3.0 inches) are most efficient. The lower range is suitable for forced aeration systems while the larger range is preferred for windrows and other systems supplied with oxygen by passive diffusion and natural convection.

7.1.6 PH LEVEL

A pH level in the range of 5.5 – 8.0 is required for effective composting. In practice, it is important that the initial pH levels are within this range. The pH drops to the lower end of this range during the initial stages of composting (sometimes lower in the composting of fruit waste), and then rises during later stages. Lime can be added to correct for low pH, but ammonia may be lost.

7.1.7 EXTENT OF MIXING

The mixing of composting material is important for three reasons:

- It redistributes microorganisms. Microorganisms have extremely limited mobility. Consequently, there is great potential for microorganisms to live and die in one location within the compost mass, which is not conducive to rapid composting. Mixing results in redistributing microorganisms throughout the composting mass;

- Oxygen supplies are renewed. The flow of air through a composting mass may stagnate as composting proceeds. The mixing of the compost mass results in renewing oxygen supplies and in venting carbon dioxide; and

- Ensures pathogen / seed destruction throughout the compost mass. As described above, thermophilic temperatures destroy pathogens and seeds, which occur in the interior of the compost mast. Towards the exterior of the compost mass, however, thermophilic temperatures are difficult to maintain as heat leaves the compost mass faster than microorganisms generate it. Mixing ensures that thermophilic temperatures are achieved throughout the compost mass.

The speed at which composting occurs is a function of the degree to which these various parameters are controlled and, as a consequence, the extent to which conditions for microbiological activity are optimized. The following section describes various developed technologies to achieve optimum composting conditions and these are described in the following section.

7.2 MUNICIPAL COMPOSTING

The recovery and composting of biodegradable solid waste can play an important role in helping municipalities reach high diversion rates. Besides the conservation of landfill volume, removing organics from landfills reduces methane generation and decreases the amount of food which would attract pests and vectors like seagulls and rats. Diverting organics from landfills also helps to reduce the amount of landfill leachate.

A key step in planning a municipal composting program is to identify what organic waste will be composted. Potential compost feedstock's available in municipal solid waste include:

- leaves, brush and yard trimmings;
- grass clippings;
- food waste;
- bio-solids and sewage sludge;
- soiled or contaminated paper;
- food processing waste;
- organic industrial wastes and by-products (soiled paper, pulp and paper sludge); and
- agricultural waste.

The most common portion of the organic waste stream that is composted is leaf and yard waste. Unlike food waste or biosolids, leaf and yard waste is relatively easy to collect and process, with less concern for health issues. This allows the waste to be composted with low-tech, low-cost composting methods, often outdoors in piles known as windrows.

The composting of food and yard waste in central locations has been adopted by many Canadian municipalities. Many municipalities in Nova Scotia collect residential and commercial organic waste and transport it to centralized facilities for composting. In New Brunswick, the Westmoreland Albert Solid Waste Corporation collects food waste from residents in their Wet-Dry program. Similarly, the City of Edmonton collects and compost food waste as well.

An issue that can cause serious concerns for municipal composting is that of capacity. Capacity demand can fluctuate with each season, especially in the spring and fall. Also, capacity demand can fluctuate with economic conditions. Typically, as the economy improves, the amount of waste improves also. To accommodate this, it is important that the expansion of the facilities is included in the planning process.

To adequately deal with these issues and others, it is extremely beneficial to have an experienced composting facility operator managing the facility. Composting facilities are complex and unexpected problems can quickly arise. An experienced operator can prevent the problems from occurring, or keep the situations that do arise from becoming a public relations issue.

7.3 Acceptable Materials

Listed below are some categories of materials from the organic waste stream (feedstock) that will be accepted at the composting facility:

- **Food Waste**: Fruit & vegetable peelings, table scraps, meat, chicken & fish, shellfish, dairy products, cheese, cooking oil, grease & fat, bread, rice, pasta, bones, egg shells, coffee grounds & filters, tea leaves & bags;
- **Yard Waste**: Grass, leaves & brush, house & garden plant waste;
- **Boxboard & Soiled Paper**: Boxes such as; Cereal, shoe, tissue, cracker & cookie boxes, toilet paper rolls & paper towel rolls, food napkins, paper towels and other soiled paper; and
- **Other**: Sawdust & wood shavings.

No ashes or plastics of any type will be accepted at the facility.

7.4 ESTIMATED ANNUAL QUANTITY OF COMPOSTABLE MATERIAL

The total annual quantity of compostable (organic) materials produced in the study area will include all the organics produced from the residential waste stream and the IC&I waste stream. The IC&I organics will be accepted by the Regional Waste Management Facility because the low annual volume produced by the IC&I sector may be too low to justify the development of its own composting facility. Table 7-1 below provides a breakdown of the quantity of organics produced by the Residential and IC&I sectors.

Table 7-1: Quantity of Organics Produced in the Study Area

Waste Stream	Percentage of Waste Stream (%)	Annual Tonnage (Tonnes)	Annual Volume m^3 (Compacted)
Residential	41.7	10, 726	11,918
IC&I	15.21	3,159	3,510
Total	-	13,885	15,428

7.5 PREPROCESSING TECHNOLOGIES

During preprocessing, the organic materials received at the facility are prepared for composting. Preprocessing has a significant impact on the quality of the finished compost product and the speed at which processing can be conducted. In general, the more effective the preprocessing the higher the quality of the compost and the greater the efficiency of processing. Three procedures are typically performed during preprocessing include: 1) sorting feedstock material and removing materials that are difficult or impossible to compost; 2) reducing the particle size of the feedstock material; and 3) treating feedstock to optimize composting conditions. These procedure are described in more detail in the following subsections.

7.5.1 SORTING

The level of effort required to sort and remove unwanted materials from the composting feedstock depends on several factors, including the source of the feedstock, the end use of the product, and the operations and technology involved. The more diverse the feedstock material, the more sorting and removal will be required. The end-use specifications for the finished compost product can also affect the level of effort involved as some end uses require a higher quality product than others. For example, compost that will be used as landfill cover can have higher levels of unwanted materials than compost that will be used on food crops.

In general, sorting of MSW prior to composting requires more labour and machinery than sorting yard trimmings because of the diversity of MSW. Both the physical and chemical materials found in the feedstock can have a negative impact on the marketability of the finished product. Both manual and mechanical techniques can be used to sort feedstock materials and remove unwanted items. Manual separation along a conveyor belt represents the most effective method to remove noncompostable materials and chemicals from feedstock. Health and safety provisions for manually sorting are particularly important in the case of MSW feedstock, which might contain potentially dangerous items such as syringe needles, pathogenic organisms, broken glass, or other materials that could cause injury or infection. Mechanical sorting and removal techniques are based on the physical (i.e., weight and size) properties of the feedstock materials. Some of the available mechanic technologies for sorting organics are describe below:

- **Screens** - Screens are used in most MSW composting facilities to control the maximum size of feedstock and to separate materials into size categories. The main purpose of this size fractionation is to facilitate further separation. Screens separate small dense materials such as food scraps, glass, and small, hard plastic pieces from the bulky, light fraction of the feedstock. The type of screen used depends on the moisture content, cohesiveness, heterogeneity, particle shape, and density of the feedstock to be segregated.

- **Wet separation technologies** - Wet separation technologies are separate materials based upon density. Water is used as the floating medium in these technologies. After entrainment in a circulating water stream, the heavy fraction drops into a sloped tank where it moves to a removal zone. The lighter organic matter floats and is removed from the recirculating water using stationary or rotating screening systems similar to those employed by wastewater treatment facilities. This technology is particularly effective for removing glass fragments and other sharp objects.

- **Ballistic or inertial separation** - This technology separates inert and organic constituents based upon density and elasticity differences. Compost feedstock is dropped on a rotating drum or spinning cone and the resulting trajectories of glass, metal, and stones, which depend on density and elasticity, bounce the materials away from the compost feedstock at different lengths.

7.5.2 REDUCING THE PARTICLE SIZE OF THE FEEDSTOCK

Size reduction usually is performed after noncompostable have been separated from the compostable feedstock. The exact order of steps varies in different composting operations depending on the type and volume of feedstock to be composted. Proper sequencing of these preparation processes can have a significant impact on system performance.

The primary reason for performing size reduction is to increase the surface area to volume ratio of the feedstock materials. This enhances decomposition by increasing the area in which microorganisms can act upon the composting materials. If composting materials are too small, however, air flow through the compost pile will be reduced. This reduced oxygen availability has a negative impact on decomposition. Maximizing composting efficiency requires establishing a balance between reducing particle size and maintaining aerobic conditions. Particle sizes of 1.3 to 7.6 cm (O. 5 to 3.0 inches) are most efficient.

Size reduction homogenizes MSW feedstock materials, achieving greater uniformity of moisture and nutrients to encourage even decomposition. A variety of size-reduction devices are available, the most common of which are hammermills, shear shredders, and rotating drums.

- **Hammermills** - Hammermills reduce the size of feedstock materials by the action of counter rotating sets of swinging hammers that pound the feedstock into smaller sized particles. The hammer axles can be mounted on either a horizontal or a vertical axis and usually require material to pass through a grate before exiting. Mills that lack the exit grate are termed flail mills.

- **Shear shredders** - Shear shredders usually consist of a pair of counter rotating knives or hooks that rotate at a slow speed with high torque. The shearing action tears or cuts most materials, which helps open up the internal structure of the particles and enhances opportunities for decomposition.

- **Rotating drums** - Rotating drums use gravity to tumble materials in a rotating cylinder. Material is lifted by shelf-like strips of metal along the sides of the drum, which can be set on an incline from the horizontal. Some of the variables in drum design include residence time (based on length, diameter, and material depth), inclination of the axis of rotation, and the shape and number of internal vanes (which lift materials off of the bottom so they can fall through the air).

7.5.3 TREATING FEEDSTOCK MATERIALS TO OPTIMIZE COMPOSTING CONDITIONS

To enhance composting, MSW feedstock can be treated before processing. Such treatment can optimize moisture content, carbon-to-nitrogen (C:N) ratio, and acidity/alkalinity (pH).

- **Moisture Content**: Maintaining a moisture content within a 40 to 60 percent range can significantly enhance the composting process. Before composting begins, the feedstock should be tested for moisture content. The "squeeze test" is a simple method of determining whether the moisture content falls within the proper range. If just a few drops of water are released from a handful of the feedstock when squeezed, the moisture content is acceptable. If a more definitive determination of moisture content is needed, a sample of the feedstock can be weighed, oven-dried at about 104°C for 8 hours, and weighed again. The moisture content can be derived by the following formula:

  moisture content = (wet weight – dry weigh) wet weight

  MSW compost mixtures usually start at about 55 percent moisture and dry to 35 percent moisture (or less) prior to find screening and marketing. Mechanical aeration and agitation directly influence the moisture content of the composting pile. Aeration increases flow through the composting pile, inducing evaporation from the interior spaces. Turning composting piles exposes the interior of the piles, releasing heated water as steam. This moisture loss can be beneficial, but if excess moisture is lost (i.e., the moisture content falls to 20 percent), rewetting might be required. MSW composting piles usually require additional water.

- **Carbon to Nitrogen (C:N) Ratio**: Most of the nutrients needed to sustain microbial decomposition are readily available in MSW feedstock. However, carbon and nitrogen might not be present in proportions that allow them to be used efficiently by microorganisms. composting proceeds most efficiently when the C:N ratio of the composting material is from 25:1 to 35:1. When the C:N ratio is greater than 35:1, the composting process slows down. When the ratio is less than 25:1, there can be odour problems due to anaerobic conditions, release of ammonia, and accelerated decomposition.
  While the diversity of MSW feedstock material makes an estimation of the C:N ratio somewhat difficult, a precise C:N ratio can be determined by laboratory analysis. Feedstock materials with different C:N ratios can be mixed to obtain optimal levels of carbon and nitrogen when necessary.

- **Acidity/Alkalinity (pH)**: The closer the pH of the feedstock material is to the neutral value of 7, the more efficient the composting process will be. If pH levels are significantly higher than 8 (an unusual situation), acidic materials, such as lemon juice, can be added to the feedstock. If the feedstock has a pH significantly below 6, buffering agents, such as lime, can be added.

- **Mixing**: Mixing is often required to achieve optimal composting conditions. Mixing entails either blending certain ingredients with feedstock materials or combining different types of feedstock materials together. For example, bulking agents (such as wood chips) are often added to feedstock materials that have a fine particle size (such as grass). Bulking agents have the structural integrity to maintain adequate porosity and help to maintain aerobic conditions in the compost pile. Bulking agents are dry materials and tend to have a high carbon content. Therefore, whenever bulking agents are used, care should be taken to ensure that C:N ratios do not become too high.
  Mixing is most efficient when it is conducted after feedstock sorting and size reduction and before processing begins. This can minimize the quantity of materials that must be mixed because noncompostable have been removed. In addition, once piles have been formed for processing adequate mixing becomes extremely difficult. For simple composting operations that do not require high levels of precision, mixing can be performed during size reduction or pile formation by feeding different ingredients or types of materials into these operations. When higher levels of precision are required, mixing equipment (such as barrel, pugmill, drum, and auger mixers) may be used. Most mixers also compress materials, which can reduce pore space in the feedstock and inhibit aeration in the compost pile.

7.6 Composting Technologies

After MSW feedstock materials are pre-processed, they can be introduced into the compost processing operations. During processing, various methods can be employed to decompose the feedstock materials and transform-them into a finished compost product. There are four main technologies used in composting municipal organic solid waste. These include:

- open piles;
- turned windrows;
- aerated static piles; and
- in-vessel systems.

These four technologies are described in the following sections.

7.6.1 OPEN PILES

Open piles, also referred to as heap composting, is one of the simplest of all composting methods, and one of the slowest. Heap composting is the decomposition of organics in small, open piles, and is most commonly seen in use by home composters. The open piles take advantage of the natural air movement through the heap. As decomposition occurs, the inside portion of the pile becomes active and heats. Warm air rises up and out of the pile, drawing cooler air in. While wind currents can help move air through the pile, larger heaps experience compaction and therefore are more difficult to aerate sufficiently.

Open pile composting is typically used for small amounts of organics, like backyard composting operations, and not in centralized operations. Therefore, this operation is not a recommended option for the study area.

7.6.2 OPEN AIR TURNED WINDROWS

Windrow composting involves placing the organic matter in long windrows or piles that are agitated or mixed for aeration on a regular basis. The sizes of windrows vary and depend on the size of the equipment used to turn the organics. For small windrows, a front-end loader can be used to agitate the pile, while larger or longer windrows may require a windrow turner. While they are regularly turned, windrows receive their aeration primarily through natural or passive air movement. If windrows are too large, anaerobic areas can be created within the pile, which can result in strong odours being released when the windrow is turned. Alternatively, windrows that are too small may not be able to achieve temperatures high enough for satisfactory composting. Because windrows are operated in the open, provisions must be made to control drainage and wind-blown debris.

This method of composting is very common for composting separately collected yard waste – such as leaves, brush, etc. – but because of odour and pest issues is not very common for composting food waste. In Europe, the German Government has banned open windrowing of organics that includes food wastes.

One of the advantages to windrow composting is that it is low-tech and can be built and operated at a relatively low cost. Because turned windrows are operated outdoors, fewer structures are required to be built. However, because of this, the potential for odours escaping is greater with a windrow than with a contained system. If a windrow is not properly cared for or is experiencing problems, odours can become a serious problem, especially when high-nitrogen feedstock's such as food waste or grass clippings are used.

Another advantage of windrow composting is the ability to handle fluctuations in waste flow. When a large influx of material enters the facility, such as grass clippings or yard trimmings in the spring or leaves in the fall, the windrow can be extended or another windrow constructed.

Capital costs are associated with the cost of the land (in order of 10 acres for 25,000 tonnes per year), preparation of the operating base for the windrows (i.e. impermeable), surface water drainage and treatment system, site works (i.e. grading, road construction and landscaping). Other major capital cost is the turning equipment, compost screening and brush shredding equipment.

Operating costs involve the operating and maintenance costs of a loader, turning equipment, a brush shredder, a compost screen, site management, surface water treatment chemicals, and the environmental testing of compost and the composting site. For 25,000 tonnes per year of yard waste this type of compost facility the capital cost would be in the range of $1 million to $2.5 million with an operating cost in the range of $40 to $80 per tonne. Overall cost (i.e. capital and operating) on a per tonne basis is not very sensitive to capacity of the facility – larger capacity sites do not reduce the per tonne costs significantly.

7.6.3 ENCLOSED TURNED WINDROW

This involves the same composting approach as above but the first 1 to 2 weeks of the windrow composting process being housed in an agricultural-style building (i.e. pole barn or fabric structure) with the building exhausted through a biofilter for odour treatment. This approach will enable a mixture of food waste and yard waste to be processed in a basically low-tech approach. After 2 weeks composting in the building, the compost would be windrowed outside, but not turned, for an additional 2 to 3 months. This approach can solve the odour issues with turned windrows operated in the open air when processing yard waste and food wastes.

Overall capital costs for a 25,000 tonne per year facility using this approach would be in the order of $3 to $5 million with operating costs in the order of $60 to $90 per tonne.

7.6.4 AERATED STATIC PILES OR WINDROWS

Organics composted in aerated static piles are shaped in windrows but are more heavily managed than the turned pile. The pile is not agitated, but instead air is blown into the pile to keep them aerated. Air is forced through pipes located below the compost pile to create either a negative or positive pressure within the windrow and thus encouraging airflow. Because the porosity of the material is crucial in keeping the pile uniformly aerated, amendments such as wood chips or brush are added to the material. To contain odours, absorb moisture and insulate the pile, a layer of finished compost is often used to cover the pile. Alternatively, the windrows can be covered with a fabric which enables the piles to breathe but sheds any rain which falls on the pile.

This approach is common in Europe but it is not very common in North America. The size of the site can be reduced because there is no space required between windrows for the turning equipment and the aeration process will reduce the time required to produce finished compost.

Capital costs associated with this process are similar to turned windrows except for the aeration pipe work and fans and the turning equipment. Overall capital costs for a 25,000 tonne per year facility would be in the range of $1 to $2 million with operating costs of $40 to $80 per tonne.

7.6.5 In-Vessel Systems

According to the "*Environmental Standards for Compost Facilities – Final Draft*" released by the Newfoundland and Labrador Department of Environment in September 2003, compost facilities handling more than 1,000 tonnes per year of organic waste from municipal sources shall be in-vessel type systems. Also, the composting material requires a building residency time of 50 calendar days to complete the primary and secondary (curing) composting and achieve a level of product maturity suitable for outdoor stabilization.

In-vessel composting systems are the most management and capital intensive of the four technologies. With these systems, organics (i.e. yard waste, food waste, food processing waste, agricultural wastes) are composted within a closed building or container. Typically, in-vessel composting systems use forced aeration and a mechanical turning process to speed up the composting process and reduce costs. The organics are processed in the in-vessel systems for between 1 and 4 weeks following which the material is cured.

In-vessel systems offer efficient control over the general management of the composting process, including odours, system biology, aeration, agitation, moisture, and particle size. This control makes them highly suitable for composting mixed municipal organics and biosolids, even within urban areas. For instance, Miller Composting operates an in-vessel composting system in Halifax Regional Municipality's busy Burnside Industrial Park and has experienced few odour complaints.

Because of extra capital costs associated with in-vessel composting, capacity must be very carefully planned and accounted for. Loads can peak during the spring and fall as residents send large loads of grass clippings, brush or leaves to the facilities. When planning its waste management system, the Halifax Regional Municipality carefully charted waste streams in order to determine the maximum capacity required by the composting facilities. However, spring and fall loads have been more than expected and have at times exceeded capacity. To reduce the load, the municipality is required to temporarily export organics to composting facilities in other municipalities.

There are a small number of composting systems that can be described as being in-vessel, in particular bin composting, rectangular agitated beds, silos, and rotating drums. These systems are described in more detail below:

- **Bin composting**: Bin Composting is one of the more simpler forms of in-vessel composting. With this system, organics are contained within one or more large containers that are force-aerated. Climate conditions within the bin – like pH, temperature and moisture – are carefully controlled. Little or no turning is required. Because the organics are compartmentalized, the size of the system can be tailored to either large or small operations. If the facility experiences an increase in load, then the operator can increase the facility's capacity by adding additional compartments. In doing so, however, the operator must also increase the size of the curing area. The New Era Farms composting facility in Halifax Regional Municipality encountered a similar problem in an attempt to expand the capacity of the facility. The composting facility first had to increase the size of its curing pad to handle the quantity of compost processed there. When the flow of organics increased, the facility was unable to add additional composting units because the curing pad addition had taken up the additional space.

  There are a number of companies marketing these types of technologies in North America and Europe. Typically the process involves mixing food waste and yard waste on an enclosed tipping floor and then loading the mixed organics into a fully enclosed bin with a forced aeration system and process instrumentation and controls. Exhaust from the bin is treated in an odour treatment system prior to discharge to the environment.

  The principal benefit of this type of system is that it can process a mixture of food wastes and yard wastes with minimal odour effects. The foot print of the facility is significantly less than a turned windrows system, reducing land costs. However these facilities require expertise in the operation of mechanical systems and biological processes to avoid the potential for odours.

  Capital costs of a bin system rated at 25,000 tonnes per year would be in the range of $10 to $15 million with an operating cost of $30 to $50 per tonne. Examples of this technology can be found in Halifax, Truro and the Region of Peel.

- **Rectangular agitated beds**: Rectangular agitated beds technologies are being used in Halifax and Guelph and many locations in the US and Europe to process a mixtures of food wastes, yard wastes, food processing wastes and bio solids. A number of technology suppliers sell this type of composting technology.

  The facilities involve concrete channels with an underfloor aeration system with a mechanical turning machine with travels along rails installed along the top of the channel walls. Organics are loaded into the channel from one end and discharged out of the other end by means of the turning machine, which travels down the channel on a daily basis. Typically the waste is processed in the channels for a 1 to 3 week period.

  The channels are installed within a building, which is provided with a building exhaust system and odour treatment system. The forced aeration system is designed to improve the performance of the biological composting process.
  The overall capital costs of these types of facility for 25,000 tonne per year capacity are in the range of $10 to $15 million with an operating cost in the range of $50 to $80 per tonne. This type of technology is particularly sensitive to the capacity of the facility, with overall per unit costs increasing with lower capacities and reducing with higher capacities. However, the technology is being used at a number of small livestock operations in Ontario to compost manures.

- **Silos:** Silos are another in-vessel composting system. Similar in configuration to a bottom-unloading agricultural silo, raw materials are added to the top of the silo, and an auger removes finished compost from the bottom. Air is forced up through the silo from the bottom and can be filtered at the top for odour control.

  The vertical stacking action of composting silos can minimize the land area needed for composting, but this can lead to problems with compacting, temperature control and airflow which in turn reduce the efficiency of the composting process and can create malodorous conditions. The compost is turned very little during the process, meaning that the feedstock must be very well mixed before entering the silo.

  The silo type of composting facility is being used at a number of locations in North America to compost dewatered bio solids from sewage treatment plants. As far as we are aware this type of process is not being used for composting a mixture of food wastes and yard wastes. It is therefore not recommended as technology option for the study area.

- **Rotating Drums**: Rotating drums use a horizontal vessel to mix, aerate and move composting material through the system. Raw materials are added at the front of the drum and are supplied with air through the discharge end. The length of the drum, its rotation speed and the inclination of the drum determine how long the material is in the system. To more carefully control the process, some drums are partitioned into two or three compartments. When compost reaches the end of the drum and is finished, the discharge end is opened and the finished compost removed.

  The rotating drum composting technology was developed in the 70's to process and compost mixed solid wastes collected from residences and businesses. This type of process is being utilized at the new composting facility in Edmonton. At this facility the mixed waste is processed and composted utilizing rotating drums and other mechanical processes, which separate out non organics from the mixed waste stream. The quality of the compost produced from this process is not critical in Edmonton since the compost will be used for the reclamation of open pit mines. It is generally recognized that the quality of compost produced from mixed waste is not good enough for the use of the product in agriculture or horticulture.
  This technology is not appropriate for the composting of source-separated organics and yard waste.

Table 7-2 ranks the various composting methods described here according to their cost and diversion potential. The rankings are low, medium or high and are relative to the other programs in the chart.

Table 7-2: Estimated costs of potential composting options

Composting Method	Material Composted	Capital Cost*	Operating Cost per Tonne*
Open Air Turned Windrow	Yard Waste	$1 million to $2.5 million	$40 to $80
Enclosed Turned Windrow	Yard Wastes Food Wastes	$3 million to $5 million	$60 to $90
Aerated Static Piles	Yard Wastes	$1 million to $2 million	$40 to $80
Bin (In-Vessel) Composting	Yard Waste Food Waste	$10 million to $15 million	$30 to $50
Rectangular Agitated Beds	Yard Wastes Food Wastes Bio Solids	$10 million to $15 million	$50 to $80

* Costing based on 25,000 tonnes per year capacity.

7.7 THE CURING STAGE

Once the materials have been composted, they are cured. Curing should take place once the materials are adequately stable. While testing for stability is an inexact science, oxygen uptake and $C0_2$ evolution tests can be considered to discern the degree of maturity of compost derived from MSW feedstock. One method is to monitor the internal temperature of the compost pile after it is turned. If reheating of the pile occurs, then the material is not ready for curing. Another method is to put the compost material in a plastic bag for 24 to 48 hours. If foul odours are released when the bag is opened, the materials are not ready for curing.

During the curing stage, compost is stabilized as the remaining available nutrients are metabolized by the microorganisms that are still present. For the duration of the curing stage, therefore, microbial activity diminishes as available nutrients are depleted. In general, materials that have completed the composting stage are formed into piles or windrows and left until the specified curing period has passed. Since curing piles undergo slow decomposition, care must be taken during this period so that these piles do not become anaerobic. Curing piles should be small enough to permit adequate natural air exchange. A maximum pile height of 8 feet often is suggested. If compost is intended for high-quality uses, curing piles should be limited to 6 feet in height and 15 to 20 feet in width.

According to the “Environmental Standards”, the first stage of the curing process is required to occur within a building. The compost pile will be placed within the building in windrow piles for approximately 28 days. Once this stage is complete the compost pile can be placed outdoors to complete the stabilization process. A minimum of 4 months is required to complete the stabilization process using outdoor windrows. A curing/stabilization process of this duration will allow decomposition of the composting materials to be completed. Once the curing process is completed, the finished compost should not have an unpleasant odour. Incompletely cured compost can cause odour problems.

7.8 ODOUR CONTROL

Sources of odours include various compounds that maybe present in composted organic wastes (such as dimethyl disulfide, ammonia, and hydrogen sulfide). These odours can be produced during different stages of the composting process: conveying, mixing processing, curing, or storage.

The types of odour controls chosen depend on the odour sources, the degree of odour reduction required, and the characteristics of the compounds causing the odour.

Some facilities collect and treat odorous gases from the tipping and composting areas. These include:

- **Biofilters** - Based on the "*Environmental Standards for Compost Facilities – Final Draft"* released by the Newfoundland and Labrador Department of Environment in September 2003, the compost facility shall use biofilters for odour control. In a biofiltration system, a blower or ventilation system collects odorous gases and transports them to the biofilter. The biofilter contains a filtration medium such as finished compost, soil, or sand. The gases are evenly distributed through the medium via a perforated piping system surrounded by gravel or a perforated aeration plenum (an enclosure in which the gas pressure is greater than that outside the enclosure). The incoming gas stream is usually moisturized to keep the filter medium from drying out.

  As the gases filter up through the medium, odours are removed by biological, chemical, and physical processes. Microorganisms oxidize carbon, nitrogen, and sulphur to non-odorous carbon dioxide, nitrogen, sulphate, and water before those compounds can leave the filter medium. The biofilter medium acts as a nutrient supply for microorganisms that biooxidize the biodegradable constituents of odorous gases. Biofilters also remove odorous gases through two other mechanisms that occur simultaneously adsorption and absorption. Adsorption is the process by which odorous gases, aerosols, and particulate accumulate onto the surface of the faltering medium particles. Absorption is the process by which odorous gases are dissolved into the moist surface layer of the biofilter particles. As microorganisms oxidize the odorous gases, adsorptive sites in the filtering medium became available for additional odorous compounds in the gas stream.

  Several different biofilter designs have been used in the composting industry. These include:

  1) Open System - Biofilter is placed directly on the soil surface, or portions can be placed below the soil grade. Typically an appropriate area of soil is excavated, an aeration pipe distribution network is placed in a bed of washed gravel, and the area is filled with the filter medium.

  2) Closed System - A closed system consists of a vessel constructed of concrete or similar material with a perforated block aeration plenum. The vessel is filled with the biofilter materials.

- **Odour Piles** – Odours from composting piles are diverted to flow over finished compost;

  To effectively remove ammonia from composting exhaust gases, other removal technologies such as acid scrubbing (discussed below) might be needed in addition to biofilters.

- **Air Scrubbers** - Air scrubbers use scrubbant solutions to remove odorous compounds through absorption and oxidation. In packed tower systems, the scrubbant solution is divided into slow-moving films that flow over a packing medium. The air stream being treated is usually introduced at the bottom of the packing vessel and flows upward through the medium. The scrubbant solution is recirculated to minimize chemical usage. In mist scrubber systems, the scrubbant solution is atomized into very fine droplets that are dispersed, in a contact chamber, throughout the air stream being treated. Mist scrubbers use a single pass approach: the chemical mist falls to the bottom of the chamber and is continuously drained.

- **Adsorption** – Gasses are passed over an inert medium to which the odour causing compounds attach, thereby cleaning the gases;

- **Dispersion Enhancement (i.e. tall stacks)** – Facilitates greater dispersion of the odorous gases, and;

- **Combustion** – Gases are captured and odorous gases are burned.

7.9 NEWFOUNDLAND AND LABRADOR ENVIRONMENTAL STANDARDS FOR COMPOST FACILITIES

In September 2003, the Newfoundland Department of Environment issued "*Environmental Standards for Compost Facilities – Final Draft*" that establish criteria and procedures for composting in the province. These standards are provided in Appendix J and significant sections are discussed below. These standards apply to the development of all in-vessel composting facilities and to outdoor windrow/static piles handling more than 1,000 tonnes per year of organic material.

Compost facilities handling more than 1,000 tonnes per year of organic waste from municipal sources shall be in-vessel type systems. Also, any proposed compost facilities are subject to registration in accordance with the *Environmental Protection Act* and as detailed in the *Environmental Assessment Regulations.*

Only guidelines for in-vessel type systems are discussed in this section due to the guidelines establishing that the facility must be in-vessel.

7.9.1 CONSIDERATIONS

The composting standards set out siting and operational requirements. Table 7-3 summarizes the general siting criteria.

Table 7-3: General siting criteria for compost Facilities in Newfoundland and Labrador

<table>
<tr><th>Siting Requirement</th><th colspan="2">Criteria</th></tr>
<tr><td>Land Use</td><td colspan="2">Avoid 100 year flood plains, parks, nature reserves, areas where there may be endangered species of plants or animals, wildlife migration corridors, areas with historical significance, wetlands or areas with unique physical features.

Avoid seismic zones, fault areas or other geologically unstable areas.</td></tr>
<tr><td>Access and Road Restrictions</td><td colspan="2">Access roads shall be accessible year round by the weight and type of vehicles anticipated.</td></tr>
<tr><td>Airport</td><td colspan="2">Consult Transport Canada if within 20 km of a licensed airport.</td></tr>
<tr><td>Soil Conditions</td><td colspan="2">For outdoor windrows, composting shall be conducted on an impermeable pad made of concrete or asphalt.</td></tr>
<tr><td rowspan="6">Separation Distances</td><td rowspan="2">Property Type</td><td>Minimum Separation Distances from active compost areas (m).</td></tr>
<tr><td>In-vessel</td></tr>
<tr><td>Property Boundary</td><td>50</td></tr>
<tr><td>Residential, Industrial, Commercial, and Institutional Properties</td><td>1,600</td></tr>
<tr><td>Water Courses, Rivers, and Lakes</td><td>150</td></tr>
<tr><td>Water Supply</td><td>300</td></tr>
</table>

7.9.2 DESIGN REQUIREMENTS

Receiving Area - The receiving area for in-vessel systems shall be within a building and the tipping floor shall be made of an impermeable material such as concrete. The receiving area and tipping floor shall be appropriately sized to accommodate at least 2 days of incoming waste, without restricting truck or equipment movement. Adequate provision for containing any moisture from the organic material shall be in place.

The facility shall be designed to minimize the amount of time that the doors are required to be opened when trucks are delivering material.

Composting and Curing - Buildings shall be sized to accommodate a material residency time of no less than 50 calendar days to complete the primary and secondary (curing) composting and achieve a level of product maturity suitable for outdoor stabilization.

Storage and Stabilization - Storage capacity is required on-site for a minimum of four months of material to allow stabilization of compost prior to shipment to market.

Leachate Management System - Provide for collection of all leachate generated by the process and function all year round. Discharge of treated leachate into the environment shall be compared to background surface water quality data and comply with the appropriate CCME Environmental Quality Guidelines, based on water use in the area.

Surface Water Management System - A surface water management and control system, as part of a surface water management plan, shall include:

- Appropriate erosion and siltation controls;
- Landscaping;
- Appropriate ditching for diversion of stormwater;
- Storm water settling pond for sediment removal prior to discharge;
- Appropriate diversion channels to minimize run-on/run-off to working areas of the compost facility; and
- An appropriate sampling schedule and analysis for key indicators.

Surface water discharged from the site shall comply with the appropriate Canadian Environmental Quality Guidelines and the *Environmental Control Water and Sewage Regulations*.

Odour Control Systems and Protocols - All in-vessel systems require a properly designed bio-filter for odour control. Negative pressure shall be maintained inside of the buildings when the doors are closed. Proper operational odour management protocols shall be in place.

General Site Infrastructure

- *Access Requirements* – designed to handle the types and volumes of traffic anticipated;
- *Buildings / Corrosion Protection* – Buildings shall have corrosion protection, particularly in air handling systems, building structural components and various items such as bolts, hanger brackets, electrical panels, etc.;

- *Fencing* – Adequate fencing and gates to prevent pedestrian and vehicular traffic from entering the facility during non-operational hours;
- *Water supply* – Adequate supply of clean water is required.

7.9.3 OPERATIONS

The proponent is required to have an operations manual as well as an up-to-date contingency plan. Also, key personnel are required to be trained in proper compost facility operations and hold certification through the Compost Council of Canada sponsored programs. At least one person shall be certified as a compost facility operator.

Odour Management – Operational protocols for odour management shall be in place. Maintenance and monitoring procedures for bio-filters need to be developed and followed.

Receiving Waste – Procedures must be in place to ensure only acceptable waste is accepted at the facility. A designated inspection and holding area is required for waste that may be suspected of containing hazardous materials. Any material accumulated will be removed from site, by an appropriately licensed contractor, on a regular basis.

Operational Management – Operational monitoring is required and proper records of the monitoring is to maintained:

- Temperature – In vessel systems shall achieve a temperature of 55^{o}C for 3 consecutive days in the composting material;
- Moisture – Moisture content shall be maintained within the optimum range of 40 and 60%; and
- Carbon – Nitrogen Ratio – Records of the raw material mix and the C:N ratio shall be maintained.

Finished Product Testing – The finished compost is to be tested for quality on a regular basis, at least every 1,000 tonnes of production, or prior to marketing any product.

Site Access – Public access to the site is to be controlled so that the general public does not have direct access to the facility unless accompanied by staff members.

Post Processing – Shall be completed in a fashion which minimizes the potential for windblown litter and dust.

Storage and Stabilization – Storage and stabilization shall be properly sized, operated and maintained in order to manage the flow of material.

Leachate Management – Leachate management shall be maintained throughout the life of the site.

Animal, Rodent, and Vector Control Program –An active vector and rodent control program is required.

Litter Control Program – Includes the requirement for tarping of loads and regular litter collection.

Dust Control Program – Roads shall be properly maintained and dust control programs implemented as required.

Fire Safety Program – Develop fire safety program in consultation with the local fire department and, where required, the Department of Forest Resources and Agri-Foods.

Groundwater / Surface Water Monitoring Program – Monitoring programs need to be developed which assess the impacts of site operations on groundwater and surface water.

Reporting Requirements – Daily inspection reports detailing the day-to-day activities on the site are required.

7.10 IN-BIN VERSUS IN-VESSEL COMPOSTING

During the initial stage of composting, the incoming waste or feed stock is mechanically and manually separated into material that can be composted or material that cannot or would be harmful to the composting process. After separation, the material will be reduced in size by shredding and a bulking agent (i.e. wood chips) will be added. This stage is common to all types of composting processes. Once pre-processing is complete, the feed stock will then be transferred to a either a in-bin or in-vessel compost. These two systems are described in more detail in the following sections.

7.10.1 IN-BIN COMPOSTING SYSTEM

After the incoming waste has been processed in the pre-processing system, the feed stock is delivered to bins to begin the first stage of the composting process. The bins are fully enclosed and covered, usually stainless steel interior and a steel exterior of various dimensions. The bin is usually insulated to control the heat produced when the organic materials decompose and have a capacity of 30 to 40 m^3 of feedstock. Each bin is loaded with a mixture of feedstock and bulking agent and then composted as a batch. Additional bins are added as more feedstock is delivered. The bins can be loaded with a bucket loader, conveyor or other special machinery.

In most bins, air is introduced at the base of the feedstock and flows up through the feedstock into a headspace at the top. In other bins, air flows in the opposite direction, from the headspace to the base of the bin. Typically, the air from the bottom or headspace is exhausted through a biofilter to control odours. Several bins can be aerated from a single fan by connecting individual bins to a distribution heater with aeration controlled by a computer that constantly monitors moisture content, time or temperature depending on the system. Leachate typically drains in the air distribution space at the base of the bin where it is either collected for later reuse or is directed to holding tanks.

Aerated bins are essentially static systems. No agitation or turning takes place within the bin. Therefore the feedstock must carefully be blended and well mixed prior to loading. Many systems allow for the bins to be emptied so that the materials can be examined, supplemented with water or more bulking agents, re-mixed, and reloaded for continued composting. However, the process of emptying and reloading bins obviously requires labour, time and expense so it is not practiced in many cases. After this composting process is complete, the feedstock is transported to the curing phase. Photo 7-1 below shows a typical in-bin composting system.

Photo 7-1: Typical In-Bin Composting System.

7.10.2 IN-VESSEL COMPOSTING

After the incoming waste has been processed in the pre-processing system, the feedstock is delivered to the vessels to begin the first stage of the composting process. Vessel are typically long concrete channels with an aerated floor and rails on top of the walls. Aeration is provided in multiple zones along the length of the vessels. Each zone is aerated by a dedicated blower located in the aisles along the sides of the vessels. The blowers are computer controlled based on temperature readings from sensors for each zone in the vessels, and by a baseline timer.

The compost tuner is a machine that rides on the rails on top of the walls, and begins processing at the open end of the vessel where the feedstock is loaded. As the turner moves down the vessel, it mixes, aerates, shears and moves the feedstock about three to four metres towards the discharge end with each pass. Typically, the turner would make one pass per day through each vessel such that by the end of 14 to 28 days, the compost has finished the first stage of composting and is discharged out of the end of the vessel.

By maximizing the rate of stabilization, the vessel systems also minimize the potential for problem odour generation. The regular turning of the feedstock mechanically breaks down the materials into smaller particle sizes. This agitation exposes new surfaces for decomposition and minimizes the occurrence of dead zones within the vessel where anaerobic conditions can be developed and odours can be generated. The frequent mixing provided by the agitated vessel system facilitates the use of a wider variety of bulking agents making use for other waste products, such as yard waste, wood waste, or grades of recycled paper that have limited markets. The frequent mixing ensures that the more heterogeneous feedstock’s are broken up, stabilized, and thoroughly mixed in the vessel.

The agitation brings several advantages. Feedstock mixtures, and therefore the compost produced, are more uniform. Uniformity also improved because agitation breaks up air channels that form within the composting mass. Usually less bulking agent can be used when agitation is provided. Added water is also reasonably well distributed when agitation is provided. Without agitation, adding water is more difficult. Methods to agitate materials within containers vary among composting systems. The photo below depicts a typical n-vessel system. The turner is on the right of the photo.

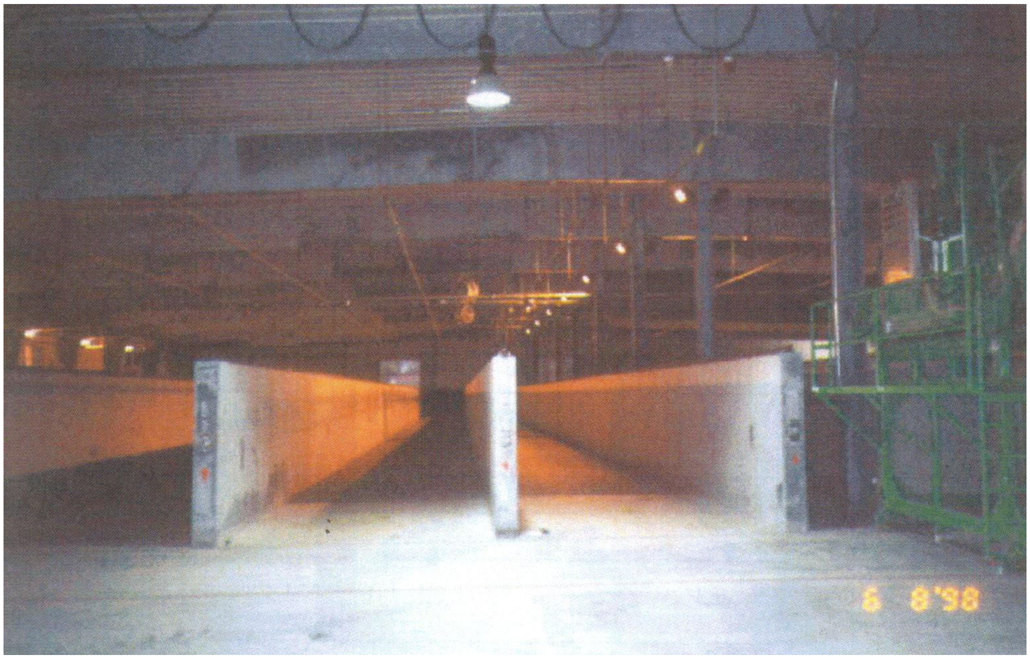

Photo 7-2: Typical In-Vessel Composting System.

7.10.3 CAPITAL COST COMPARISON: IN-BIN VERSUS IN-VESSEL COMPOSTING

Preliminary capital costing was developed based on available prices for similar composting plants. The capital cost included the following:

- Site Work;
- Buildings;
- Utilities;
- Roads;
- Process Equipment;
- Odour Control;
- Mobile Equipment;
- Sediment Control; and
- Engineering.

The estimated capital cost to construct an in-bin compost plant ranges from approximately \$600 to \$980 per tonne delivered and from approximately \$600 to \$850 for an in vessel system. Based on this range, the conceptual capital cost for a 17 000 tonne compost plant would range from \$10,200,000 to \$16,700,000.

7.10.4 OPERATIONAL COST COMPARISON: IN-BIN VERSUS IN-VESSEL COMPOSTING

Operation cost were developed from existing operation cost for a 5,000 annual tonne compost plant and estimated operation cost from other facilities and included the following:

- Wages and Benefits;
- Fuel;
- Maintenance;
- Repairs;
- Electricity;
- Administration;
- Testing; and
- Leachate Removal.

The estimated operation cost for an in-bin or in-vessel range from approximately \$55 to \$75 per tonne delivered. Based on this range, the estimated annual operating cost for a 17,000 tonne compost plant would be in the range of \$940,000 to \$1,300,000.

7.11 OPTION # 1: WRIGHT ENVIRONMENTAL COMPOSTING SYSTEM

Under the two stream (wet/dry system), all compostable material will arrive at the facility in the "wet" bag. The wet bag materials will includes all organic materials, non-recyclable paper, contaminated recyclables and normal garbage. Wet bag materials are estimated to account for 30% of the waste stream. The wet bag material will be processed on a separate processing line. It is assumed that approximately 16, 011 T/year of wet waste will be delivered to the facility, with 13, 885 T/year will be organics.

The facility will have a footprint of approximately 285 m x 155 m.

7.11.1 PRE-PROCESSING OF ORGANIC WASTE

When wet waste arrives at the Regional Waste Management Facility, it will be weighed on the scales at the entrance to the facility and then delivered to the compost facility where it will be unloaded onto the tipping floor and inspected for non-processable materials. An in-floor conveyor will transfer waste through a bag breaker, where bags will be shredded and waste will be size-reduced. Next, a trommel screen removes over-sized materials and plastic film. Residual materials removed in the trommel screen will be sent to landfill. Remaining organic wastes pass under a magnet to remove all iron and steel materials. The waste will be then mixed with woodchips[9] and conveyed to the composter.

The pre-processing equipment will be housed in the same building as the in-vessel composter.

Two scenarios for pre-processing the "wet waste" are provided in Figures 7-1 and 7-2. The two scenarios use the same processing equipment but the layout of each system is different.

[9] Woodchips are used in most compost operations to provide a bulking agent.

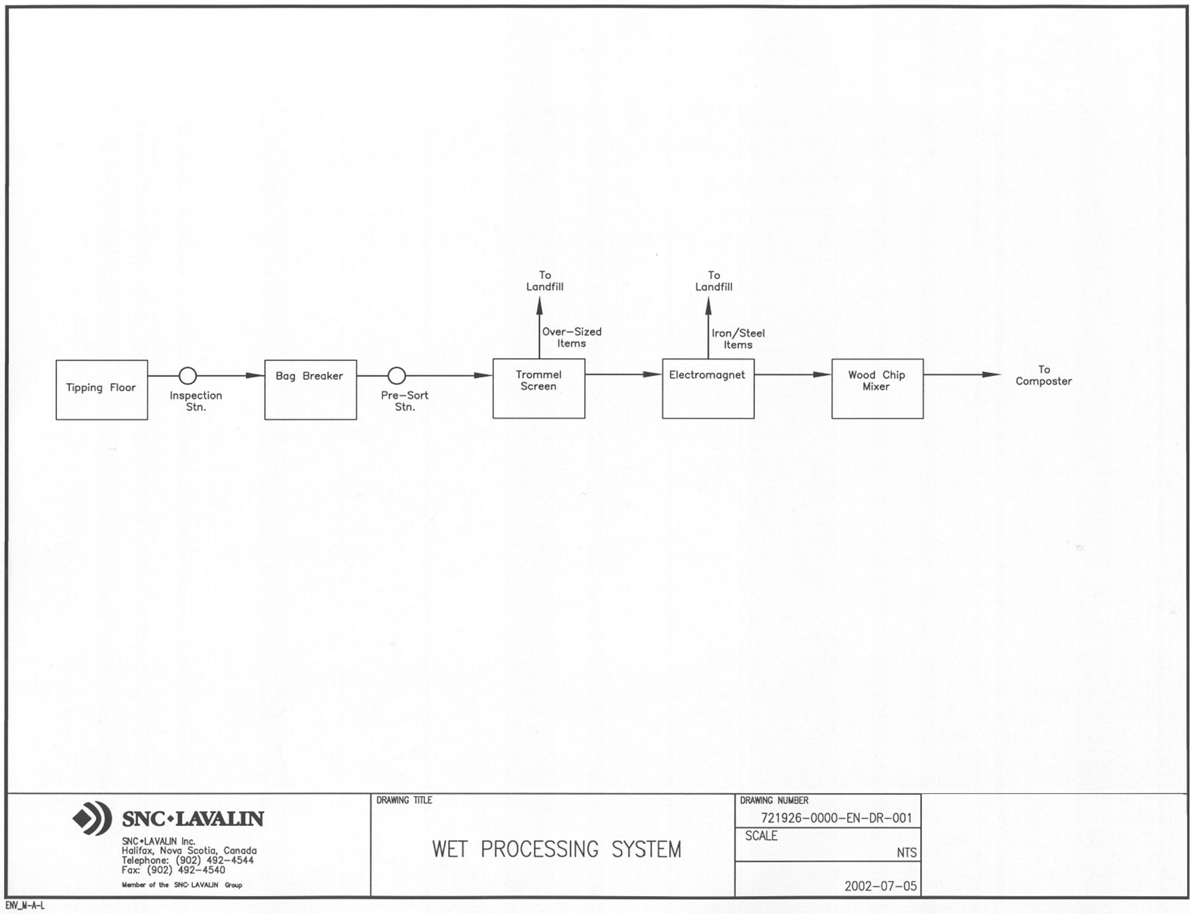

Figure 7-1: Process Flow Diagram for the Preferred Organic Processing System (Option #1)

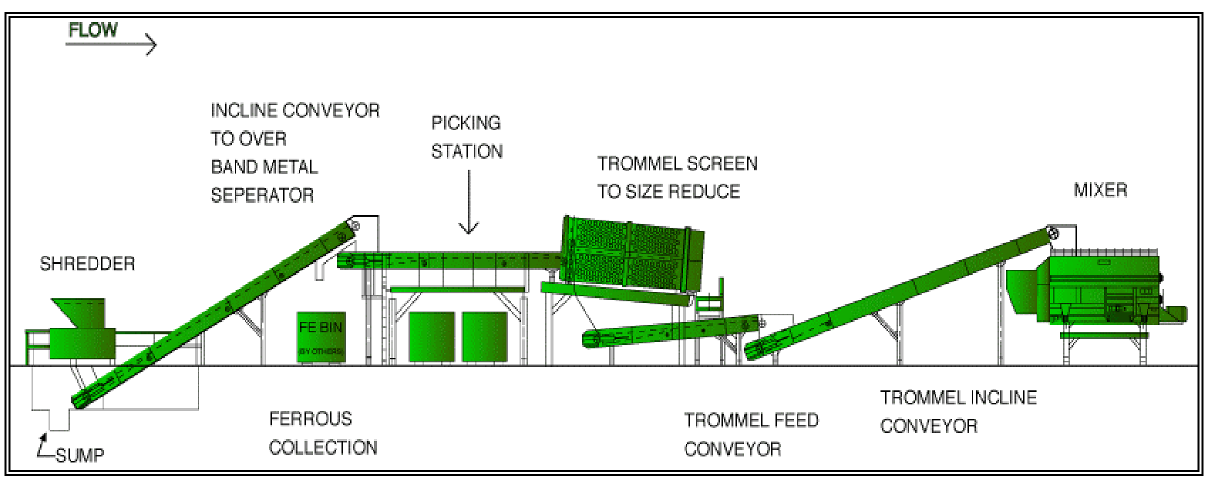

Figure 7-2: Conceptual Design of Pre-Processing “Wet Bag” System

7.11.2 COMPOSTING SYSTEM

According to the *Newfoundland and Labrador Environmental Standards for Composting Facilities*, the compost material requires to be contained within a building for 50 calendar days to complete the primary and secondary (curing) composting. The in-vessel system will have a residency time of 14 days. The compost material will be placed in indoor windrows for the remaining 36 days

The material will then undergoes four months of outdoor windrow stabilization. Compost will be screened to remove oversized materials prior to transport to market.

<u>In-Vessel System</u>
More detailed information on the Wright in-vessel system is provided in Appendix K.

The composting system uses fully enclosed, flow-through tunnels that can transform organic wastes into a soil-like material after 14 days retention in-vessel. Odours are contained by maintaining the tunnel under negative pressure and by filtering tunnel exhaust air through an effective biofilter. An aeration system and an automatic watering system will be implemented into the composting system to maintain the temperature, biological activity, and moisture of the compost.

Composting material is moved in a plug flow fashion through the composting tunnel. Material is supported on tray flooring that is pushed forward as a continuous unit by an external hydraulic ram. When the ram is moving an empty tray into the tunnel, all trays within the tunnel are moving forward. As an empty tray is being inserted, compost from a single tray is being unloaded at the tunnel end using a series of horizontal breaker bars and a discharge auger. The auger discharges the compost from the unloading tray onto a conveyor and the tray emerges from the tunnel ready for inspection and re-use. As one tray is pushed into the tunnel, one tray is discharged from the tunnel through a small door located below the level of the auger.

Incoming material is composted for one half of the total retention days in Zone 1. Composting material then moves through a set of spinners that act to mix the material and move it into the next zone. Water is added during material cross-mixing to re-establish proper moisture levels. Material remains in the second zone for an additional number of day's equivalent to retention time in Zone 1. The product is then automatically removed from the tunnel.

Leachate that drains out of the composting material flows into plenums that run along the base of the tunnel and from the plenums to sump boxes located at the sides of the tunnel.

Leachate is typically pumped back into the tunnel from the sump boxes through pipes located at each sump box. Leachate can be pumped from the sump boxes for treatment if desired.

A conceptual design of the in-vessel system is provided in Figure 7-3.

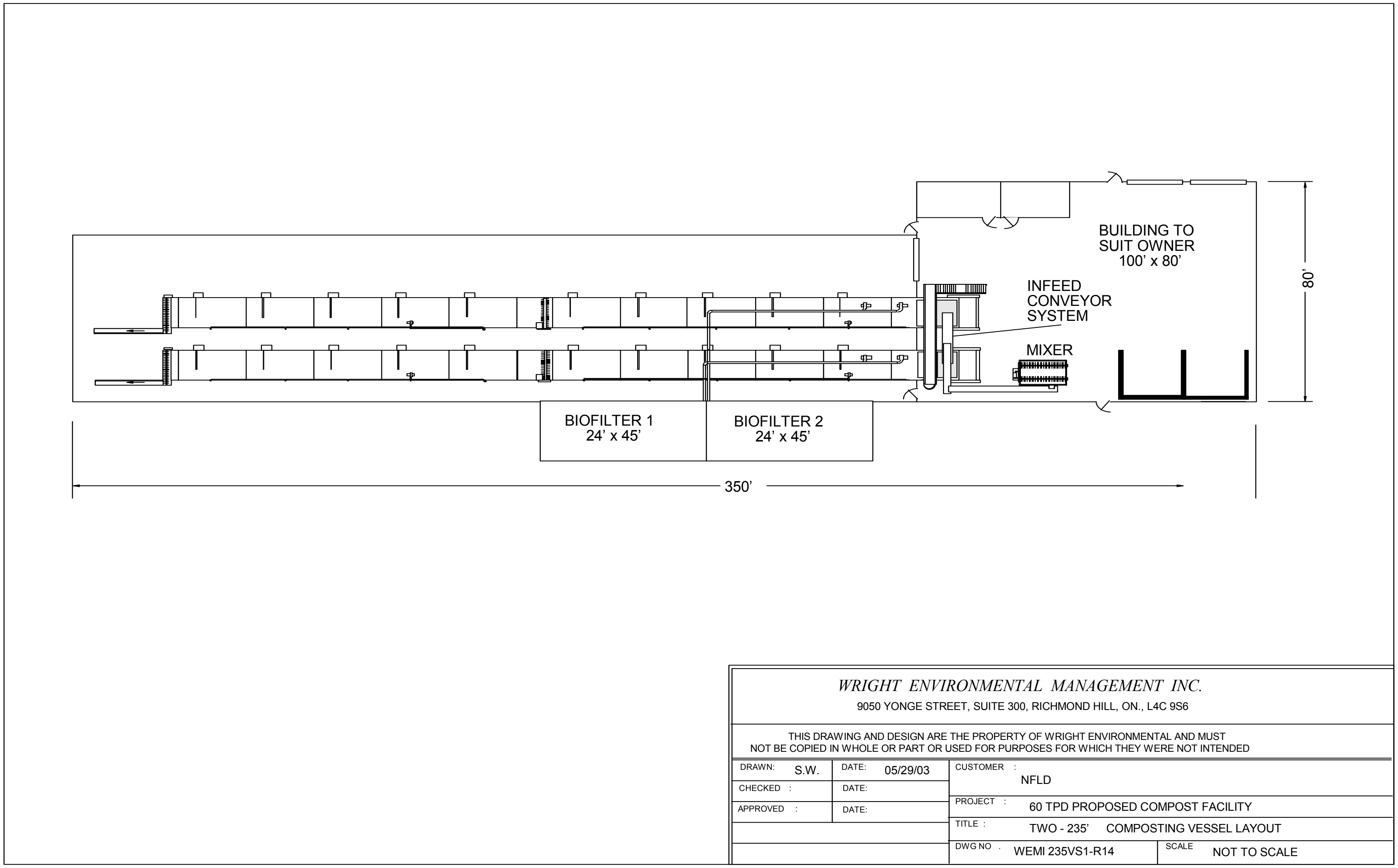

Figure 7-3: Conceptual Design of Composting System

Composting and Processing Equipment

- Remote Mixer - Mixing will be completed using a remote mixer.

- Mixer Discharge Conveyor and Tunnel Feed Conveyor - The in-feed conveyor will convey feedstock from the remote mixer to the tunnel feed conveyor and into the composter tunnels. A loading platform adjacent will be provided to allow an operator to monitor the tunnel loading process.

- Composting Tunnel (60 Tonnes per day system) - Two composting tunnels will be provided to compost 30 tonnes (each) per day of the specified feedstocks. Each tunnel is approximately 235' long by 10' feet wide

- Tunnel discharge Conveyor - The vessel discharge conveyor is provided to convey compost from the discharge chute at the rear of the composter tunnel away from the tunnel to a bunker or holding area.

- Process Control System - The electrical control system for the composting tunnel and associated equipment includes:

    - Composter Control Panel to deliver power to all tunnel motors and electrical components, tunnel feed conveyor and tunnel discharge conveyor;

    - Biofilter - The biofilter is a natural filtration system that cleanses the air stream of organic and inorganic odorous compounds. The biofilter medium is specially blended to sustain physical and biological activity through ideal organic content, surface properties, porosity, pH and moisture content. The biofilter is approximately one meter in depth constructed with piping laid in a base of water washed stones covered with a carefully selected mixture of organic materials. Biofilter medium will be provided including water washed stones, air distribution pipe and required biofilter media to cover the stones and pipe.

Indoor Windrow Composting

Once the in-vessel composting process is completed, the compost pile will be placed in indoor windrow piles for approximately 36 days. A 30% volume reduction from the original compost feedstock was assumed.

The piles will be approximately 2 m in height, 6 m wide, and 45 m in length. To accommodate 36 days of compost material for curing you require 3 piles. The area of the building to accommodate this volume is approximately 58 m x 65 m. Piles are spaced by approximately 10 m to allow for equipment operations.

Outdoor Windrow Stabilization

To complete the curing and stabilization process the compost material will be placed in outdoor windrow piles for approximately 4 months. A 35% volume reduction from the original compost feedstock was assumed.

The piles will be approximately 2 m in height, 6 m wide, and 45 m in length. To accommodate four months of compost material for stabilization you require 8 piles. The area required to accommodate this volume is approximately 138 m x 60 m. Piles are spaced by approximately 10 m to allow for equipment operations.

7.11.3 CAPITAL AND OPERATIONAL COST OF WRIGHT ENVIRONMENTAL COMPOSTING FACILITY

The capital cost associated with the construction of the Wright Environmental Composting Facility is provided in Table 7-4.

Table 7-4: Capital Cost of the Wright Environmental Composting Facility.

Item	Cost ($)
Land Purchase - Assumed Solid Waste Management Commission would not have to purchase land.	$0
Site Preparation - Site grading, excavation, clearing, grubbing, etc. Assumed size of site would be 285 m x 155 m. Assumed an average of 1.0 m excavation and backfill for the site at $4.5/ m^3$.	$198,788
Composting Building- To accommodate pre-processing operations and composting operations it was assumed the building would have to be approximately 130 m x 30 m. The unit cost of the metal pre-engineered building including concrete floor is $800/m^2$.	$3,120,000
Indoor Windrow Building - To accommodate 4 weeks of compost for curing it assumed the building would have to be approximately 58 m x 65 m. The unit cost of the metal pre-engineered building including concrete floor was assumed to be $350/m^2$.	$1,319,500
Preprocessing and Composting Equipment	$4,200,000
Access Road - Assumed that approximately a 500 m access road would require construction. It was assumed the access road would require paving, at an assumed cost of $100/m.	$50,000
Onsite Paving - Assumed 500 m^2 of paving at a cost of $20/m^2$.	$10,000
Water Supply - A water supply will be needed for employee use, washroom facilities, and facility washdown. Cost of developing water supply for larger Waste Management Facility is not included. Cost includes connecting to water supply for main site and distribution throughout composting facility.	$20,000

Item	Cost ($)
Power Supply - Cost of developing power supply for larger Waste Management Facility is not included. Cost includes connecting to power supply for main site and distribution throughout composting facility. It was assumed that the power supply is approximately 500 m from the composting facility. The cost to extend the power supply was assumed at $25/m. Onsite electrical distribution was assumed to a lump sum of $2000.	$14,500
Sewer System - Assumed sewer services from composting facility will be connected to sewer services for larger Waste Management Facility. Assumed a lump sum of $5000 for piping.	$10,000
Loader	$150,000
Installation of Monitoring Wells	$15,000
Fencing and Gates - 3m fence around perimeter of site (approx. 880 m perimeter) at $55/m. $2000 was assumed for the cost of gates and $300 was assumed for signage.	$50,700
Sub-Total	$9,158,488
Contingency (10%)	$915,849
Engineering (15%)	$1,373,773
TOTAL	$11,448,109

The operational cost associated with the Wright Environmental Composting Facility is provided in Table 7-5.

Table 7-5: Operational Cost of the Wright Environmental Composting Facility.

ITEM	COST ($/year)
Staffing – Three full time employees @ $15/hour + 35% payroll burden	$126,360
Loader Operations	$160,000
Environmental Monitoring	$5,000
Leachate Treatment	$30,000
Maintenance (5% of capital equipment cost)	$210,000
Snow Clearing	$10,000
Power Lighting, misc	$15,000
TOTAL	$556,360

7.12 OPTION # 2: US FILTER IPS COMPOSTING SYSTEM

Under the two stream (wet/dry system), all compostable material will arrive at the facility in the “wet” bag. The wet bag materials will includes all organic materials, non-recyclable paper, contaminated recyclables and normal garbage. Wet bag materials are estimated to account for 30% of the waste stream. The wet bag material will be processed on a separate processing line. It is assumed that approximately 16, 011 T/year of wet waste will be delivered to the facility, with 13, 885 T/year will be organics.

The system is an enclosed in-vessel, agitated, aerated, automated process with biofiltration odour control. It is designed to process a variety of organic residuals and transform the material into a quality compost product. The system as a reputation for ease of operation and dependability. Surpassing its nearest competitor by more than 200 percent, it is the most widely used in-vessel system in North America. Because front end loaders load and off-load raw and finished materials into multiple open-top bays, complicated mechanical conveying systems are not needed. The bays and cure bunkers are open so access is easily afforded. One of the most desirable features is the IPS Composting System is comprised of multiple bays. This feature allows different materials to be received and processed under a wide variety or perimeters without changes in equipment or process. The facility will have a footprint of approximately 60 m x 130 m.

7.12.1 FACILITY PROCESS STEPS

Step 1: Mixed Solid Waste Receiving Area

Trucks will deliver “wet” waste to the receiving area. Operators will removed large non compostable materials from the waste stream for transport to the landfill. A front end loader can deliver selected organic residuals directly to the composting building and will place them n the receiving pit/conveyor.

Step 2: Pre-Processing Fermentation Drum

A conveyor will transfer the mixed solid waste from the pit into the fermentation drum. As needed, liquid (water) will be added to the drum and the material will remain in the rotating drum for 24 hours. The drum will then discharge the material into a two-tiered trommel screen that will separate the rejects (inorganic materials) from the organic compostable materials.

Step 3: Pre-Processing Transfer

Rejects from the receiving area and fermentation drum will enter a roll-off container for disposal in the landfill. A conveyor will transfer the organic fraction to the loading end of the compost processing building where a levelling screw will broadcast the material entry into the holding area.

Step 4: Compost Loading Area

A front end loader will transfer the organic materials to the front end of each bay. The yardwaste will go into designated bays that are separate from the mixed solid waste bays.

Step 5: Compost Agitator Machine

The compost agitator will automatically mix the contents of the bays once each day and mill move the composting material down the bay as it agitates the material.

Step 6: Compost Aeration and Temperature

The mixture will be automatically aerated, agitated and transported downs the concrete bays for a period of 30 days. Air supply to maintain aerobic conditions and optimum temperatures during the competing process will be forced up through each bay by process air blowers. Each bay will utilize four blowers that will be controlled by wall mounted temperature probes with each blower passing air to a different section of the bay.

Step 7: Compost Water Addition

Two sections of each bay will have spray nozzles within the bay walls. The sprays are automatically controlled to ensure optimum product moisture content and avoid over-drying the compost.

Step 8: Odour Control

Ventilation fans will exhaust and direct the process air out of the building through a piping system to a compost biofilter located next to the facility. The biofilter will adsorb and remove odorous compounds and release the cleansed air into the atmosphere.

Step 9: Composting Transfer to Finishing Area

After 30 days, the composted material will enter the discharge end of the bay. A front end loader will remove the finished compost from each bay and transfer the material to the Walking Floor Trailer in the Refining Area.

Step 10: Refining Area

The Walking Floor Trailer will meter the composted material in the Secondary Screen that will separate finer inorganic materials from the organic fraction. A front-end loader will transfer the organic fraction to the curing area.

Step 11: Curing Area

After 60 days of curing, the compost will be ready for distribution and marketing.

See Figure 7-4 for flow diagram and materials balance and Figure 7-5 for Layout of the proposed IPS Composting Facility for the Central Newfoundland Study Area. See Appendix L for more information on the US Filter IPS Composting System.

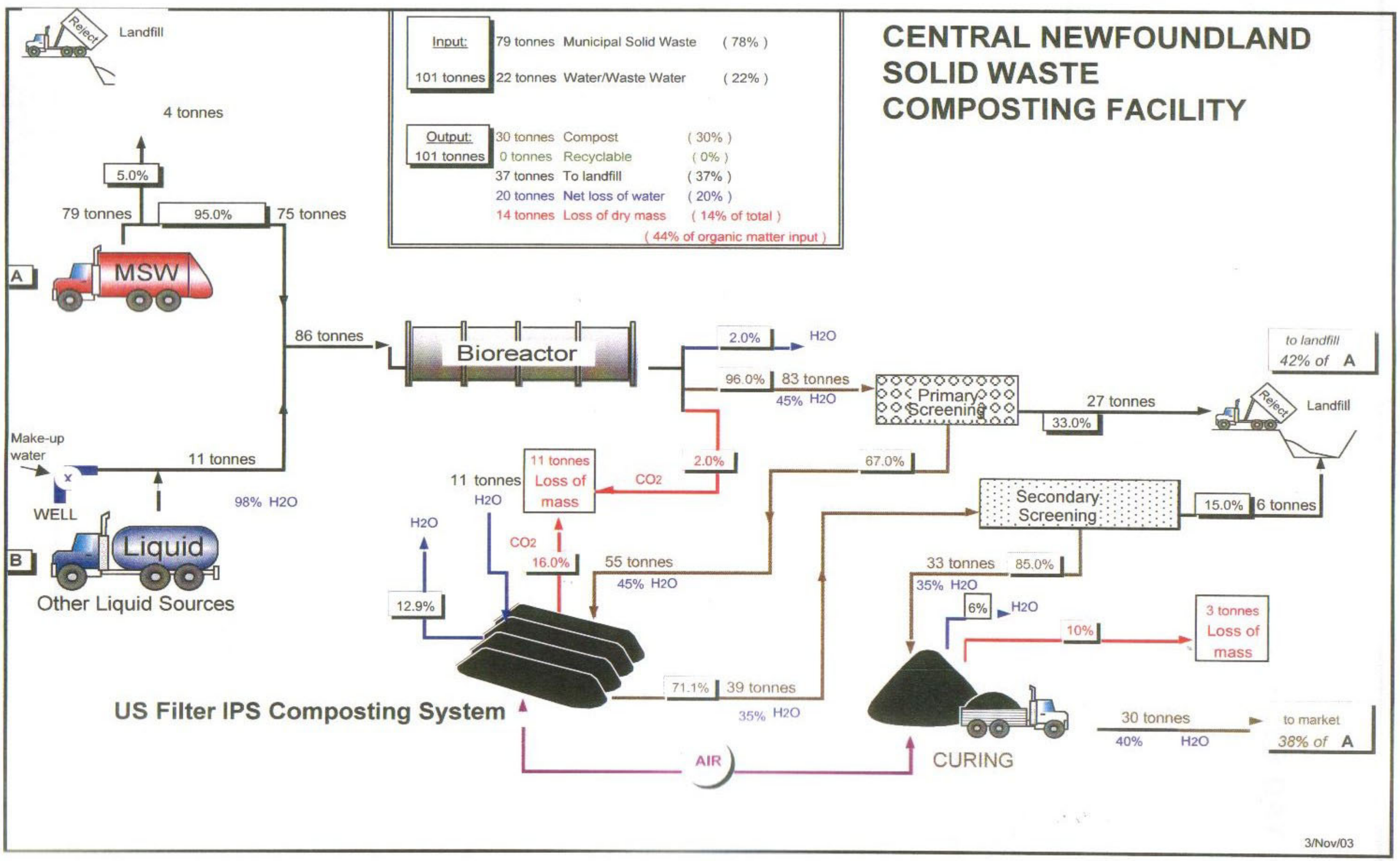

Figure 7-4: Flow Diagram and Materials Balance for US Filter IPS Composting System for Central Newfoundland.

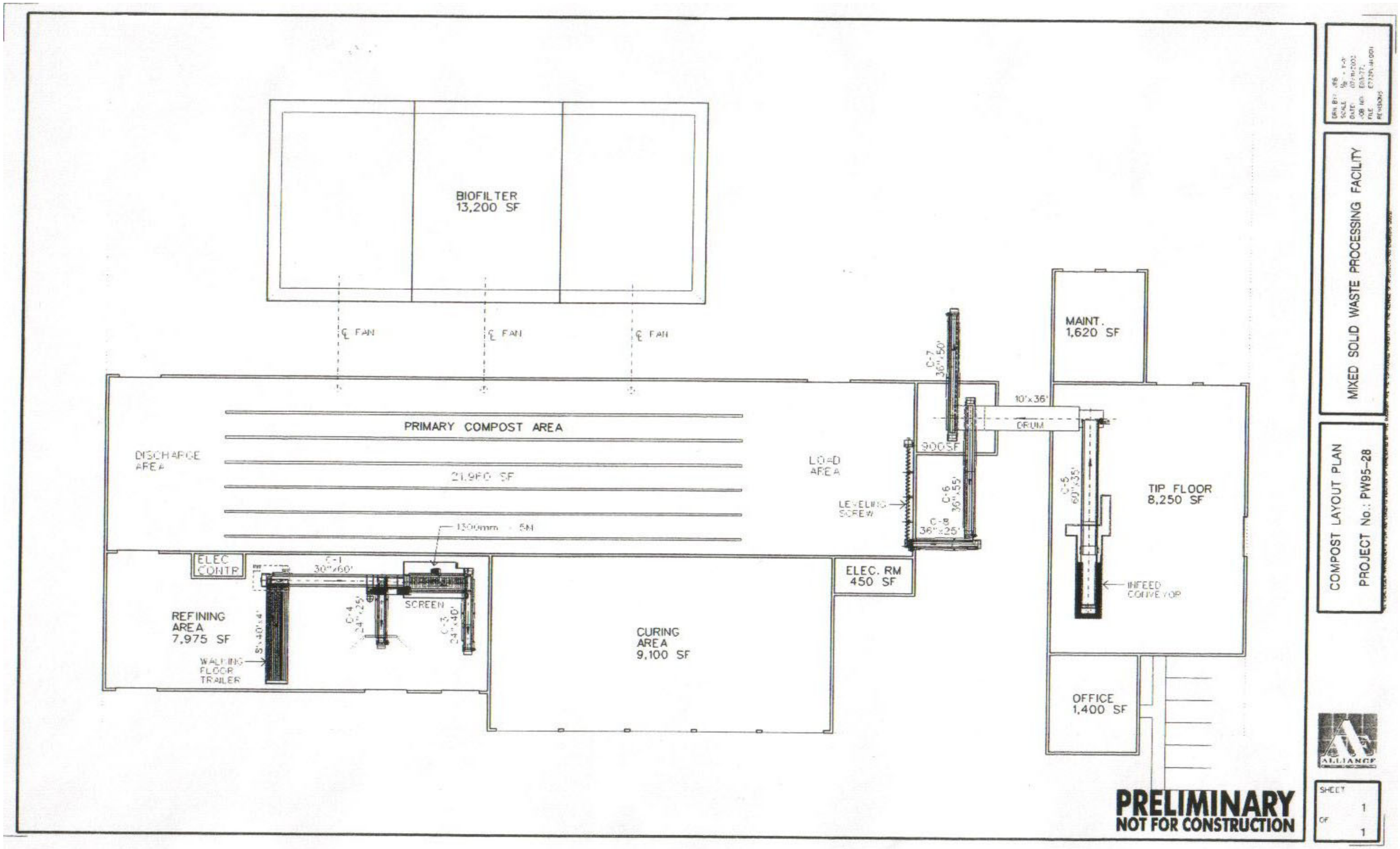

Figure 7-5: Layout of IPS Composting Facility for Central Newfoundland.

7.12.2 CAPITAL AND OPERATIONAL COST OF US FILTER IPS COMPOSTING FACILITY

The capital cost associated with the construction the US Filter IPS Composting Facility is provided in Table 7-6.

Table 7-6: Capital Cost of the US Filter IPS Composting Facility.

Item	Cost ($)
Land Purchase - Assumed Solid Waste Management Commission would not have to purchase land.	$0
Site Preparation - Site Work and Paving.	$455,000
Composting Building: Pre-Processing, Compost, Refining and Curing.	$2,730,000
Biofilter Odour Control	$455,000
HVAC	$130,000
Pre-Sorting Equipment	$2,405,000
Conveyors, Walking Floor, Level Screw, etc.	$780,000
IPS Equipment and Services	$1,040,000
Curing and Screen Equipment	$975,000
General Equipment (Loader and Skid Steer)	$130,000
Water Supply - A water supply will be needed for employee use, washroom facilities, and facility washdown. Cost of developing water supply for larger Waste Management Facility is not included. Cost includes connecting to water supply for main site and distribution throughout composting facility.	$20,000
Power Supply - Cost of developing power supply for the Waste Management Facility is not included. Cost includes connecting to power supply for main site and distribution throughout composting facility. It was assumed that the power supply is approximately 500 m from the composting facility. The cost to extend the power supply was assumed at $25/m. Onsite electrical distribution was assumed to a lump sum of $2000.	$14,500
Sewer System - Assumed sewer services from composting facility will be connected to sewer services for larger Waste Management Facility. Assumed a lump sum of $5000 for piping.	$10,000
Installation of Monitoring Wells	$15,000
Fencing and Gates - 3m fence around perimeter of site (approx. 400 m perimeter) at $55/m. $2000 was assumed for the cost of gates and $300 was assumed for signage.	$24,300
Sub-Total	$9,183,800
Contingency (10%)	$918,380
Engineering and Services: Final Design and Permitting, Construction Supervision/Resident Inspection, Start-up. Training, Test Performance Testing, and etc.	$1,196,000
TOTAL	**$11,298,180**

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The operational cost associated with the “Wet” Processing facility is provided in Table 7-7.

Table 7-7: Operational Cost of the US Filter IPS Composting Facility.

ITEM	COST ($/year)
Labour Cost	$221,000
Fringe Cost	$59,800
Vacation Coverage	$13,000
Personnel Other	$3,900
Travel	$2,600
Administration and Office Supplies	$29,900
Utilities	$124,800
Repairs and Maintenance	$44,200
Vehicle Expense	$41,600
Minor Repairs and Maintenance	$20,800
TOTAL	**$561,600**

7.13 RECOMMENDATION

Based on the results of the investigation of the “Alternatives for Composting Technologies”, BNG recommends the US Filter IPS Composting Facility for the Central Newfoundland Regions. While the costing for both compost alternatives were almost identical, the US Filter IPS Composting System seems to provide a higher quality compost using a lower quality feedstock than the Wright Composting System that requires a higher quality feedstock. The major difference between the two systems that allows the US Filter IPS Composting Facility to accept a lower quality feedstock is the daily turning of the feedstock within the concrete channels. This system will allow for more flexibility than the Wright System.

8.0 HOUSEHOLD HAZARDOUS WASTE DEPOT

Household hazardous waste (HHW) is a very small portion of the waste stream, however it represents a potential risk to employees and facility operations and the landfill. HHW are those materials that would be classified as hazardous wastes or waste dangerous goods if stored in quantities that exceed Transportation of Dangerous Good Regulations[10]. Leftover household products that contain corrosive, toxic, ignitable, or reactive ingredients are considered to be "household hazardous waste" or "HHW." Products are also considered hazardous if they are capable of causing substantial injury, serious illness, or harm to humans, domestic livestock, or wildlife. Products, such as paints, cleaners, oils, batteries, and pesticides, that contain potentially hazardous ingredients require special care when you dispose of them. Biomedical wastes are not classified as HHW and will not be accepted at the facility[11].

Improper disposal of HHW can include pouring them down the drain, on the ground, into storm sewers, or in some cases putting them out with the trash. The dangers of such disposal methods might not be immediately obvious, but certain types of HHW have the potential to cause physical injury to sanitation workers; contaminate septic tanks or wastewater treatment systems if poured down drains or toilets; and present hazards to children and pets if left around the house.

The Central Newfoundland Waste Management Strategy will include a program to recover HHW. The Ontario Ministry of Environment and Energy (MOEE) estimates that at least 3 kg of hazardous materials are generated annually per household[12]. Based on the 2001 Census Data, there are 35,959 dwellings in the study area. Therefore, it is estimated that approximately 108 tonnes of HHW will be generated in the study area annually. It is important to recognize that the management of dangerous goods and hazardous wastes generated by the IC&I sector is not part of the proposed HHW recovery program.

The preferred system will include a permanent depot located at the regional waste management facility. The operation of the depot will be outsourced to a private sector operator that has the experience and expertise in the management of HHW. The preferred system will also include smaller scaled depots at each local waste management facility location. Consideration will be given in the future to the operation of a mobile HHW

[10] Residential HHW are not regulated, as quantities are small and below those designated by the TDGA.
[11] Institutions and clinics generate bio-medical wastes; typical personal hygiene products are not bio-medical wastes and can be discarded in the wet bags.
[12] BAE-Newplan Group Limited, 1998. Evaluation of Waste Management Alternatives for Corner Brook/Nay of Islands/Humber Valley Region. Project No. 725831.

collection service designed to meet the needs of residents not easily serviced by the location of the central waste management facility and local waste management facilities. Details of what materials will be accepted at the facility are listed in sections below.

8.1 HOUSEHOLD HAZARDOUS MATERIALS

8.1.1 HAZARDOUS MATERIALS IN THE HOME

Table 8-1 list the most common household products that are considered to be hazardous.

Table 8-1: Common Types of Hazardous Materials found in Households [13].

Product	Possible Hazard	Disposal Suggestions	Precautions and Substitutes
Aerosols	Inhalation of harmful chemicals and explosion and flammability of cans.	Put only empty cans in trash. Do not burn. Do not place in trash compactor.	Store in a cool place. Propellant may be flammable. Instead: use non-aerosol products.
Batteries	Swallowing may be dangerous if it leaks.	Save for hazardous waste collection day.	No recommendations or substitutes.
Bleach: Chlorine	Fumes irritate eyes. Corrosive to eyes and skin. Poisonous if swallowed.	Use up according to label instructions.	Never mix with ammonia. Instead: use non-chlorine bleach products.
Detergent Cleaners	All are corrosive to some extent. Eye irritant. Poisonous if swallowed.	Use up according to label instructions. May be diluted and washed down sink.	Use the mildest product suitable for your needs.
Disinfectants	Eye and skin irritant. Fumes are irritating. Poisonous if swallowed.	Use up according to label instructions. May be diluted and washed down sink.	Some may contain bleach, others ammonia, do not mix.
Drain Cleaners	Very corrosive. May be fatal if swallowed. Contact with eyes may cause blindness.	Use up according to label instructions.	Prevention best: keep sink strainers in good condition.
Flea Control Products	Moderately to very poisonous.	Use up or save for hazardous collection day.	Do not use cat products on dogs. Vacuum house regularly and thoroughly.
Insect Spray	All are poisonous, some extremely so. May cause damage to kidneys, liver, or central nervous system.	Use very carefully and according to label instructions. Save for hazardous collection day.	Avoidance is best. Only use when absolutely necessary.

[13] United States of America – Department of Defense, 1990. Solid Waste Management. NAVFAC MO-213.

Product	Possible Hazard	Disposal Suggestions	Precautions and Substitutes
Medicines	Frequent cause of child poisoning.	Flush down sink or toilet.	Check contents of medicine chest regularly. Old medicines may lose their effectiveness, but no necessarily their toxicity.
Metal Polish	May be flammable. Mildly to extremely poisonous.	Use up or save for hazardous collection day.	Use only in a well ventilated area. Instead, substitute with vinegar, and/or baking soda.
Mothballs	Some are very flammable. Eye and skin irritant, poisonous, and may cause anaemia in some individuals.	Use up according to label instructions.	Do not use in living areas. Clean items before storage.
Oven Cleaner	Very corrosive. Very harmful if swallowed. Irritating vapours. Can cause eye damage.	Use very carefully and according to label instructions. Save for hazardous collection day.	Do not use aerosols which can explode and are difficult to control.
Toilet Bowl Cleaner	Corrosive. May be fatal if swallowed.	Use up according to label instruction or wash down sink.	No recommendations.
Window Cleaner	Vapours may be irritating. Slightly poisonous.	Use very carefully and according to label instructions.	No recommendations.
Wood Cleaners	Fumes irritating to eyes. Product harmful if swallowed. Eye and skin irritant. Petroleum types are flammable.	Use very carefully and according to label instructions. Save for hazardous collection day.	No recommendations.

8.1.2 HAZARDOUS MATERIALS IN THE GARAGE AND WORKSHOP

Table 8-2 list the most common garage and workshop products that are considered to be hazardous.

Table 8-2: Common Types of Hazardous Materials found in Garages and Workshops [14].

Product	Possible Hazard	Disposal Suggestions	Precautions and Substitutes
Aerosols	Inhalation of harmful chemicals and explosion and flammability of cans.	Put only empty cans in trash. Do not burn. Do not place in trash compactor.	Store in a cool place. Propellant may be flammable. Instead: use non-aerosol products.
Asphalt Roofing Compound	Eye irritant. Fumes moderately toxic.	Use up according to label instructions.	No recommendations or substitutes.
Auto: Antifreeze	Very poisonous. Has a sweet taste – attractive to small children and pets.	Amounts less than 1 gallon can be poured down the sink with plenty of water. Do not do this if you have a septic tank. Put in secure container and take to a garage or service centre.	Clean up any leaks or spills carefully.
Auto: Batteries	Contain strong acid. Very corrosive. Dangerous to eyes and skin.	Recycle.	Trade in old batteries.
Auto: Degreasers	Eye and skin irritant. Corrosive. Poisonous.	Use up according to label instructions.	Choose a strong detergent type over a solvent type.
Auto: Motor oil and Transmission Fluid	Poisonous. May be contaminated with lead. Skin and eye irritant.	Recycle.	No substitutes.
Auto: Waxes and Polishes	Fumes irritating to eyes. Harmful if swallowed. Eye and skin irritant.	Use up according to label instructions.	Use outside.
Lacquer & Lacquer Thinner	Extremely flammable. Very poisonous.	Use up or save for hazardous collection day.	Ventilate area very well. Do not use in a room with a pilot light, open flame, and spark generating equipment. Do not smoke while using.

[14] United States of America – Department of Defense, 1990. Solid Waste Management. NAVFAC MO-213.

Product	Possible Hazard	Disposal Suggestions	Precautions and Substitutes
Paint Strippers, Thinners, and Solvents	Many are flammable. Eye and skin irritant. Moderate to very poisonous.	Use up or save for hazardous collection day.	Avoid aerosols. Buy only as much as you need. Ventilate area well. Do not used near open flame. Use water products as much as possible.
Paints: Oil Based and Varnishes	Flammable. Eye and skin irritant. Use in small, closed area may cause unconsciousness.	Use up or save for hazardous collection day.	Use only in a well ventilated area. Instead, substitute with vinegar, and/or baking soda.
Pesticides, Herbicides, Fungicides, Insecticides, Rodent Poison, and Wood Preservatives.	All are dangerous to some degree. Can cause central nervous system damage, kidney and liver damage, birth defects, internal bleeding, eye injury, and etc.	Use up carefully, flowing label instructions. Save for hazardous waste collection day.	Do not buy more than you need. Use lease toxic pesticide suitable for your needs. Consider alternative to pesticide use.

8.1.3 MATERIALS ACCEPTABLE FOR DISPOSAL

Listed below are household items that do not belong in the regular waste stream. These items are to be taken to the HHW Depot.

- Batteries;
- Gasoline;
- Leftover liquid paint;
- Leftover corrosive cleaners;
- Pesticides/herbicides;
- Fuel oil & used motor oil;
- Solvents & thinners;
- Pharmaceuticals & drugs; and
- Aerosol cans containing hazardous substances.

* This list may be modified to meet the needs and requirements of the Regional WMF.

Hazardous wastes generated by the IC&I will not be accepted at the HHW depot.

8.1.4 MATERIALS NOT ACCEPTABLE FOR DISPOSAL

Listed below are household items that will not be accepted by the HHW depot.

- Any materials from farms, businesses, offices, schools or institutions;
- No large drums or barrels - nothing larger than a five-gallon container;
- Latex paint (water based) - can be dried out and placed in your regular trash;
- Motor oil;
- Smoke detectors and radioactive materials;
- Asbestos containing materials;
- Compressed gas cylinders - no oxygen tanks, fire extinguishers, etc;
- Explosives, ammunition, fireworks, and flares; and
- Biomedical waste.

* This list may be modified to meet the needs and requirements of the Regional WMF.

8.2 COLLECTION AND DISPOSAL OF HOUSEHOLD HAZARDOUS WASTE

Household hazardous wastes are managed or disposed of in a number of different ways, depending on the type of waste. The following sections describe the collection and disposal options for the HHW generated within the study area.

8.2.1 COLLECTION

There will be a household hazardous waste drop-off depot located at each local waste management facility location and the regional landfill site. Municipalities will be responsible for collection and transportation of the HHW generated in their jurisdiction to the HHW depots. This can be carried out by designating special waste collection events (usually a day or weekend) that allows householders to remove hazardous substances from their homes for safe transport to the depot by license personnel[15]..

Once delivered to the depots, trained staff will sort the waste and place it into separate drums for safe transportation. All drums are labelled to indicate that they contain hazardous wastes and the type of chemicals contained in the drum. The drums will then be collected by hazardous waste transporters and shipped to licensed hazardous waste disposal sites.

[15] Alberta Environment, 2001. Action on Waste: Household Hazardous Waste Roundups. www.gov.ab/env/waste/aow.

8.2.2 Disposal Options

Licensed hazardous-waste transportation companies will transport the HHW to hazardous materials disposal facilities for property treatment disposal. The main disposal options are reuse, recycle, and incineration.

Many components of the HHW stream can be recycled or reused. Some HHW disposal facilities are capable of recycling antifreeze, motor oil, fluorescent lamps, motor vehicle batteries, mercury-containing items and latex paint. Not all the materials are turned back into the original product. For example, used motor oil can be burned for fuel in asphalt plants and latex paint can recycled into a caulk-like material used in construction[16].

Most HHW is usually burned in hazardous waste incinerators. These facilities hold permits to incinerate hazardous wastes. These type incinerators are designed to destroy materials handled in them, and have strict environmental controls. Wastes that are handled by hazardous waste incineration include: weed killers, insect killers, wood preservatives, solvent-containing adhesives and cleaners, acids, bases, arsenic and oil-based paint containing PCBs.

8.3 Preferred Household Hazardous Waste Depot System

The study team has provided three separate costing scenarios for Hazardous Household Waste Depot system. These include:

- One HHW depot located at the Central Waste Management Facility which would collect HHW from the entire Central Region;
- One HHW depot located at the Central Waste Management Facility and a HHW depot located at each Local Waste Management Facility site (Total of 8 Depots);
- One HHW depot located at the Central Waste Management Facility and one Mobile HHW Collection Unit that would hold household hazardous waste collection days at the local waste management facilities. It is assumed that the mobile unit will visit each local waste management facility twice per year.

The costing for each scenario does not include the cost for liability insurance or any other applicable insurance.

[16] Minnesota Pollution Control Agency, 1993. Household Hazardous Waste Disposal: A HHW Fact Sheet. No. 55155-4194.

8.3.1 SCENARIO 1 – CENTRALIZED HOUSEHOLD HAZARDOUS WASTE DEPOT

The Household Hazardous Waste system will be located at the Central Waste Management Facility. Approximately 107 T of household hazardous waste will be delivered to the facility. A conceptual design of the centralized depot is provided in Appendix A. The hazardous waste depot will be fenced which will include the following features:

- Building (5m x 5m) - The building is used to transfer small quantities of materials into bulk containers. The containers (usually 45 g. drums) are then moved outside to the storage lockers. The building also has a fume hood that workers can open cans. inspect labels, identify waste, etc.

- Secure Storage Area (10m x 10m) - The storage locker outside the building has a roof but no walls. It allows materials like car batteries to be placed on shelves with no concern for fumes or explosion. The storage areas have several segregated areas (required under *Transportation of Dangerous Goods Act*) where materials like anti-freeze, solvents, pesticides, and batteries are stored. Waste Can be stored in the following categories: Alkyd Paint, Latex Paint, Waste Oxidizers, Bases, Acids, Waste Flammable Liquids, Organics (flammables), Waste Pesticides, Waste Oil, Aerosols, Glycol Antifreeze, Lead Acid Batteries, Propane Tanks, Waste Dry Batteries, and Special Waste.

- Public Drop-off Area (5 m x 5 m)

The footprint of the site (fenced area) will be approximately 12 m x 17 m. The building and outside storage area will be fenced from the public drop off area. The entire site will be paved with asphalt to act as an impervious surface in the event of a spill. Also, a storm water drainage system that includes isolation valves will be installed.

The capital cost associated with the construction of the depot is provided in Table 8-3

Table 8-3: Capital Cost of HHW Depot

Item	Cost ($)
Land Purchase - Assumed Solid Waste Management Commission would not have to purchase land.	$0
Site Preparation - Site grading, excavation, clearing, grubbing, etc. Assumed size of site would be 12 m x 17 m. Assumed an average of 1.0 m excavation and backfill for the site at $10/ m^3$.	$2,040
Building and Secure Storage Area- It was assumed the building would have to be approximately 5 m x 5 m with the storage area being approximately 10 m x 10 m.	$30,000
Access Road	$10,000
Onsite Paving - Assumed 150 m^2 of paving at a cost of $\$20/m^2$.	$3,000
Stormwater System with Isolation Valves	$25,000
Monitoring Wells	$15,000
Fencing and Gates - 3m fence around perimeter of site as well as secure area(approx. 90 m) at $55/m. $2000 was assumed for the cost of gates and $300 was assumed for signage.	$7,250
Storage Buildings at LWMF - Storage buildings would be constructed at each LWMF. Bulking of waste would not occur at these facilities therefore they would not be considered depots. The hazardous materials would be transfered to the regional waste management authority for bulking (7 x $5000)	$35,000
Sub-Total	$127,290
Contingency (10%)	$12,729
Engineering (15%)	$19,094
TOTAL	**$159,113**

The operational cost associated with the HHW depot is provided in Table 8-4

Table 8-4: Operational Cost associated with HHW Depot

ITEM	COST ($/year)
Staffing – Facility will be open at selected times and staffing will be covered by existing staff of the Waste Management Facility.	$0
Transportation of HHW from LWMF to RWMF (48.7 T @ $1000/T)*	$48,700
Chemical Testing Equipment	$15,000
Transportation and Disposal Cost (107 T @ $500/T)	$53,500
Environmental Monitoring	$1,000
Power Lighting, misc	$2,000
TOTAL	**$120,200**

8.3.2 SCENARIO 2 –HOUSEHOLD HAZARDOUS WASTE DEPOTS AT CENTRAL FACILITY AND LOCAL WASTE MANAGEMENT FACILITIES

HHW Depot at Central Facility

Although the tonnage accepted at the Centralized HHW depot will decrease by approximately 50% (58.3 T/year), the conceptual design and capital cost will remain the same as in Section 9.3.1.

HHW Depot at Local Waste Management Facilities

The Household Hazardous Waste system located at the Local Waste Management Facilities will include the following features:

- Pre-Fabricated Steel Container/Building (7 m x 3 m) - The building will be a modified metal container with two separate rooms. One room will be used to transfer small quantities of materials into bulk containers. The containers (usually 45 gallon drums) will then moved to the other room for storage. The storage room will have segregated areas (required under *Transportation of Dangerous Goods Act*) where materials like anti-freeze, paints solvents, pesticides, batteries, etc. are stored.

- The building will not be connected to electrical services.

- Public Drop-off Area (5 m x 5 m).

The footprint of the site (fenced area) will be approximately 12 m x 10 m. The building and outside storage area will be fenced from the public drop off area. The entire site will be paved with asphalt to act as an impervious surface in the event of a spill. Also, a storm water drainage system that includes isolation valves will be installed.

The capital cost associated with the construction of a depot at each local waste management facility is provided in Table 8-5. The cost to construct each individual HHW depot is approximately $62,563. The combined capital cost of constricting HHW depots at 7 local waste management facilities is approximately $437,941.

Table 8-5: Capital Cost of HHW Depot

Item	Cost ($)
Land Purchase - Assumed Solid Waste Management Commission would not have to purchase land.	$0
Site Preparation - Site grading, excavation, clearing, grubbing, etc. Assumed size of site would be 10 m x 10 m. Assumed an average of 1.0 m excavation and backfill for the site at $10/ m^3$.	$1,000
Building and Secure Storage Area - Modified metal trailer with 2 rooms. The structure will be approximately 6 m x 3 m. No services will be supplied to the building.	$8,000
Access Road - Included in cost of Transfer Station	$0
Onsite Paving - Included in cost of Transfer Station	$1,000
Stormwater System with Isolation Valves	$20,000
Monitoring Wells	$15,000
Fencing and Gates - 3m fence around perimeter of site as well as secure area(approx. 50 m) at $55/m. $2000 was assumed for the cost of gates and $300 was assumed for signage.	$5,050
Sub-Total	$50,050
Contingency (10%)	$5,005
Engineering (15%)	$7,508
TOTAL	**$62,563**

The operational cost associated with each HHW depot is provided in Table 8-6. The total Operational Cost for all the facilities is approximately $93,700.

Table 8-6: Operational Cost associated with HHW Depot

ITEM	($/year)							
	Central Facility (58.3 T/year)	**Terra Nova (10.4 T/year)**	**Indian Bay (10 T/year)**	**Gander Bay (8 T/year)**	**Fogo (4.7 T/year)**	**Virgin Arm (10.2 T/year)**	**Point Lem. (3.8 T/year)**	**Buchan's Junction (1.5 T/year)**
Staffing – Facility will be open at selected times and staffing will be covered by existing staff of the Waste Management Facility.	$0	$0	$0	$0	$0	$0	$0	$0
Chemical Testing Equipment	$7,500	$1,200	$1,200	$1,200	$1,000	$1,200	$1,000	$750
Transportation and Disposal Cost (58.3 T @ $500/T)	$29,150	$5,200	$5,000	$4,000	$2,350	$5,100	$1,900	$750
Environmental Monitoring	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000
Power Lighting, misc	$2,000	$0	$0	$0	$0	$0	$0	$0
SUB-TOTAL	$39,650	$7,400	$7,200	$6,200	$4,350	$7,300	$3,900	$2,500
TOTAL								**$78,500**

8.3.3 SCENARIO 3 – CENTRALIZED HOUSEHOLD HAZARDOUS WASTE DEPOT PLUS MOBILE UNIT

The tonnages accepted at the facility will be the same as in Section 5.3.1 (107 T/year). The mobile facility will bring the items collected at the local waste management facilities to the centralized facility. Therefore, the conceptual design of the facility will remain the same as in Section 9.3.1.

The capital cost associated with the construction of the depot (including cost of purchasing a Mobile HHW Unit) is provided in Table 8-7.

Table 8-7: Capital Cost of HHW Depot

Item	Cost ($)
Land Purchase - Assumed Solid Waste Management Commission would not have to purchase land.	$0
Site Preparation - Site grading, excavation, clearing, grubbing, etc. Assumed size of site would be 12 m x 17 m. Assumed an average of 1.0 m excavation and backfill for the site at $10/ m^3$.	$2,040
Building and Secure Storage Area- It was assumed the building would have to be approximately 5 m x 5 m with the storage area being approximately 10 m x 10 m.	$30,000
Mobile HHW Unit	$100,000
Access Road	$10,000
Onsite Paving - Assumed 150 m^2 of paving at a cost of $20/m^2$.	$3,000
Stormwater System with Isolation Valves	$25,000
Monitoring Wells	$15,000
Fencing and Gates - 3m fence around perimeter of site as well as secure area(approx. 90 m) at $55/m. $2000 was assumed for the cost of gates and $300 was assumed for signage.	$7,250
Sub-Total	$192,290
Contingency (10%)	$19,229
Engineering (15%)	$28,844
TOTAL	**$240,363**

The operational cost associated with the HHW depot (including the cost of operating the Mobile HHW Unit) is provided in Table 8-8

Table 8-8: Operational Cost associated with HHW Depot

ITEM	COST ($/year)
Staffing Mobile Unit (Two trips / transfer facility / year - 2 days per trip) - Approx. 28 days @ $240/day (2 people @ 8 hr/day @ $15/hr)	$7,840
Operational Cost of Mobile Unit	$20,000
Staffing Centralized Facility – Facility will be open at selected times and staffing will be covered by existing staff of the Waste Management Facility.	$0
Chemical Testing Equipment	$15,000
Transportation and Disposal Cost (107 T @ $500/T)	$53,500
Environmental Monitoring	$2,000
Power Lighting, misc	$2,500
TOTAL	**$100,840**

8.3.4 SUMMARY OF THREE COSTING SCENARIOS

Table 8-9 provides a summary of the three costing options.

Table 8-9: Summary of Three HHW Costing Scenarios

LOCATION	CAPITAL COST	AMORTIZATION COSTS	OPERATING COSTS	TOTAL ANNUAL COST
Central Facility Only	$159,113	$16,206	$120,200	**$136,406.01**
Central Facility Plus Local Waste Management Facilities	$437,941	$44,605	$78,500	**$123,105.26**
Central Facility Plus Mobile Unit	$240,363	$24,482	$100,840	**$125,321.50**

Note: Based on a 20 year amortization at 8% interest.

Based on the lower annual cost of constructing HHW depots at the Local Waste Management Facilities, the study team recommends HHW facilities be constructed at all the Local Waste Management Facilities as well as the Central Waste Management Facility.

9.0 CONSTRUCTION AND DEMOLITION MATERIALS FACILITY

Materials which may be present in the waste stream that are inert, do not readily compost, do not create leachate and do not require permanent disposal in a containment landfill may provide resources for recycling and re-use. Construction and Demolition (C&D) waste is generated from the construction, renovation, repair, and demolition of structures such as residential and commercial buildings, roads, and bridges. The composition of C&D waste varies for these different activities and structures. Overall, C&D waste is composed primarily of wood products, asphalt, drywall, and masonry; other components often present in significant quantities include metals, plastics, earth, shingles, insulation, paper and cardboard.

A C&D waste storage area/recycling depot and landfill will be located at the regional waste management facility. There will also be a designated C&D materials storage area at each local waste management facility locations. It is possible that the C&D collected at the local waste management facilities may be disposed in the existing landfill located at the local waste management facility sites. These facilities will accept all materials based on a specified acceptable materials list to be established by the Committee[17,18].

9.1 METHODS OF REDUCING C&D DEBRIS

Reducing the amount of C&D debris disposed of in landfill facilities provides numerous benefits. Less waste can lead to the development of fewer new disposal facilities and increase the longevity of existing disposal sites. Reducing, reusing, and recycling C&D debris offsets the need to extract and consume virgin resources. In addition, generators of C&D debris benefit by not having to pay tipping fees or reduced tipping fees for disposal. It is recommended that these methods of reducing C&D debris be encourage throughout the study area through a public education campaign. Examples of these methods of reducing C&D Debris are provided below.

[17] Committee in this context refers to the eventual inter-municipal governance model selected to implement and operate the Regional waste management system.
[18] The facility will be designed to accept commercial quantities of C & D materials. This may change should private sector C & D initiatives develop.

9.1.1 Reduce

Techniques of reducing the amount of material used in construction without any harmful consequences to the structure are still being developed. For example, one of the best debris reduction techniques is efficient framing of a structure. This can greatly reduce the amount of lumber used and C&D debris generated during wood framing for structures.

9.1.2 Reuse

Most building supply stores sell materials for construction and renovation projects. However, materials such as used lumber and bricks and items such as doors and windows can be salvaged from many demolition projects. A more selective disassembly of existing structures can reduce the cost of buying new materials and reduce the quantity of waste entering the C&D stream.

9.1.3 Recycle

Many building components can be recycled where markets exist. Asphalt, concrete, and rubble are often recycled into aggregate or new asphalt and concrete products. Wood can be recycled into engineered-wood products like furniture and plastic-composite decks, as well as mulch, compost, and other products. Metals, including steel, copper, and brass, are also valuable commodities to recycle. Additionally, although cardboard packaging from home building sites is not classified as a C&D waste, many markets exist for recycling this material.

9.2 Characterization of C&D Waste Stream for the Study Area

The Newfoundland and Labrador Environmental Standards for Construction and Demolition Waste Disposal Sites define construction and demolition waste as:

> “Materials which are normally incorporated in the construction of, and found in the materials resulting from demolition or destruction of, buildings, structures, roadways, walls and landscaping features, and includes, but not limited to, soil, landscaping waste such as root balls and organic mat, brick, mortar, concrete, drywall, plaster, windows, doors, glass, ceramic items, cellulose, fibreglass fibres, lumber, non-pressure treated and non-creosote wood, asphalt shingles and other roofing materials, siding, floor coverings and ceiling tile, wire, conduit, pipes, plastic films, and other building plastics and metals, including the debris remaining following destruction by fire. Materials which are portable

and easily removed from a structure, such as furniture, drapery, appliances, plant machinery and equipment, and other items which are not generally considered part of the real property, are not included in this definition"

It is difficult to characterize the C&D waste stream since it varies based on the quantity and types construction and demolition activities beginning carried out within the region at a given period of time. For example, several factors that may affect the quantities and characteristics of C&D waste produced include within the study area include[19]:

- Frequency of construction demolition projects;
- Project type (i.e. residential, commercial, or industrial building, road, bridge);
- Size of structure;
- Activity being performed (i.e. construction, renovation, repair, demolition);
- Materials used in construction (i.e. brick versus wood);
- Demolition practices (i.e. manual versus mechanical); and
- Time schedule (i.e. rushed versus paced).

Table 9-1 summarizes the types and sources of C&D materials expected to be generated within the study area, sources, and possible recycling re-use options.

Table 9-1: Types and Sources of C&D Materials Generated in Central Newfoundland[20]

C&D Activity	Separated Materials	Possible Re-use/Recycling
Road reconstruction	Asphalt	Crushed and mixed with new asphalt; fill material; road sub-base.
	Concrete (without rebar)	Road sub-base; re-used in concrete; concrete blocks; fill material; riprap on roads and lagoons.
	Concrete (with rebar)	Fill material; riprap.
	Separated rebar; metal, signs; sign posts; guardrails, and culverts	Re-use for original purpose, processing at a steel mill.
	Fill materials (earth, gravel, sand)	Clean fill material; landscaping material; landfill cover.
Excavation/leveling	Topsoil	Landscaping; residential fill; landfill cover;
	Sand	Fill; residential; road construction
	Earth contaminated with wood or buried utilities	Fill; landfill cover; disposal at landfill
	Stone	Rip-rap; fill; landscaping
Site clearance	Trees and brush	Firewood; landscaping chips; composting; landfill disposal.

[19] Mac Viro Consultants, Inc. (Ontario). Preliminary Study of Construction and Demolition Waste Diversion Constraints and Opportunities. Prepared for the Ontario Ministry of the Environment. March 1992.
[20] Saskatchewan Environment, 1993. Construction/Demolition Recycling and Disposal. EPB172/1M/03 .

C&D Activity	Separated Materials	Possible Re-use/Recycling
	Soils	Landscaping agricultural and residential fill
	Mixed concrete, rubble, sand and steel	Land reclamation fill; landfill disposal
Building C&D Material - Reusable	Clean bricks; whole cindercrete blocks; concrete or stone facades, and ceramics	Re-use for original purpose; landscaping; permanent roadway construction in landfills
	Undamaged windows, roofing and metal/vinyl siding, wooden cabinets, counters, flooring, staircases/trim, plumbing/electrical fittings, carpeting, clean insulation, wooden beams/facades	Resale for re-use
Building C&D Material - Recyclable	Broken bricks, cindercrete blocks, facades, tiles/ceramics, concrete/stone	Landscaping; crushed clean fill for road sub-base, roadways and rip-rap; use for stabilization of road bases or fill at landfills; clean fill for land reclamation
	Broken window glass, glass fixture	Recycle at glass recycler;
	Broken wooden beams; trim; wood scrap; trees	Chipping or shredding for landscaping; composting; fuel source
	Metal girders, supports, rebar, damaged metal siding, roofing	Recycle, sell to scrap dealer
	Scrap aluminum door and window frames	Sell to scrap dealer; recycle at an aluminum smelter
Building C&D Material - Disposal	Mixed waste not suitable for separation; materials which cannot be re-used or recycled; asphalt shingles; linoleum flooring	Disposal at an approved waste disposal ground

Table 9-2 provides estimated quantities of C&D material generated in the study area. No data was available from Newfoundland and Labrador, therefore, waste estimates were based on the Quebec per capita rates and scaled using Statistics Canada data on total construction, road construction, and bridge construction expenditures.[21] The study team used 1992 data to calculate tonnages and volumes of C&D material generated.

[21] Construction and Demolition Waste in Canada: Quantification of Waste and Identification of Opportunities for Diversion from Disposal, SENES Consultants Limited, 1993.

Table 9-2: C&D Waste Generation in Study Area

	1992 C&D Waste generated in NF and Lab. (T)	C&D Material generated for Study Area (T)	Buchans Junction (T)	Point Leamington (T)	Virgin Arm (T)	Fogo (T)	Gander Bay (T)	Indian Bay (T)	Terra Nova (T)	C&D - Directly to Central Facility (T)
Generated										
Road and Bridge Related										
Asphalt	9,026	1,330	19	48	128	59	101	126	113	735
Concrete	5,510	812	12	29	78	36	62	77	69	449
Building Related										
Wood	24,727	3,642	53	130	352	163	277	345	309	2,013
Rubble	66,409	9,782	143	350	945	437	744	926	830	5,407
Paper	2,296	338	5	12	33	15	26	32	29	187
Gypsum	2,296	338	5	12	33	15	26	32	29	187
Building material	2,583	380	6	14	37	17	29	36	32	210
Metal	3,532	520	8	19	50	23	40	49	44	287
Other	2,009	296	4	11	29	13	23	28	25	164
Total Tonnages	118,387	17,438	255	624	1,685	779	1,327	1,651	1,479	9,638

(T) = Tonnes

Based on a 6.1% population decrease over 50 years, it is estimated that a total of 828,401 Tonnes of C&D material will be generated throughout this timeframe.

9.3 ALTERNATIVES FOR PROCESSING C&D MATERIALS

Currently, the majority of C&D debris generated in Newfoundland and Labrador (NL) ends up in municipal solid waste landfills. A part of the NL Waste Management Strategy is to implement the diversion of bulky materials and C&D materials from landfills. Those C&D materials that cannot be diverted or "recycled" will be disposed of in a landfill designed specifically for C&D waste. Since much of this waste stream is inert, solid waste guidelines do not usually require C&D landfills to provide the same level of environmental protection (liners, leachate collection, etc.) as landfills licensed to receive MSW. The following subsections provide further information on alternatives proposed for the management of C&D debris in the Central Newfoundland Region.

9.3.1 STOCKPILING

All C&D materials delivered to the regional waste management facility and local waste management facilities will be separated into various categories (i.e. wood, metals, concrete, and etc.) and stockpiled onsite. Depending on the quantity of materials collected and the availability of markets for products produced from C&D debris, several processing options will be reviewed to determine the feasibility of recycling the materials compared to landfilling.

9.3.2 RECYCLING

The recycling of C&D materials includes the removal of products or materials from the waste stream for the purpose of recycling the materials in the manufacture of new products. The materials most likely to be recovered and recycled from the C&D waste stream are concrete, asphalt, metals, and wood. To a much lesser degree, gypsum wallboard and asphalt shingles can also been processed and recycled, depending on quantity and market availability. The most likely existing barriers of increased C&D materials recovery rates include[22].:

- the cost of collecting, sorting, and processing C&D debris;
- the low value of the recycled-content material in relation to the cost of virgin materials;
- the low cost of C&D debris landfill disposal compared to MSW disposal fees.

[22] Franklin Associates, 1998. Characterization of Building-related Construction and Demolition Debris in the United States. Report No. EPA530-R-98-010

The preferred option for the recycling of C&D materials is to stockpile the materials at the waste management facilities until the quantity of C&D materials and associated markets for end products exists. If it is determined to be feasible to recycle the C&D materials, processing equipment will be rented and delivered the regional waste management facility to process the C&D materials. Materials stockpiled at the local waste management facility site will be delivered to the regional waste management at that time, if feasible to do so. All non-recyclable materials will be landfilled, either at the regional facility or at the local waste management facility locations.

9.3.3 C&D Landfill at Regional Facility

It is proposed that a C&D landfill be constructed at the regional waste management facility. The landfill will consist of unlined cells for the disposal of products of the C&D waste stream that cannot be recycled or reused.

9.3.4 Landfilling at Local Waste Management Facilities

It is proposed that products of the C&D waste stream that cannot be recycled or reused be landfilled at the local waste management facility locations. This is dependant on the location of the local waste management facility being at an existing landfill site. This would greatly reduce transportation cost associated with transporting the C&D material to the regional waste management facility.

9.4 C&D Landfill

Traditionally, landfilling has been the most commonly used practice in the management of C&D waste. Landfills that receive household and commercial waste are required to have an elaborate liner system to protect the underlying soil and groundwater from contamination. However, in most cases, C&D landfills do not require liners. This is dependant of site specific conditions and types of materials accepted at the landfill.

9.4.1 Design and Operation Details

The "*Environmental Standards for Construction and Demolition Waste Disposal Sites – Final Draft*" released by the Newfoundland and Labrador Department of Environment in September 2003, outlines design and operation criteria. These are discussed in detail in Section 9.6

9.5 C&D Recycling Depot

It is proposed that a C&D recycling depot be located at the waste management facility. Recycling of C&D materials at the facility will be dependent on the quantity of C&D materials delivered to the facility and availability of markets for products produced from recycling C&D materials. The preferred option is to stockpile the C&D debris at the facility until the quantity of C&D materials and demand for the recycled products justify recycling the material. If and when the quantity of C&D materials and availability of markets justify the recycling of the C&D material, processing equipment can be either purchased or rented and the materials can be processed. A study shall be undertaken to determine the feasibility of recycling C&D materials generated within the study area. The following subsections provide information on the types of materials that will be accepted at the depot and the types of equipment available for processing C&D waste and end products produced.

9.5.1 Acceptable Materials

Some materials that will be accepted at the C&D Recycling Depot include:

- Wood;
- Yard debris and land clearing debris;
- Asphalt;
- Concrete;
- Roofing Materials;
- Metal Debris;
- Drywall; and
- Windows, doors, cabinets, flooring, light fixtures, and etc.

* This list may be modified to meet the needs and requirements of the Regional WMF.

9.5.2 Unacceptable Materials

Some materials that will not be accepted at the C&D Recycling Depot include:

- Household garbage
- Asbestos containing materials;
- Burned materials;
- Hazardous wastes;
- Contaminated materials;
- Insulation;

- Furniture/appliances
- Mattresses;
- Cardboard and paper;
- Plastic;
- Tires; and
- Rugs

* This list may be modified to meet the needs and requirements of the Regional WMF.

9.5.3 PROCESSING EQUIPMENT

Equipment, such as separation systems, crushers, trommel screens, grinders, and bailing systems, can cost millions of dollars to purchase and operate. Table 9-3 provides some examples of the types, function, and cost of various C&D recycling equipment. Please note that equipment price range varies with input and output of materials processed.

Table 9-3: Examples of C&D Recycling Equipment.

Equipment Type	Materials Processed	Usage Description	Price * Range
Compactors	Drums, Pallets, Crates, Bulky Waste	Compacts waste with over 65,000 lbs. of force & displaces over 175 cubic yards per hour.	$10,700 to $18,995
Pulverizes	Gypsum, Industrial Trash, Soft Metals	Punctured pieces of materials are dropped between rotating high teeth then screened.	$108,475 to $153,275
Loading Cranes	Steel, C&D Debris, Land Clearing Debris	Used for the removal of debris in logging operations, and construction sites.	$32,000 to $755,000
Separation Systems	All C&D Debris	Material is fed onto a vibrating screen in which the Trommel sorts and discharges waste.	$125,000 to $350,000
Balers-Horizontal	Cardboard, Metal, Paper, Plastic	(see above) Designed with side fed units.	$13,800 to $32,000
Granulators	Plastics, Rubber, Foam, Crates, Bins	Materials are broken up into pieces by rotors then reduced into pellets by rollers' teeth.	$18,500 to $150,000
Tub Grinders	C&D Debris, Land Clearing Debris	Grinds materials from 120-320 cubic yards per hour from a top feeder w/dual auger discharge.	$100,000 to $300,000
Trommels	Yard Waste, Wood Chips, Sludge	From a conveyor the fed material is screened and dispersed evenly then outfed and stacked.	$51,800 to $225,000
Hauling Trucks	Solid Waste, Scrap, Bulky Materials	For hauling SW materials that holds up to 44,000 lbs. (various types).	$21,000 to $61,000
Trailers	Solid Waste, Scrap, Sludge	For hauling SW up to 80,000 lbs. there are 3 types: Transfer, Roll-Off, and Walking Floor.	$27,900 to $68,000

* Prices are in US Dollars and are subject to change depending on manufacturer.

9.5.4 END-PRODUCTS

Table 9-4 summarized several methods and end-products associated with the recycling of C&D waste.

Table 9-4: End Products Produced from Recycling C&D Materials.

Recyclable Materials	Methods of Recycling and/or End Uses
Bricks	• broken bricks can be crushed and used as aggregate
Wood	• wood fuel • chipped and used as mulch, animal bedding and compost • particle board
Treated Wood	• new construction materials
Concrete and Blocks	• crushed and used as aggregate for new ready-mix • road base (cannot contain lead-based paint) • fill material (cannot contain lead-based paint)
Shingles	• can be used in the production of new asphalt • can be used as an aggregate base.
Cardboard	• can be separated and sold for paper fibre feedstock
Metals	• reused for metal feedstock
Gypsum Wallboard	• new wallboard • animal bedding and cat litter • soil amendments (permit required) • paper backing can be re-pulped and made into new backing

9.6 NEWFOUNDLAND AND LABRADOR ENVIRONMENTAL STANDARDS FOR CONSTRUCTION AND DEMOLITION WASTE DISPOSAL SITES

The Newfoundland Department of Environment has issued “Standards For Construction And Demolition Waste Disposal Sites” that establish criteria and procedures for construction and demolition waste (C&D) disposal sites in the province. These standards are provided in Appendix B and significant sections are discussed below. These standards apply to the disposal of C&D waste in the province. These standards do not apply to:

- Reuse or reclamation of construction and demolition wastes;
- Transfer and transportation of construction and demolition waste from one place to another;
- Disposal of “clean fill”;
- Disposal of small quantities of C&D waste, provided that the quantity of such waste does not exceed a total accumulation over time of 100 m^3. The waste will be

generated on the property on which the disposal takes place. The waste is to be covered with at least 300 mm of clean soil.

Any proposed C&D waste disposal site is subject to registration in accordance with the Environmental Protection Act and as detailed in the Environmental Assessment Regulations.

9.6.1 SITING CONSIDERATIONS

The composting standards set out siting and operational requirements. Table 9-5 summarizes the general siting criteria.

Table 9-5: General Siting Criteria for C&D Facilities in Newfoundland and Labrador

Siting Requirement	Criteria	
Land Use	In accordance with municipal zoning requirements.	
Access and Road Restrictions	Access roads shall be accessible year round by the weight and type of vehicles anticipated. Facilities shall not be developed in areas where there are road weight restrictions, which would severely limit payloads of haulage vehicles for much of the year. The facility shall have access suitable for travel by trucks, from a public street or road to the receiving or transfer area. The access roadway shall be a two-lane roadway or equivalent one-way access and egress lanes. The intersection of any access road with a public street or road shall be designed, equipped, constructed and maintained in accordance with the requirements of the provincial Department of Works, Services, and Transportation.	
Separation Distances	Property Type	Minimum Separation Distances (m).
	Property Boundary	50
	Public Street or road	100
	Water Courses, Rivers, and Lakes	100
	Water Supply	100

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9.6.2 Design Requirements

The proponent is required to provide design details and a design report to the Department of Environment. These design report must include the following information:

- **Site location** – Site location shall be accurately described;
- **Size and Capacity** - Description of the layout, dimensions, and elevations;
- **Design Details** – The following details are to be incorporated into the design:
  1. The base of the filled areas shall be sloped for gravity drainage to a point outside the filled areas, at a grade of no less than 2%;
  2. Side slopes of excavations intended to be filled with construction and demolition waste shall not exceed 1 vertical to 2 horizontal;
  3. Side slopes of finished surfaces intended to be the final elevations shall not exceed one vertical to three horizontal;
  4. The base of the filled areas shall be at least one metre above the seasonal high groundwater table;
  5. Lowering or interception of the groundwater table by means of gravity under drains or curtain drains are permitted.

Depending on site specific conditions, the Department of Environment may require additional design details, including a liner.

- **Buffer Areas** – Proponent must show minimum buffer distances are satisfied;
- **Hydrogeology and Surface Water Conditions** – Proponent must provide details on the local hydrogeology and surface water conditions. Depending on the results of the hydrogeological investigations and the details of material quantities and types to be handled, the department may require additional design features including liners or leachate collection/treatment systems.
- **Cover Materials** – A plan for placing and covering the C&D material. As a minimum design requirement, the C&D waste shall be placed and compacted in cells, separated by layers of cover material. Intermediate cover shall be at least 300 mm thick, and shall be enhanced to the standard for final cover if it is not overfilled within one year of placement. The final cover material at the surface shall be at least 600 mm thick and shall be planted with a permanent vegetative cover or granular soil cover, of a type

which will minimize soil erosion by water and wind, and shall have a cross slope between 2% and 6% to facilitate drainage of surface water.

- **Acceptable Material** – Provide list of materials to be accepted at the facility.

- **Receiving Area** – Details of receiving and storage area including the infrastructure involved.

- **On-site Processing** – Details of any processing facilities for volume reduction or materials recovery is to be provided.

- **Employee Facilities** – Appropriate facilities are to be provided, to satisfy occupational health and safety regulations and provide a secure space for keeping of administrative records, PPE, tools, and combustible fuels and lubricants.

- **Access** – Designed to handle types and volumes of traffic anticipated.

- **Environmental Monitoring** – An environmental monitoring program is to be developed at any C&D waste disposal site where the design capacity of the facility exceeds 5,000 m3.

- **Surface Water Management and Control System** – Provided to control rum-on of surface waters, particularly storm waters, unto working areas of the site, to collect and control run-off from the site, and to reduce potential erosion in order to protect the integrity of the intermediate and final cover.

9.6.3 CONSTRUCTION REQUIREMENTS

Prior to opening the C&D disposal site, the proponent shall provide documentation, in the form of a Certificate of Completion, that the site has been constructed as designed, that all facilities and systems are in place and functional and that the site is ready to receive waste.

9.6.4 OPERATIONS REQUIREMENTS

The proponent is required to have an operations manual as well as an up-to-date contingency plan. Operation requirements are as follows:

- **Covering of Waste** – The covering of waste shall take place such that the surface area of exposed construction and demolition waste in the cells shall not exceed 2000 m^2 at any one time. Waste shall be placed in segregated cells divided by soil fire breaks, comprising of a soil barrier at least 600 mm thick. Soil used for fire breaks to divide cells may be clean fill and shall be free of organic matter. The volume of individual cells shall not exceed 5000 m^3.

- **Open Burning** - Open burning is prohibited.

- **Compaction** – Waste shall be compacted in a cell at least once per quarter year or on the accumulation of 1000 m^3 of material in loose form, whichever occurs first.

- **Signage** – Appropriate signs shall be provided at the entry to the site indicating the name and purpose of the facility, hours of operation, and contact information. Appropriate signs directing traffic around the site are to be provided.

- **Site Security and Access Control** – The site shall be closed with a locked entry except during hours of operation. The site shall be attended by at least one on-site person at all times while the site is open for operation.

- **Receiving of Waste** – All incoming loads shall be viewed by an attendant during discharge from haulage vehicles and any non-compliant material shall be immediately segregated and removed from the site. Details of non-compliant material shall be recorded.

- **Dangerous Materials** – Loads on fire and dangerous materials shall be segregated and controlled until they can be removed properly from site.

- **Litter Control and Housekeeping** –An active litter control program is required.

- **Animal, Rodent, and Vector Control Program** – An active vector and rodent control program is required to limit potential problems.

- **Stormwater Management and Erosion Control Program** – Suitable techniques for erosion and sedimentation control are required.

- **Dust Control Program** – Suitable dust control measures are to be routinely undertaken.

- **Fire Control Program** – Fire safety plans, including the comments of the first responder fire department as to the adequacy of the plan, are to be provided.

- **Groundwater / Surface Water Monitoring Program** – Monitoring programs need to be developed which assess the impacts of site operations on groundwater and surface water.

9.7 OUTLINED OF PREFERRED SYSTEM

The study team has provided 3 separate costing scenarios for C&D disposal in the study area. These include:

- 100% of C&D material delivered to the local waste management facility will be transported to the central facility;
- 50% of C&D material delivered to the local waste management facility will be transported to the central facility;
- 0% of C&D material delivered to the local waste management facility will be transported to the central facility.

The central facility will have a C&D storage area as well as a C&D landfill. A conceptual design of the C&D Storage Area is provided in Appendix M. Storage capacity for one year will be incorporated in the storage area. This will provide the opportunity for diversion/processing of C&D material prior to landfilling the C&D material. The C&D material will be separated into the following piles:

- Asphalt;
- Concrete;
- Wood;
- Rubble;
- Gypsum;
- Building material;
- Metal;
- Other;
- 2 Misc. piles

A gravel tipping floor was incorporated into the design of the storage area in the event that mixed loads are delivered to the facility.

During the design of these facilities the project team made the following assumptions:

- Materials will be stored in 3 m piles;
- Asphalt - 20% of total generated will be delivered to site. 10% of total will be landfilled;
- Concrete - 100% of total generated will be delivered to site. 100% of total will be landfilled;
- Wood - 50% of total generated will be delivered to site. 25% of total will be landfilled;
- Rubble- 50% of total generated will be delivered to site. 50% of total will be landfilled;

- Gypsum- 100% of total generated will be delivered to site. 50% of total will be landfilled;
- Building Material - 100% of total generated will be delivered to site. 100% of total will be landfilled;
- Metal - 100% of total generated will be delivered to site. 10% of total will be landfilled;
- Other - 100% of total generated will be delivered to site. 75% of total will be landfilled;

9.7.1 Scenario 1 – 100% of C&D Material From Local Waste Management Facility

With 100% of the C&D material generated in the transfer regions being delivered to the central facility, approximately 12, 419 m^3 of C&D material will be delivered during the first year of operation. A total volume of 425,500 m3 of C&D material will be delivered to the central facility over 50 years.

Design and Capital Cost of the Storage Area

The total area of the C&D Storage Area is approximately 150 m x 160 m. The capital cost associated with site development is provided in Table 9-6.

Table 9-6: Capital Cost for C&D Storage Area

Item	Cost ($)
Land Purchase - Assumed Solid Waste Management Commission would not have to purchase land.	$0
Site Preparation - Clearing, Grubbing, and excavation. Assumed a cost of $4.5/m^2$.	$108,621
Access Road	$10,000
Ditching	$10,000
Signage	$500
Sub-Total	$129,121
Contingency (10%)	$12,912
Engineering (15%)	$19,368
TOTAL	$161,401

Design and Capital Cost of C&D Landfill Area

The total area of the C&D Landfill is approximately 324 m x 324 m. The capital cost associated with site development is provided in Table 9-7.

Table 9-7: Capital Cost for C&D Landfill

Item	Cost ($)
Land Purchase - Assumed Solid Waste Management Commission would not have to purchase land.	$0
Site Preparation - Clearing and Grubbing. Assumed size of site would be 10.4 ha at a cost of $5000/ha.	$52,000
Excavation / Construction of Berm - Assumed 54,000 m^3 @ $5/$m^3$	$270,000
Access Road	$10,000
Ditching	$20,000
Signage	$500
Monitoring Wells/Hydrogeological Investigation	$15,000
Develop Operating/Contingency Plan	$10,000
Sub-Total	$377,500
Contingency (10%)	$37,750
Engineering (15%)	$56,625
TOTAL	$471,875

Operational Cost of Facility

The operational cost associated with entire C&D Facility is provided in Table 9-8. The operational cost will be shared between the storage facility and the landfill.

Table 9-8: Operational Cost for C&D Facility

ITEM	COST ($/year)
Staffing – One full time employee @ $15/hour + 35% payroll burden	$42,120
Loader (Rented) - 20hr/week @ 52 weeks/year @ $40/hr	$41,600
Bulldozer (Rented) - 5hr/week @ 52 weeks/year @ $100/hr	$26,000
Environmental Monitoring	$1,000
TOTAL	$110,720

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Transportation Cost from Local Waste Management Facilities to Regional Waste Management Facility

Two types of vehicles will be used to transport the C&D waste from the Local Waste Management Facilities to the Central Waste Management Facility. The heavy material (asphalt, concrete, rubble and metal) will be transported using a tandem truck. The low-density material (wood, gypsum, building material and others) will be transported using a 53 ft trailer.

The loading capacity of a tandem truck is 17 tonnes and the loading capacity of the 53 ft trailer is limited to 25 tonnes.

The annual transportation cost is estimated based on the annual trips needed, round-trip time (including unloading time) and hourly prices of the vehicles ($150/hr for trailers, $50/hr for tandem truck). The transportation cost for transporting 100% of the material received at the Local Waste Management Facilities to the Central Waste Management Facility is presented in Table 9-9.

Table 9-9: Transportation cost to transport 100% of C&D Material to Central Facility

Local Waste Management Facility	Round Trip (hours)	Trailer				Tandem Truck				Total
		Hourly Rate ($/hr)	Tonnage (T)	Annual Trips	Annual Cost	Hourly Rate ($/hr)	Tonnage	Annual Trips	Annual Cost	
Buchan's Junction	3.88	$150	68	3	$1,744	$50	182	11	$2,131	*$3,875*
Point Leamington	2.85	$150	167	7	$2,997	$50	445	27	$3,853	*$6,850*
Virgin Arm	3.18	$150	450	18	$8,590	$50	1,202	71	$11,295	*$19,885*
Fogo	6.88	$150	208	9	$9,288	$50	556	33	$11,351	*$20,639*
Gander Bay	3.10	$150	354	15	$6,965	$50	947	56	$8,667	*$15,632*
Indian Bay	4.46	$150	441	18	$12,045	$50	1,178	70	$15,613	*$27,658*
Terra Nova	3.46	$150	395	16	$8,299	$50	1,055	62	$10,719	*$19,018*
Total			**2,083**				**5,565**			**$113,558**

9.7.2 SCENARIO 2 – 50% OF C&D MATERIAL FROM LOCAL WASTE MANAGEMENT FACILITY

With 50% of the C&D material generated in the transfer regions being delivered to the central facility, approximately 9,642 m^3 of C&D material will be delivered during the first year of operation. A total volume of 330,337 m^3 of C&D material will be delivered to the central facility over 50 years.

Design and Capital Cost of the Storage Area

The total area of the C&D Storage Area is approximately 145 m x 150 m. The capital cost associated with site development is provided in Table 9-10.

Table 9-10: Capital Cost for C&D Storage Area

Item	Cost ($)
Land Purchase - Assumed Solid Waste Management Commission would not have to purchase land.	$0
Site Preparation - Clearing, Grubbing, and excavation. Assumed a cost of $4.5/m^2$.	$97,875
Access Road	$10,000
Ditching	$10,000
Signage	$500
Sub-Total	$118,375
Contingency (10%)	$11,838
Engineering (15%)	$17,756
TOTAL	$147,969

Design and Capital Cost of C&D Landfill Area

The total area of the C&D Landfill is approximately 290 m x 290 m. The capital cost associated with site development is provided in Table 9-11.

Table 9-11: Capital Cost for C&D Landfill

Item	Cost ($)
Land Purchase - Assumed Solid Waste Management Commission would not have to purchase land.	$0
Site Preparation - Clearing and Grubbing. Assumed size of site would be 8.4 ha at a cost of $5000/ha.	$42,000
Excavation / Construction of Berm - Assumed 47,500 m^3 @ $5/$m^3$	$237,500
Access Road	$10,000
Ditching	$15,000
Signage	$500
Monitoring Wells/Hydrogeological Investigation	$15,000
Develop Operating/Contingency Plan	$10,000
Capital Cost of Developing C&D Disposal Cells at the Local Waste Management Facilities	$112,500
Sub-Total	$442,500
Contingency (10%)	$44,250
Engineering (15%)	$66,375
TOTAL	$553,125

Operational Cost of Facility

The operational cost associated with entire C&D Facility is provided in Table 9-12. The operational cost will be shared between the storage facility and the landfill.

Table 9-12: Operational Cost for C&D Facility

ITEM	COST ($/year)
Staffing – One full time employee @ $15/hour + 35% payroll burden	$42,120
Loader (Rented) - 15 hr/week @ 52 weeks/year @ $40/hr	$31,200
Bulldozer (Rented) - 4 hr/week @ 52 weeks/year @ $100/hr	$20,800
Environmental Monitoring	$1,000
Operational Cost for C&D landfills at the Local Waste Management Facilities	$18,000
TOTAL	**$113,120**

Transportation Cost from Local Waste Management Facilities to Regional Waste Management Facility

Two types of vehicles will be used to transport the C&D waste from the Local Waste Management Facilities to the Central Waste Management Facility. The heavy material (asphalt, concrete, rubble and metal) will be transported using a tandem truck. The low-density material (wood, gypsum, building material and others) will be transported using a 53 ft trailer.

The loading capacity of a tandem truck is 17 tonnes and the loading capacity of the 53 ft trailer is limited to 25 tonnes.

The annual transportation cost is estimated based on the annual trips needed, round-trip time (including unloading time) and hourly prices of the vehicles ($150/hr for trailers, $50/hr for tandem truck). The transportation cost for transporting 50% of the material received at the Local Waste Management Facilities to the Central Waste Management Facility is presented in Table 9-13.

Table 9-13: Transportation cost to transport 100% of C&D Material to Central Facility

Local Waste Management Facility	Round Trip (hours)	Trailer				Tandem Truck				Total
		Hourly Rate ($/hr)	Tonnage (T)	Annual Trips	Annual Cost	Hourly Rate ($/hr)	Tonnage	Annual Trips	Annual Cost	
Buchan's Junction	3.88	$150	34	2	$1,163	$50	91	6	$1,163	*$2,326*
Point Leamington	2.85	$150	84	4	$1,712	$50	223	13	$1,855	*$3,567*
Virgin Arm	3.18	$150	225	9	$4,295	$50	601	36	$5,727	*$10,022*
Fogo	6.88	$150	104	5	$5,160	$50	278	17	$5,848	*$11,008*
Gander Bay	3.10	$150	177	7	$3,250	$50	474	28	$4,334	*$7,584*
Indian Bay	4.46	$150	221	9	$6,022	$50	589	35	$7,807	*$13,829*
Terra Nova	3.46	$150	198	8	$4,149	$50	528	31	$5,360	*$9,509*
Total			**1,043**				**2,784**			**$57,845**

9.7.3 SCENARIO 3 – 0% OF C&D MATERIAL FROM LOCAL WASTE MANAGEMENT FACILITY

With 0% of the C&D material generated in the transfer regions being delivered to the central facility, approximately 6,864 m^3 of C&D material will be delivered during the first year of operation. A total volume of 235,174 m^3 of C&D material will be delivered to the central facility over 50 years.

Design and Capital Cost of the Storage Area

The total area of the C&D Storage Area is approximately 130 m x 140 m. The capital cost associated with site development is provided in Table 9-14.

Table 9-14: Capital Cost for C&D Storage Area

Item	Cost ($)
Land Purchase - Assumed Solid Waste Management Commission would not have to purchase land.	$0
Site Preparation - Clearing, Grubbing, and excavation. Assumed a cost of $4.5/m^2.	$81,900
Access Road	$10,000
Ditching	$10,000
Signage	$500
Sub-Total	$102,400
Contingency (10%)	$10,240
Engineering (15%)	$15,360
TOTAL	$128,000

Design and Capital Cost of C&D Landfill Area

The total area of the C&D Landfill is approximately 252 m x 252 m. The capital cost associated with site development is provided in Table 9-15.

Table 9-15:Capital Cost for C&D Landfill

Item	Cost ($)
Land Purchase - Assumed Solid Waste Management Commission would not have to purchase land.	$0
Site Preparation - Clearing and Grubbing. Assumed size of site would be 6.4 ha at a cost of $5000/ha.	$32,000
Excavation / Construction of Berm - Assumed 40,000 m^3 @ $5/$m^3$	$200,000
Access Road	$10,000
Ditching	$10,000
Signage	$500
Monitoring Wells/Hydrogeological Investigation	$15,000
Capital Cost of Developing C&D Disposal Cells at the Local Waste Management Facilities	$225,000
Develop Operating/Contingency Plan	$10,000
Sub-Total	$502,500
Contingency (10%)	$50,250
Engineering (15%)	$75,375
TOTAL	$628,125

Operational Cost of Facility

The operational cost associated with entire C&D Facility is provided in Table 9-16. The operational cost will be shared between the storage facility and the landfill.

Table 9-16:Operational Cost for C&D Facility

ITEM	COST ($/year)
Staffing – One full time employee @ $15/hour + 35% payroll burden	$42,120
Loader (Rented) - 10 hr/week @ 52 weeks/year @ $40/hr	$20,800
Bulldozer (Rented) - 3 hr/week @ 52 weeks/year @ $100/hr	$15,600
Environmental Monitoring	$1,000
Operational Cost for C&D landfills at the Local Waste Management Facilities	$36,000
TOTAL	**$115,520**

Transportation Cost from Local Waste Management Facilities to Regional Waste Management Facility

There are no transportation costs associated with this Scenario.

9.5.4 SUMMARY OF THREE COSTING SCENARIOS

Table 9-17 provides a summary of the three costing options.

Table 9-17: Summary Table for C&D Waste Options

Location	Capital Cost	Amortization Costs	Operating Costs	Transportation Costs	Total Annual Cost
C&D Facility (0% of Local Waste Management Facility)	$756,125	$77,013	$115,520	$0	$192,533.00
C&D Facility (50% of Local Waste Management Facility)	$701,094	$71,408	$113,120	$57,845	$242,372.97
C&D Facility (100% of Local Waste Management Facility)	$633,276	$64,501	$110,720	$113,558	$288,778.56

Note: Based on a 20 year amortization at 8% interest.

Based on the lower annual cost of constructing C&D disposal facilities at the Local Waste Management Facilities, the study team recommends C&D disposal facilities be constructed at all the Local Waste Management Facilities as well as the Central Waste Management Facility.

10.0 LANDFILL FACILITY

The landfill facility is the final step in the waste management system. The landfill will provide permanent storage of materials after the recycling and organic diversion efforts are complete. The following section outlines the preferred landfill design parameters.

10.1 LANDFILL SIZING

In determining the space requirements for the proposed landfill a number of assumptions were made:

- an annual average tonnage requiring disposal of 46 500 tonnes;
- a projected site life of 50 years;
- no change in current waste diversion benefits (reduction, reuse, recycling and composting) for years 1 to 5, 25% waste diversion for years 6 to 10, and 50% waste diversion for years 11 to 50;
- a maximum depth of landfill of 20 metres;
- completed landfill side slopes of 4 (horizontal):1 (vertical);
- minimal excavation of native site overburden material;
- the landfill would have an engineered liner and cover;
- site infrastructure including, scales, maintenance building, sedimentation control; and
- leachate treatment, site roads and monitoring wells.

10.2 SITE DESCRIPTION

The area evaluated for the proposed development of a landfill is situated near the community of Norris Arm, approximately 45 km west of Gander, NL (see Figure 10-1). The site is located between the Lewisporte Junction Road and the Norris Arm North Side access road and has a total area of approximately 3.7 km2. The site is accessed by trails and logging roads both from the Trans Canada Highway (south of the site) and the Norris Arm North Side access road (west of the site).

From the Geotechnical Investigation Report (October 2003) for the site prepared by Newfoundland Geosciences Limited (NGL), other key site characteristics are as follows:

- the site is undeveloped and consists of wooded (approximately 80%) and boggy (approximately 20%) areas;
- the site slopes gently towards the north-northwest and presents a maximum elevation variation of approximately 60 m (approximate value from field GPS readings);

- the site geology is characterized by 0.1 to 1.2 m thick upper organic layer underlain (in sequence) by a silt/sand layer (0.3 to 1.3 m thick), a veneer of glacial till and, finally, sedimentary bedrock of the Badger Group (sandstone, siltstone, and conglomerate). No exposed bedrock was observed on-site by NGL personnel. Based on field observations, the inferred depth to bedrock for 20 of the 38 test pits was 0.6 to 5.2 m below surface;
- laboratory analysis revealed the following average group percentages for the site till:

  - 17.4% gravel
  - 47.7% sand
  - o 34.8% silt/clay

- field observations shortly after the excavation of 31 of the 38 test pits indicated a groundwater elevation of 0.4 to 4.4 m below surface. Noting that test pits do not always present an accurate representation of groundwater location, the installation of piezometers would be required to confirm the elevation of groundwater at the site.

Site mapping identified a number of surface water features that include bog/marsh areas and ponds that limit the land available for landfill development. Topographic features, ground slope and the shape of the available land combine with the surface features to further define the limits of the land area that is suitable for development. In the case of this site, founded on these considerations, the recommended location for the landfill and associated infrastructure is near the western boundary of the area.

It is proposed that traffic enter the site via a new road extending east from the Norris Arm North Side access road. The initial infrastructure, scale, site building, and public areas would be situated the access road. The proposed developed configuration of the site, including the landfill, sedimentation control pond and leachate treatment areas, is presented on Figure 10-1.

10.3 SITE COMPONENTS

This section outlines the major components that will be required at the landfill and how they would function. It is acknowledged that some components (e.g., the site access road, electricity and telephone servicing and the scale) will be shared with the proposed MRF, composting facility, hazardous waste depot, C&D depot, and etc. See Volume 2, Appendix N for concept design of the proposed Regional Waste Management Facility,

Site Access

Access to the landfill would be via a dedicated two-way paved all season access road between the landfill and the Norris Arm North Side access road.

Operating Hours

The public drop off would typically be open 5½ days per week to receive waste and closed on statuary holidays. Hours of operation would be posted on the access road for delivery of waste

Site Electricity and Telephone

Three-phase power would be required to service the site. Telephone and electricity lines would be brought in along the site access road.

Scale

Upon entering the site, collection and transport vehicles would be directed to the inbound scale, to have sources of incoming loads identified, weighted and directed to the appropriate disposal location. Non-haulage vehicles would bypass the scale. A scale house, either free standing or as part of the administration offices, would be located adjacent to the scale.

Site Buildings

Located in proximity to the inbound scale would be the administration office, which would be a single storey building, containing the administrative offices, lunchroom, locker rooms, first aid room and potentially the scale house. A permanent two-storey building and compound would be required for equipment maintenance and storage. The ground floor of the building would contain service bays, office, parts storage and washrooms. The building would be fully serviced with on-site potable water and septic system. The area around the building would contain the septic field, water well, fire pond, and parking areas.

Public Drop-off

Private vehicles, exiting the inbound scale can access the building and dump waste directly into the waiting trailer or on the tipping floor (depending on the local waste management facility).

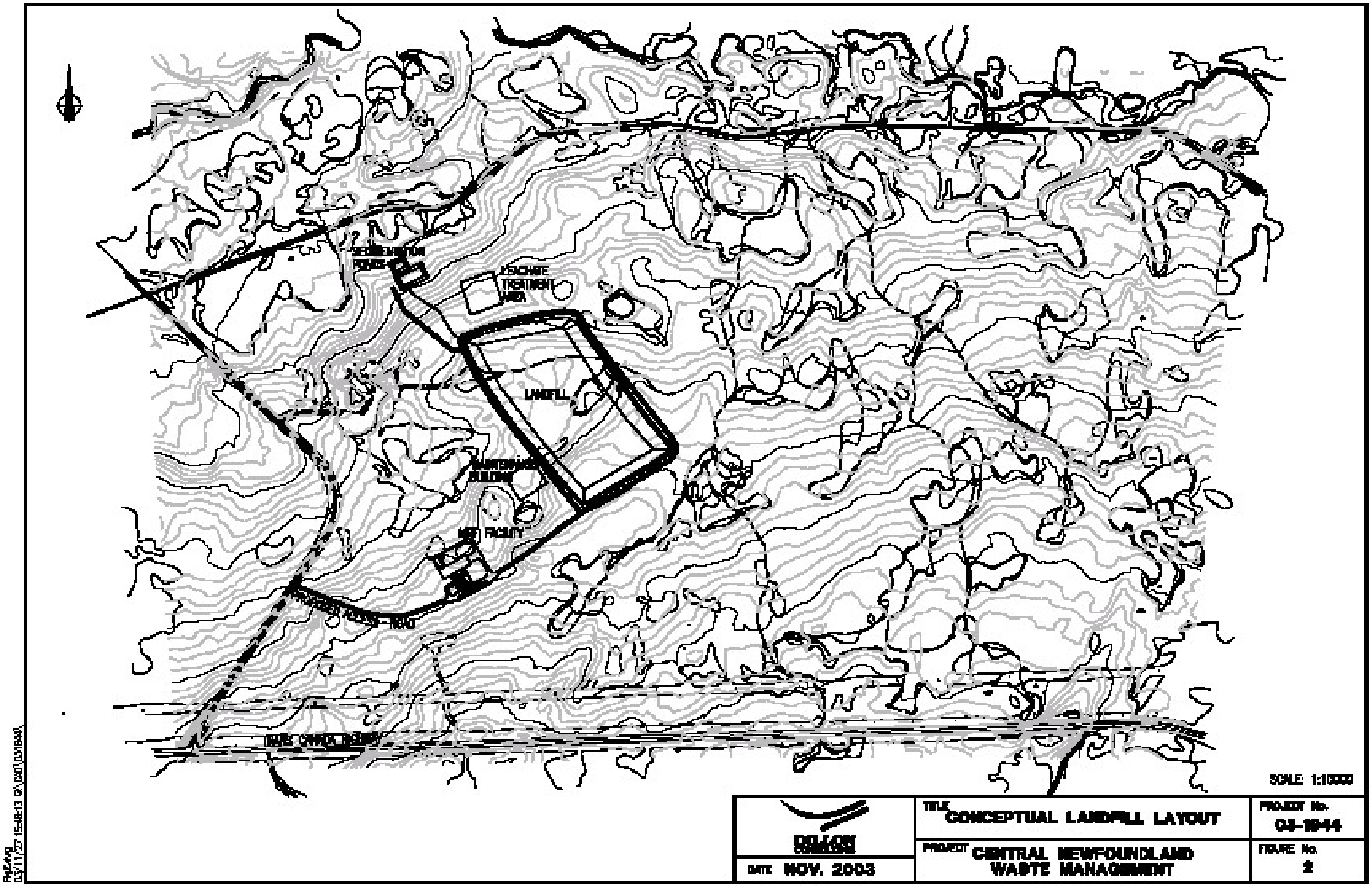

Figure 10-1: Conceptual Layout of Landfill Facility at Norris Arm

Storage Area

Vehicles carrying construction and demolition waste, white goods or metal waste would, upon leaving the inbound scale, would proceed to the temporary storage area. Deposit their load and then exit the site by means of the outbound scale.

Municipal and commercial waste haulage vehicles would precede to the tipping floor of the MRF or compost facility where the loads would be deposited onto the tipping floor. A small loader would sort the delivered waste to allow for a homogeneous waste mass that would be pushed into the in-feed conveyor of the recycling stream or directly to the baling unit. The no recoverable waste would be compressed into baled and a forklift would transfer the bales to a flatbed truck for delivery to the landfill.

Site Equipment (Landfill)

Mobile site equipment will be required on the site:

- landfill compactor (315 hp) – spread and compact waste;
- track-type tractor (230 hp) – spread and compact waste;
- backhoe/loader (97hp) - general site maintenance
- excavator (128hp) - general site maintenance, and
- dump truck - general site maintenance, haul daily cover.

The equipment would be supplemented with rental equipment on an “as-needed” basis.

Landfill Disposal Cells

Landfills can generally be classified as being a natural attenuation, or a lined landfill. With a natural attenuation landfill the existing site soil conditions function as a barrier or liner to minimize the movement of leachate from within the landfill and to provide a form of basic leachate treatment through the process of attenuation. In this treatment process leachate migrating through the unsaturated zone above the water table encounters small soil particles that can chemically bind and hold (attenuate) some leachate chemicals. A cap, typically constructed of native soils, provides a barrier to minimize the infiltration of storm water into the landfill. This type of landfill is typically not designed or permitted due to the use of the native soils to provide a limited basic level of leachate treatment, the potential for environmental impact on the surrounding properties and change in environmental design practices.

The second type of landfill is considered a lined landfill. With this type of landfill the waste material is confined between a liner system and a cap system. In both the liner and cap there are layers of natural and synthetic materials that act as a barrier or liner and other layers that provide for the collection and transmission of leachate and landfill gases.

The standards for lined landfills vary greatly throughout Canada and are specific to each province. For example:

- Nova Scotia requires a leachate collection layer that will maintain a 300 mm head, or lower, on the liner system, a liner system consisting of a 60 mil HDPE geomembrane and 1000 mm soil liner with a permeability of 1.0 x 10-7 cm/sec and a leak detection layer consisting of a secondary leachate/leak collection layer and a and 60 mil HDPE geomembrane. A cap consisting of a geomembrane and drainage or gas collection layers.

- Prince Edward Island requires a leachate collection layer that will maintain a 300 mm head, or lower, on the liner system, a liner system consisting of an 80 mil HDPE geomembrane and 1000 mm soil liner with a permeability of 1.0 x 10-7 cm/sec and a cap consisting of a geomembrane and drainage or gas collection layers.

- New Brunswick requires a leachate collection layer that will maintain a 300 mm head, or lower, on the liner system and a liner system consisting of an 80 mil HDPE geomembrane and 600 mm soil liner with a permeability of 1.0 x 10-7 cm/sec. A cap consisting of a geomembrane or soil liner and drainage and gas collection layers.

- Ontario requires a leachate collection layer that will maintain a 300 mm head, or lower, on the liner system and a liner system consisting of a 60 mil HDPE geomembrane and 750 mm soil liner with a permeability of 1.0 x 10-7 cm/sec. A cap consisting of a geomembrane or soil liner and drainage and gas collection layers.

The Environmental Protection Agency (EPA) prepared a document to provide minimum criteria for landfills constructed in the United States. This document, Subtitle D of the Resources Conservation and Recovery Act (RCRA), outlines, among other items, technical design criteria for municipal solid waste disposal. Included in the design criteria are the minimum requirements for a disposal cell including:

- a leachate collection system that maintains a maximum head of 300 mm;

- a liner system consisting of a 60 mil HDPE geomembrane and a soil liner that is 600 mm thick with a permeability of 1.0 x 10-7 cm/sec soil liner; and

- a cap with a geomembrane, drainage and gas collection layer.

10.4 PROPOSED LINER

The liner system proposed for the new landfill consists of two basic elements. The first element is the leachate collection layer and the second is a barrier system.

The leachate collection layer is directly below the waste and consists of a granular blanket with perforated pipes placed within the granular material. The collection pipes drain toward a low point where the collected leachate is directed to a holding tank or treatment plant. Underlying the leachate collection layer is the liner system that consists of low permeability materials to minimize the migration of leachate into the surrounding environment. This is accomplished by utilizing materials that have properties that enhances the overall performance of the liner system. Typically the liner system will consist of a high-density polyethylene (HDPE) geomembrane liner underlain by a soil liner consisting of a naturally occurring clay type soil. In place of the naturally occurring soil liner a synthetic soil liner can be employed. This liner, or geosynthetic clay liner, consists of a very low permeability clay mineral placed between two fabrics (geotextiles) to contain the clay mineral. The geomembrane and soil liners act as a composite liner. Beneath the liners a granular material is placed to provide a level surface between the liner system and the native ground. A typical liner is shown in Figure 10-2.

Once a portion of the landfill has reached its operational height the area is covered to reduce infiltration of precipitation and redirect the surface runoff to the sedimentation control system. Similar to the liner system the cover system consists of a granular layer to promote runoff and a barrier layer to reduce infiltration. Once the final elevation of the waste is reached a layer of granular material is placed to provide a working surface for the elements of the cover system. The layer allows for the collection and venting of landfill gases. Above this layer a barrier consisting of a low-density polyethylene (LDPE) geomembrane liner is placed to reduce the infiltration of precipitation. The control the runoff of precipitation and to prevent damage to the geomembrane liner a protective layer of granular material would be placed. A typical cover is depicted in Figure 10-3.

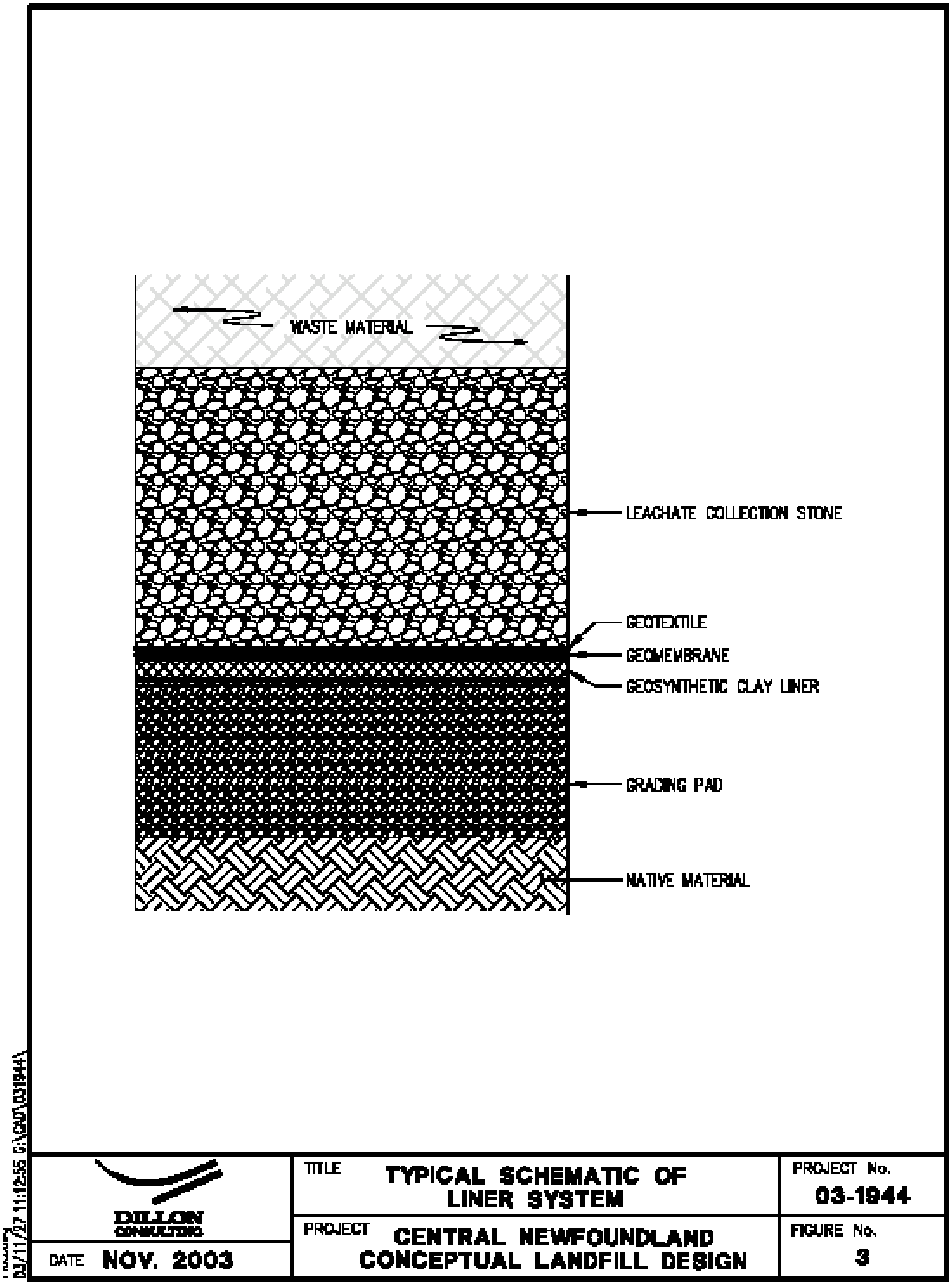

Figure 10-2: Typical Schematic of Liner System

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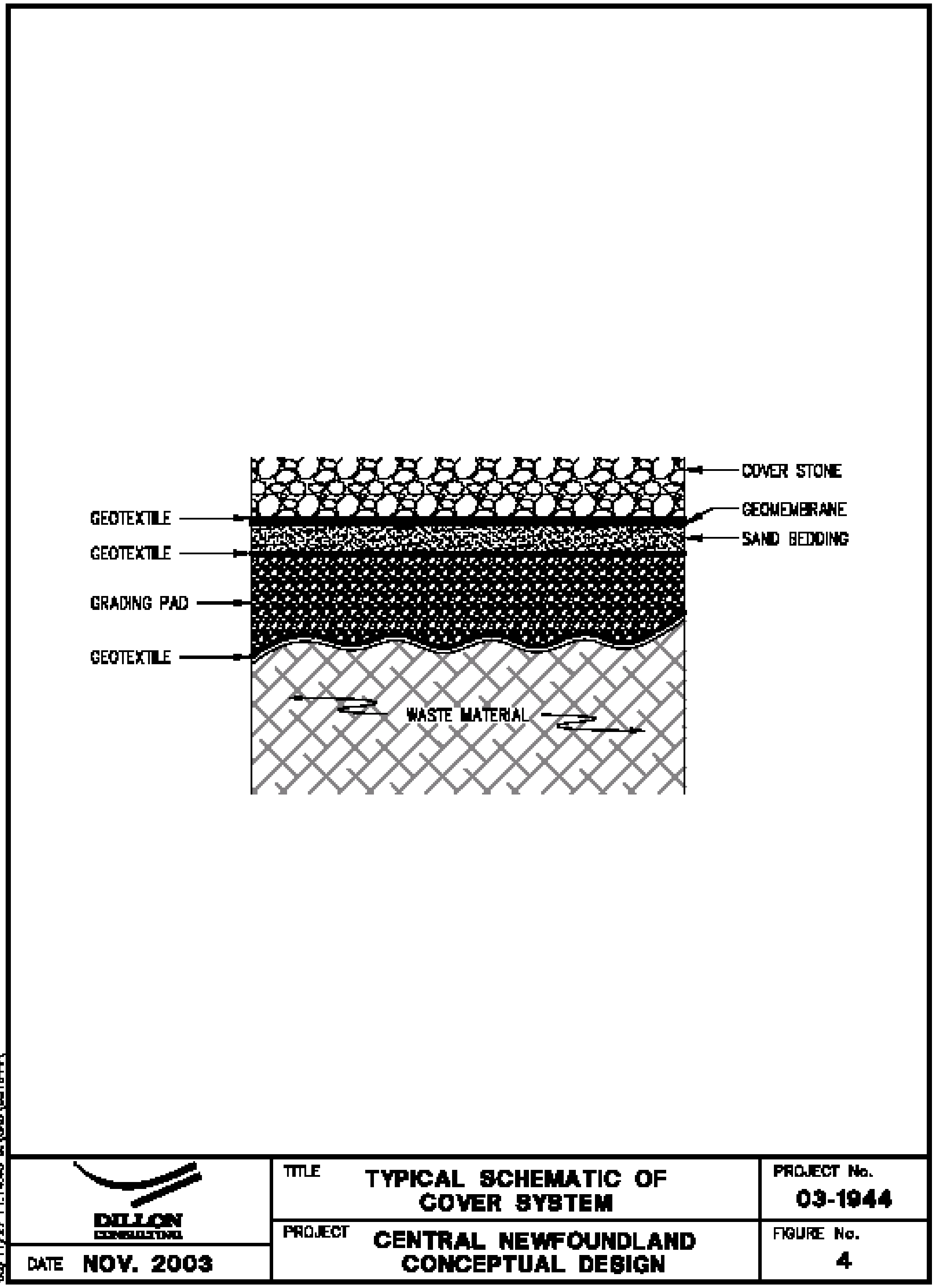

Figure 10-3: Typical Schematic of Cover System

10.5 SURFACE WATER CONTROL

Surface water control is required to minimize the impact on the environment from the construction activities and operation of the landfill. The basis element of surface water controls is to maintain post-development flow rates at pre-development levels and not to alter the pre-development water quality. It is important to minimize the contact between sediment and surface water by:

- constructing ditches to intercept and divert surface water away from areas of sediment;
- constructing temporary measures to separate surface waster away from placed waste to minimize leachate generation; and
- installing a low permeability cover to limit infiltration.

For surface water that has picked up sediment from construction activities or from cover soils the water is directed into the ditches to the sedimentation ponds. The ponds, sized to handle major storm events, settle out any sediment that is suspended in the surface water. If the sediment cannot be settled out by gravity the ponds may require the addition of chemicals to ensure the sediment is removed prior to discharging to the environment. The clarified water is discharged to the environment in a controlled fashion.

10.6 LEACHATE TREATMENT SYSTEM

When precipitation comes into contact with waste, organic and inorganic chemicals are leached out of the waste. This liquid is referred to as leachate. The composition of the leachate is dependent on the waste characteristics, age of the waste, and the site-specific biological process of waste decomposition. Therefore, the leachate quality from any landfill will change over time. Prior to being discharged to any receiving water, leachate must be treated to meet Provincial Guidelines for wastewater discharge.

The following section describes the components of a conceptual leachate treatment facility that could be used to treat leachate generated from Robin Hood Bay and/or from a new landfill facility.

Equalization

Equalization tanks are typically located at the front end of any treatment process, and serve the purpose of equalizing flows into the treatment plant. For this application, they would store peak flows during wet weather events, and provide a more continuous feed to the treatment plant by slowly releasing the stored leachate during drier periods. As such, the treatment facility need only be designed for the average leachate flow, and not the peak leachate flow, resulting in cost savings. Shock loading of the system is also avoided.

Pre-Treatment

During the initial years, the landfill will undergo an acid phase where organic matter easily leaches from waste and heavy metals become soluble as precipitation infiltrates into the landfill. As such, concentrations of heavy metals in leachate can initially be high. Conditions during the initial years of a landfill also promote the movement of calcium and magnesium cations, which are leached from the waste. The presence of these cautions can cause the pH of the leachate to fluctuate and can also cause scale to form on the treatment equipment. Physical and chemical pre-treatment is required to remove the heavy metals from the leachate.

The physical/chemical pre-treatment process follows the equalization tankage. During the pre-treatment process, chemicals are mixed with the leachate to adjust pH and promote the settling of heavy metals and scale forming cations. This is typically followed by a clarification step, where the larger clumps of metals/solids are allowed to settle out and the formed sludge is removed from the system. This sludge will have a solids concentration of approximately 0.5% and will require dewatering to 20% solids prior to disposal in the landfill. Liquid resulting from the dewatering process can be recycled back to the front of the leachate treatment plant.

Biological Treatment

The biological treatment step will follow pre-treatment of the leachate. Biological treatment is used to reduce Biochemical Oxygen Demand (BOD) and ammonia at a ratio of about 10:1. During the biological treatment process, microorganisms treat the wastewater by consuming organic matter and removing ammonia. During the initial years, concentrations of BOD are high, while concentrations of ammonia are low. At this time, the addition of nutrients such as nitrogen and phosphorus may be necessary in order to obtain desired BOD removal. Where concentrations of BOD in leachate during initial years are high, the treatment process can become complex where significant reductions are required to meet effluent discharge standards. During later years, BOD concentrations are typically low and ammonia concentrations are typically high. At this time, specific treatment for removal of excess ammonia may be required. Following the biological treatment process, the microorganisms are separated from the treated water and treated effluent is discharged to the receiving water.

Aerated lagoons may be used for biological treatment, especially where land availability is not a concern. The first lagoon(s) in the treatment system will be aerated in order to provide an oxygen source for BOD consuming microorganisms. The lagoons will serve as settling basins to separate microorganisms from the treated leachate. Periodic removal of settled solids (sludge) from these lagoons will be required. The treated effluent can then be discharged to the receiving water.

Nutrient Removal

The biological treatment process alone may be unable to remove nutrients to the required provincial discharge level. In this case, an additional treatment step is required for treatment of constituents such as ammonia. This step can consist of an additional treatment unit such as an air-stripping tower.

Sludge Digestion and Dewatering

There are two waste sludges that will be produced by the treatment process. The first originates from the pre-treatment step where heavy metals and scale forming cations are removed from the leachate. The second source of sludge is the biological treatment process, where sludge is organic in nature.

Depending on the nature of the sludges, digestion may be required to stabilize sludge to improve dewatering. Digestion takes place in a dedicated, enclosed tank, and can be either aerobic (aerated) or anaerobic (oxygen deficient). The process of digestion further breaks down organic matter in the sludge and reduces the volume of sludge to be dewatered. All sludges generated through the leachate treatment process will require dewatering to increase solids prior to disposal. Dewatering can be accomplished by a number of different methods, including a belt press, filter press or centrifuge. Wastewater resulting from the dewatering process can be recycled through the leachate treatment facility.

Bioaquatics Treatment Systems

Traditional leachate treatment infrastructure can be augmented or, in some instances, replaced with systems that utilize processes that occur in natural wetlands. Various plants and subsurface media can be utilized to develop an engineered wetland to treat effluent to acceptable discharge levels. The ecological process within the wetland are a complex integrated matrix of plants, animals, microorganisms and the environment (sun, soil, and air) interacting to improve water quality. Accommodations are made in the design of these systems in northern climates to address the impacts of winter conditions. Some systems are enclosed in a heated greenhouse structure to provide added control over the wetland treatment processes.

These systems often require pre-treatment similar to the biological treatment discussed above such as pH adjustment, sediment removal and metals removal prior to the Bioaquatics wetland. Since these systems have not been widely used for landfill leachate, field pilot testing will be required prior to construction. However, on the positive sire, these systems, once constructed, offer very favourable operating costs. Based on these factors, it is recommended that Bioaquatics treatment be fully evaluated during the detailed design stage of this facility. Costs estimated proved in Table 10-1 have been based on having an equalization tank with some pre-treatment followed by a wetland based treatment system.

10.7 LANDFILL GAS MANAGEMENT

Landfill gas is a by-product of degradation of municipal solid waste. Landfill gas management at small landfills has historically been accomplished by ambient (passive) venting. Ambient venting involves the installation of vertical vent stacks through the completed landfill cap. The operation of ambient vents is sometimes augmented by the installation of wind turbine (e.g. “venmar”) units at the stack discharge.

Growing concern about the impact to the environment caused by landfill gas has resulted in more sites adopting collection and flaring systems. These systems typically include gas extraction wells, piping, blowers and flaring infrastructure. In larger applications, energy recovery is incorporated as an element of the gas management system. The costing provided in Table 10-1 is based on the venting of landfill gas.

10.8 GROUNDWATER MONITORING

Prior to delivery of waste to the landfill it is necessary to characterize the groundwater regime in and around the landfill, through the use of a series of monitoring wells located up gradient and down gradient of the landfill. The data collected is used in subsequent years as a baseline for comparison of water quality information collected as a normal operating condition.

10.9 CONCEPTUAL COSTING

This section provides an estimate of the probable capital cost associated with the development of the Central Newfoundland Solid Waste Landfill site based on the information available at this time. Items that require an initial capital expense, such as land purchase, electrical power line extensions, access roads or intersection on the Norris Arm North Side access road have not been addressed. The capital cost estimates are founded on a 50 year development period, are in 2003 dollars and do not reflect the future value of money associated with periodic construction activities. The following tables reflect the estimated capital costs for landfill development and leachate treatment.
Operational cost estimates developed for the landfill were based on a review of information held by the project team for annual operating budgets for other lined landfill facilities in Atlantic Canada.

Table 10-1: Capital and Operating Cost for the Proposed Landfill Facility.

Item No.	Description	Estimated Budget	Estimated Tonnage	Projected Cost per Tonne
1	First five year landfill cell capital cost	$13,700,000	217,500	-
2	Remaining landfill fee capital cost	$13,600,000	1,182,500	-
3	Estimated landfill capital cost	$27,300,000	1,400,000	$19.50
4	Annual operating cost	$882,000	46,500	$19.00
5	Landfill cover capital cost	$10,500,000	1,400,000	$7.50

Table 10-2: Breakdown of Annual Operating Cost for the Proposed Landfill Facility.

Item No.	Description	Estimated Cost
1	Employee Salaries (Landfill Manager, Site Supervisor, Scale Operator, Equipment Operate and two Labourers).	$160,000
2	Employee Benefits	$30,000
3	Electricity	$15,000
4	Heat	$5,000
5	Telephone	$5,000
6	Environmental Sampling	$25,000
7	Cover Soils	$25,000
8	Leachate Treatment	$100,000
9	Operations Maintenance	$65,000
10	Site Maintenance	$30,000
11	Vehicle & Equipment Maintenance	$40,000
12	Mobile Equipment Fuel	$40,000
13	Leased/Rental Equipment	$10,000
14	Sediment Pond Chemicals	$35,000
15	Insurance	$50,000
16	Office Expenses	$5,000
17	Training and Development	$5,000
18	Mobile Equipment Reserve	$50,000
19	Post Closure Allowance	$30,000
20	Other	$10,000
	Subtotal	**$735,000**
	Contingency (20%)	**$147,000**
	Proposed Annual Operating Budget	**$882,000**

11.0 OVERVIEW OF THE COST OF THE REGIONAL WASTE MANAGEMENT SYSTEM

The following sections of the report provides the cost estimate for each component of the Regional Waste Management Facility. Tables 11-1 and 11-2 provides an overall summary of the gross costs.

The costing of each component is presented separately below. The facility components reflect the preferred system design established by the Committee. Costs have been developed based upon either first principal engineering analysis of system components or reflect price estimates provided by commercial suppliers. The cost estimate does not include land purchase. Close out cost of the existing landfill sites are not included in the tipping fee or per person costs.

The annual estimated volume of waste to be received by the Regional Authority will be 100% of residential (20,767 tonnes), the wet stream of the IC&I sector (3,158 tonnes), 100% of the Rural IC&I (11,788 tonnes), and 50% of the Urban IC&I (5,821 tonnes), for a total of 40,596 tonnes.

Table 11-1: Central Solid Waste Management Study Waste Management System Estimated Costs with Capital Cost Sharing Ratio at 100%

Item	Capital Cost	Amortization Cost[1]	Operating Cost	Annual Cost	Cost Per Tonne to Regional Authority
Local Waste Management Facilities	$8,038,112	$818,699	$879,926	$1,698,625	$41.84
Disposal Site (Landfill)	$14,700,000	$1,497,227	$1,394,222	$2,891,450	$71.22
Materials Recovery Facility (MRF)	$7,629,250	$777,056	$1,104,000	$1,881,056	$46.34
Compost Facility (IPS)	$11,298,180	$1,150,745	$561,600	$1,712,345	$42.18
Household Hazardous Wastes Depot (Regional Site Only)	$124,113	$12,641	$71,500	$84,141	$2.07
C & D Debris Depot and Landfill	$228,000	$23,222	$58,720	$81,942	$2.02
Public Drop-off Facility	$250,000	$25,463	$30,000	$55,463	$1.37
Public Education				$200,000	$4.93
Administration				$300,000	$7.39
Capital For Equipment				$250,000	$6.16
Revenue From Recovered Materials				-$687,168	-$16.93
TOTALS	$42,267,655	$4,305,054	$4,099,968	$8,467,855	$208.59
				Cost Per Person	$71.01

NOTES:
1. Amortization period is 20 years at 8% interest rate.
2. Total Waste Tonnage received by CNWMA: 40,596
3. Estimated Annual Revenue from Recovered Materials: MRF = $660,787 & Compost = $26,381

Table 11-2: Central Solid Waste Management Study Waste Management System Estimated Costs with Capital Cost Sharing Ratio at 0%

Item	Capital Cost	Amortization Cost	Operating Cost	Annual Cost	Cost Per Tonne to Regional Authority
Local Waste Management Facilities	$8,038,112	$0	$879,926	$879,926	$21.68
Disposal Site (landfill)	$14,700,000	$0	$1,394,222	$1,394,222	$34.34
Materials Recovery Facility (MRF)	$7,629,250	$0	$1,104,000	$1,104,000	$27.19
Compost Facility (IPS)	$11,298,180	$0	$561,600	$561,600	$13.83
Household Hazardous Wastes Depot	$124,113	$0	$71,500	$71,500	$1.76
C & D Debris Depot and Landfill	$228,000	$0	$58,720	$58,720	$1.45
Public Drop-off Facility	$250,000	$0	$30,000	$30,000	$0.74
Public Education				$200,000	$4.93
Administration				$300,000	$7.39
Capital For Equipment				$250,000	$6.16
Revenue From Recovered Materials				-$687,168	-$16.93
TOTALS	$42,267,655	$0	$4,099,968	$4,162,801	$102.54
				Cost Per Person	$34.91

NOTES:

1. Total Waste Tonnage received by CNWMA: 40,596
2. Estimated Annual Revenue from Recovered Materials: MRF = $660,787 & Compost = $26,381

11.1 LOCAL WASTE MANAGEMENT FACILITIES

The assessment of the collection and transportation requirements of the new system has resulted in selecting a collection and local waste management facility system that includes the following locations:

- Buchan’s Junction Waste Management Facility (524 tonnes / year)
- Point Leamington Waste Management Facility (1,282 tonnes / year)
- Virgin Arm – Carter’s Cove Waste Management Facility (3,638 tonnes / year)
- Fogo Island Waste Management Facility (1,429 tonnes / year)
- Gander Bay Waste Management Facility (2,727 tonnes / year)
- Indian Bay Waste Management Facility (3,396 tonnes / year)
- Terra Nova Regional Waste Management Facility (3,040 tonnes / year)

Tables 11-3 and 11-4 provides an overall summary of the cost associated with the local waste management facilities for the Central Region.

Table 11-3: Local Waste Management Facilities Estimated Costs with Capital Cost Sharing Ratio at 100%

Location	Capital Cost	Amortization Cost	Operating Cost	Transportation Cost	Cost Per Tonne to Regional Authority
Buchan's Junction	$1,000,125	$101,865	$42,580	$30,227	$4.30
Point Leamington	$1,044,125	$106,346	$73,335	$22,262	$4.97
Fogo	$1,055,125	$107,467	$73,785	$53,662	$5.79
Gander Bay South	$1,124,250	$114,507	$105,725	$48,288	$6.61
Indian Bay	$1,315,375	$133,974	$109,725	$104,386	$8.57
Terra Nova	$1,156,000	$117,741	$109,925	$80,912	$7.60
Virgin Arm	$1,171,625	$119,333	$134,665	$74,449	$8.09
Trailers	$160,000	$16,296	$0		$0.40
TOTALS	**$8,026,625**	**$817,529**	**$649,740**	**$414,186**	**$46.35**

NOTES:
1. Amortization period is 20 years at 8% interest rate
2. Total Waste Tonnage received by CNWMA: 40,596
3. Total Waste Tonnage received at LWMF: 16,036

Table 11-4: Local Waste Management Facilities Estimated Costs with Capital Cost Sharing Ratio at 0%

Location	Capital Cost	Amortization Cost	Operating Cost	Transportation Cost	Cost Per Tonne to Regional Authority
Buchan's Junction	$1,000,125	$0	$42,580	$30,227	$1.79
Point Leamington	$1,044,125	$0	$73,335	$22,262	$2.35
Fogo	$1,055,125	$0	$73,785	$53,662	$3.14
Gander Bay South	$1,124,250	$0	$105,725	$48,288	$3.79
Indian Bay	$1,315,375	$0	$109,725	$104,386	$5.27
Terra Nova	$1,156,000	$0	$109,925	$80,912	$4.70
Virgin Arm	$1,171,625	$0	$134,665	$74,449	$5.15
Trailers	$160,000	$0	$0	$0	$0.00
TOTALS	**$8,026,625**	**$0**	**$649,740**	**$414,186**	**$26.21**

NOTES:
1. Total Waste Tonnage received by CNWMA: 40,596
2. Total Waste Tonnage received at LWMF: 16,036

11.2 DRY RECYCLABLES PROCESSING

The dry bag material processing cost reflects the preferred system components. The estimated cost was developed after consultation with equipment suppliers and review of actual costs reported by other jurisdictions. The estimated gross installation cost of $7.63 million includes the building and related infrastructure. The preferred system incorporates the use of both mechanical and manual operations. The estimated annual revenue to be generated by the MRF is $660,787.

Tables 11-5 and 11-6 provides an overall summary of the cost associated with the MRF for the Central Region.

Table 11-5: MRF Estimated Costs with Capital Cost Sharing Ratio at 100%

Item	Capital Cost	Amortization Cost	Annual Cost	Cost per Tonne Processed	Cost Per Tonne to Regional Authority
Capital Cost	$7,629,250	$777,056	$777,056	$34.86	$19.14
Annual Operating Costs			$1,104,000	$49.52	$27.19
TOTALS	**$7,629,250**	**$777,056**	**$1,881,056**	**$84.38**	**$46.34**

NOTES:
1. Amortization period is 20 years at 8% interest rate
2. Total Waste Tonnage received by CNWMA: 40,596
3. Total Waste Processed 22,294

Table 11-6: MRF Estimated Costs with Capital Cost Sharing Ratio at 0%

Item	Capital Cost	Amortization Cost	Annual Cost	Cost per Tonne Processed	Cost Per Tonne to Regional Authority
Capital Cost	$7,629,250	$0	$0	$0.00	$0.00
Annual Operating Costs			$1,104,000	$49.52	$27.19
TOTALS	**$7,629,250**	**$0**	**$1,104,000**	**$49.52**	**$27.19**

NOTES:
1. Total Waste Tonnage received by CNWMA: 40,596
2. Total Waste Processed 22,294

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11.3 ORGANIC PROCESSING

The processing of the wet bag materials is separate from the dry bag materials sorting line. Wet bag materials contain a high percentage of organic materials that requires a separate sorting line, ventilated enclosed processing area, and a covered compost facility. The costing includes a concrete curing pad. Based upon the estimated 13,885 tonne annual volume, the estimated capital cost of the preferred compost system is $11.3 million. The estimated annual revenue to be generated by the Compost Facility is $26,381.

Tables 11-7 and 11-8 provides an overall summary of the cost associated with the In-Vessel Compost Facility for the Central Region.

Table 11-7: Compost Facility Estimated Costs with Capital Cost Sharing Ratio at 100%

Item	Capital Cost	Amortization Cost	Annual Cost	Cost per Tonne Processed	Cost Per Tonne to Regional Authority
Capital Cost	$11,298,180	$1,150,745	$1,150,745	$82.88	$28.35
Annual Operating Costs			$561,600	$40.45	$13.83
TOTALS	**$11,298,180**	**$1,150,745**	**$1,712,345**	**$123.33**	**$42.18**

NOTES:
1. Amortization period is 20 years at 8% interest rate
2. Total Waste Tonnage received by CNWMA: 40,596
3. Total Waste Processed 13,885

Table 11-8: Compost Facility Estimated Costs with Capital Cost Sharing Ratio at 0%

Item	Capital Cost	Amortization Cost	Annual Cost	Cost per Tonne Processed	Cost Per Tonne to Regional Authority
Capital Cost	$11,298,180	$0	$0	$0.00	$0.00
Annual Operating Costs			$561,600	$40.45	$13.83
TOTALS	**$11,298,180**	**$0**	**$561,600**	**$40.45**	**$13.83**

NOTES:
1. Total Waste Tonnage received by CNWMA: 40,596
2. Total Waste Processed 13,885

11.4 LANDFILL FACILITY

This section provides an estimate of the probable capital cost associated with the development of the Norris Arm Site No.1. The capital costs reflect a 50 year development period and are in 2003 dollars and do not reflect the future value of money associated with periodic construction activities. The following tables reflect the estimated capital costs for the landfill development and leachate treatment and are summarized in the tables below.

Operational costs were developed for the waste landfill option. These costs were based on discussion and review of the annual operating budgets of the landfills with operators. Tables 11-8 and 11-9 provides an overall summary of the cost associated with the Landfill Facility for the Central Region.

Table 11-9: Landfill Facility Estimated Costs with Capital Cost Sharing Ratio at 100%

Item	Capital Cost	Amortization Cost	Annual Cost	Cost Per Tonne to Regional Authority
Initial Cost (5 year cell)	$10,650,000	$1,084,726	$1,084,726	$26.72
Development Costs Year 6-50	$13,600,000		$302,222	$2.75
Annual Operating Costs			$882,000	$21.73
Closeout Costs	$10,500,000		$210,000	$1.91
Leachate Treatment Capital Cost	$4,050,000	$412,501	$412,501	$10.16
TOTALS	**$38,800,000**	**$1,497,227**	**$2,891,450**	**$71.22**

NOTES:
1. Amortization period is 20 years at 8% interest rate
2. Total Waste Tonnage received by CNWMA: 40,596

Table 11-10: Landfill Facility Estimated Costs with Capital Cost Sharing Ratio at 0%

Item	Capital Cost	Amortization Cost	Annual Cost	Cost Per Tonne to Regional Authority
Initial Cost (5 year cell)	$10,650,000	$0	$0	$0.00
Development Costs Year 6-50	$13,600,000		$302,222	$2.75
Annual Operating Costs			$882,000	$21.73
Closeout Costs	$10,500,000		$210,000	$1.91
Leachate Treatment Capital Cost	$4,050,000	$0	$0	$0.00
TOTALS	**$38,800,000**	**$0**	**$1,394,222**	**$34.34**

NOTES:
1. Total Waste Tonnage received by CNWMA: 40,596

11.5 HOUSEHOLD HAZARDOUS WASTE DEPOT

Household hazardous wastes are a very small portion of the waste stream but represents significant potential liability to the waste management system. All modern waste management systems include a component that removes household hazardous waste from disposal in a landfill. In most cases this is accomplished by integrating an education program with a drop off depot or manufacturers stewardship program[23].

The Central Newfoundland waste management plan recognizes that the responsibility of managing dangerous good and hazardous wastes from ICI sources is not the responsibility of the Committee.

The Central Newfoundland Waste Management System will include the siting of a permanent household hazardous waste depot. The HHW depot will be located at the regional waste management facility. The Committee may give consideration to a mobile service offer to those at some distance from the regional facility. The users of the depot would not be charged. A private sector company under contract will operate the depot. The operation of a HHW depot requires specialized training and dangerous good handling certification. The private sectors are also aware of the market conditions for product sale.

The conceptual designs of the depot include a permanent explosion proof building located on a concrete foundation. The depot will have a concrete loading/unloading platform that drains to a sump tank. The storm water drainage form the platform is control to ensure any leaks or spills are contained.
The depot will have a fence surrounding the building. The depot will have capacity to store several days of HHW within the building.

Estimated Capital cost is $300,000 and the operating cost is $200,000.

[23] Stewardship programs put the responsibility of disposal on the manufacturer of the product. Stewardship programs have been successful in reducing the disposal of materials such as used oil and tires in other jurisdictions.

11.6 CONSTRUCTION AND DEMOLITION DEBRIS RECYCLING DEPOT

The construction and demolition debris-recycling depot will consist of a designated storage area located near the weigh scale. The depot will be staffed. The depot will accept inert construction and demolition waste materials including; concrete, brick, wood waste, fibre board, wall board, asphalt, bulk steel and metals, clean soil, asphalt shingles, and general construction debris. The depot will promote the reuse and recycling of these materials. A tipping fee will be charged to drop-off materials. The depot will be sited on a graded flat area. The area will be covered with gravel and have a dedicated storm water collect network and detention pond.

Estimated Capital cost is $228,000 and the operating cost is $58,720.

11.7 PUBLIC DROP-OFF AREA

The regional facility will include a public drop-off area. The public drop off area will include a grade separated off-loading area where materials can be segregated into various waste streams. The off-loading area will be covered with a steel frame roof. The drop-off area will accommodate room for six steel roll-on/off bins. The bins will be designated for source separated materials such as white goods (must have refrigerants removed), waste wood, waste metal, organic materials, cardboard, and wet and dry bagged materials. The capital cost of a facility similar to that built by the Valley Waste-Resource Authority in Kentville, N.S. is $ 250,000. The facility is staffed on a part-time basis; equipment costs are required to move the bins to the processing areas. An annual operating cost of $ 30,000 is estimated.

11.8 STAFFING REQUIREMENTS

The regional waste management strategy will result in the direct creation of approximately 70 new jobs (conservative estimate). The opportunities associated with the management and recovery of recyclable materials will also result in the creation of many indirect private sector opportunities[24].

The preferred waste management system employment projections are summarized below:

[24] Estimating the number of indirect jobs goes beyond the scope of work. The economic opportunities study prepared by Jacques Whitford and Associates provides a detailed analysis of the potential employment opportunities associated with an integrated waste management strategy.

Regional Waste Management Facility
Manager
Administration (2)
Equipment Forman
Scale House Operators (2)
Site Supervisors – Landfill (2)
Process Supervisor – Compost
Process Supervisor – Dry recyclables
Equipment Operators (4)
Labourers (30 full time, 20 part-time)
Security (2)

Buchan’s Junction Waste Management Facility
One part time employee

Point Leamington Waste Management Facility
One part time employee

Virgin Arm – Carter’s Cove Waste Management Facility
One part time employee

Fogo Island Waste Management Facility
One part time employee

Gander Bay Waste Management Facility
One part time employee

Indian Bay Waste Management Facility
One part time employee

Terra Nova Regional Waste Management Facility
One part time employee

12.0 CLOSE OUT OF EXISTING LANDFILL REQUIREMENTS

The implementation of the Regional Waste Management System will require that site closure schedules being imposed by individual municipal units with in the region. Government has developed appropriate standards for close out of existing sites. The responsibility to close and the existing sites will be with the municipal unit operating the site.

The regional local waste management facility sites are all located on existing municipal dumpsites and/or incinerator sites. The new facilities would be constructed to maximize the existing benefits of the site (road and services) however these existing sites will require site closure and remedial actions to minimize the long term risk to health and safety and the environment. The Pollution Prevention Division of the Department of Environment, Government of Newfoundland and Labrador will determine the closure requirements.

It may be assumed that a site closure plan will be required at all seven proposed sites for the local waste management facilities: Buchan's Junction, Point Leamington, Virgin Arm - Carter's Cove, Seldom - Little Seldom, Gander Bay South, Indian Bay, and Terra Nova. The nature and scope of the site closure requirement will be determined by a qualitative risk assessment undertaken at each site. The risk assessment will document the extent of the potential contamination and the proximity to the nearest human or ecological receptor.

The Government of Newfoundland and Labrador currently has guidelines for the closure of Waste Disposal Sites within Newfoundland and Labrador. Also, the Government of Newfoundland and Labrador is developing new environmental Standards for the Closure of Non-Containment Landfills. Both documents are summarized in the following sections.

12.1 GOVERNMENT OF NEWFOUNDLAND AND LABRADOR GUIDANCE DOCUMENT FOR THE CLOSURE OF WASTE DISPOSAL SITES

Provided below is a summary of the Government Services Centre Guidelines for close out of sites servicing a population of less than 10,000:

- All litter and windblown debris must be collected and disposed;
- All metal and exposed garbage will be removed from the site and/or buried.

- Waste must be graded and compacted prior to application of the final cover material;
- Drainage ditches must be installed upgradient of the site;
- The dumpsite will be graded to promote storm water runoff, maximum grade 15%.
- The dumpsite will be covered with impermeable soil cover of not less than 1000 mm in thickness.
- The soil cover will have 300 m of topsail placed over it and seeded.
- Posted sign and/or barriers will restrict access to the site.
- Where the site is near a domestic water supply a groundwater-monitoring program will be required.
- Extensive rodent assessment and control program must be implemented;
- The site will be inspected annually and repairs to the cover system undertaken as required.

12.2 GOVERNMENT OF NEWFOUNDLAND AND LABRADOR ENVIRONMENTAL STANDARDS FOR CLOSURE OF NON-CONTAINMENT LANDFILLS.

Any proposed waste disposal site closure is subject to be registered in accordance with the *Environmental Protection Act* and the *Environmental Assessment Regulations*.

Prior to closure of any landfill a closure work plan has to be developed. This work plan will describe the activities to be undertaken during the closure process, provide the engineering design details for closure and outline the post closure monitoring that will be undertaken.

The closure plan is to include:

- The Landfill classification based on an environmental review of the site;
- Alternate disposal site locations;
- Methods of public notification;
- Plans for site clean-up, rodent/animal control and fire extinguishing, where required;
- Contingency plans for clean up illegal dumping after site closure;
- Design of final cover and additional work or corrective action required on the site;
- Surface and groundwater control and monitoring if required;
- Any details on the proposed after-use of the site;
- An estimate of the costs of closure and post closure monitoring and maintenance, along with the anticipated schedule of activities.

Landfill Classification

Prior to closure of the site, a site inspection to classify the site based on the potential for environmental risk must be conducted. The classification forms are used as a guide for the inspection and classification process.

Landfill classifications are as follows:

- Class C – Low Risk;
- Class B – Moderate Risk; and
- Class A – High Risk.

The Government of Newfoundland and Labrador are currently in the process of developing criteria for each of the above Classifications.

Prior to landfill closure an alternate disposal site shall be in place to handle waste from the affected municipalities. The affected municipalities and the Department of Environment must be notified at least 180 days prior to closure.

Appropriate signs shall be placed at the site entrance to notify site users of the pending closure of the site along with the date of closure and details on where waste shall be taken once the site closes.

Site Clean-up

The site shall be cleaned prior to site closure. This would include:

- Litter Control – All litter and windblown debris along the access road and around the perimeter of the site shall be collected;
- Recycling – Any white goods, metal or other recyclable materials that have been stockpiled on the site shall be collected and removed from the site.
- General Repairs – Any repairs required to on-site facilities such as fencing, roads, etc. shall be undertaken;
- Fires – Any fires at the site shall be extinguished using appropriate fire control methods, to eliminate health and safety concerns; and
- Facilities and Infrastructure – any buildings, facilities or infrastructure not needed once the site has closed shall be removed from the site due to potential safety concerns.

Animal/Rodent Control

An assessment of rodent populations must be conducted and an adequate control program for rodents and animals must be initiated prior to site closure.

Site Access

Once the site closes a sign shall be posted indicating the site is closed and providing details on where waste shall be taken, including the site location and operating hours. Other signs to be posted would include “No Dumping”, along with the possible fine schedule, and “No Trespassing”.

If an active rodent control program using poison is in place this shall be noted on the site signage.

Vehicle access to the site shall be permanently blocked, using a gate or other means to prevent unauthorized access or illegal dumping.

Plans shall be in place to clean-up waste left illegally at the site entrance.

Site Survey and Site Plan

As part of the closure planning exercise a site survey to map the extent of the landfill shall be carried out and a detailed site plan prepared.

Site Grading

Prior to applying the final cover any exposed waste on the site shall be covered and the site graded and compacted prior to the application of the final cover. The grading layer shall be thick enough to cover the surface of the waste, which will be uneven.

Capping and Final Cover

Once the site has been properly graded it shall be capped with a final cover.

The landfill final cover depth shall be approximately 1 metre (cover, top soil, and vegetative layer). If a compacted soil layer is used for the final cover, it shall be a minimum of 600 mm in depth with a maximum permeability of 10^{-6} cm/s. It shall be contoured to allow for drainage away from the site. If settling occurs the site will need to be regarded.

A vegetative layer of soil of a minimum depth suitable to support vegetative growth is to be placed on top of the soil layer.

The Government of Newfoundland and Labrador may allow variations in the depth or type of final cover based on the landfill classification and site specific conditions. The alternate final cover system could include a combination of soil and a flexible Membrane liner (FML), or a combination of soil and a geo-synthetic clay liner (GCL), or other materials.

Surface Water Control

Drainage ditches must be constructed up gradient of the site to divert precipitation / drainage waters away from the disposal area and reduce the potential for erosion and infiltration.

Groundwater and Surface Water Monitoring

Monitoring programs will be dependant on the Classification that the landfill receives. A brief overview of the monitoring requirements for each class is provided below:

- **Class C – Low Risk Landfills** – Ongoing monitoring is not required. Visual inspections of the site to assess the integrity of the final cover shall be undertaken on an annual basis.

- **Class B – Moderate Risk Landfills** – Class B landfills have been identified as having a possible future impact on adjacent properties. A suitable monitoring program will be required. The program will consist of visual inspections of final cover integrity along with sampling and analysis of groundwater and surface water at key locations up gradient and down gradient of this site.

  Inspections and sampling, including measurement of water levels, shall be carried out a minimum of twice per year, once in spring and once in fall, from at least one up gradient and two down gradient sampling locations. Samples are to be analyzed for key indicators including pH, conductivity, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), sulphate, calcium, chloride, ammonia, nitrate, phosphorus, sodium, and potassium.

  If no contamination is noted over a 5 year period the sampling frequency may be reduced. If off-site contamination is noted then the site classification will be changed to Class A – high risk and monitoring increased, along with preparations for any corrective action required.

- **Class A High Risk Landfills -** Monitoring programs for Class A landfills shall be developed on a site specific basis along with plans for any corrective actions required.

  The monitoring shall provide for a suitable level of sampling and analysis to identify and track off-site contamination. Corrective or remedial action plans shall be included to address off-site contamination.

Records

Site records, including site plans, closure plans and if available records of wastes disposed at the site shall be maintained for inspection.

12.3 ESTIMATED CLOSURE COST FOR EXISTING LANDFILL FACILITIES

Once a waste disposal site is closed it must be decommissioned. The improper closure of sites can result in a range of health and environmental concerns. The project team surveyed all the existing waste disposal sites in the study area to determine the area of waste to be covered and identify any outstanding environmental concerns associated with the sites.

A summary of the landfill close out cost is provided in Table 12-1. More detail costing is provided in Volume 2, Appendix O.

Table 12-1: Estimated Closure Cost for Existing Waste Disposal Sites.

Landfill Facility	Estimated Closure Cost
1. Aspen Cove Landfill	$129,398
2. Badger Landfill	$245,013
3. Benton Landfill	$72,347
4. Birchy Bay Landfill	$138,051
5. Boyd's Cove Landfill	$107,330
6. Botwood Landfill	$256,769
7. Browns Arm Landfill	$116,300
8. Buchans Landfill	$153,059
9. Buchans Junction Landfill	$87,009
10. Campbellton Landfill	$128,168
11. Cape Freels Landfill	$75,429
12. Carmanville Landfill	$260,750
13. Change Island's Landfill	$87,048

Landfill Facility	Estimated Closure Cost
14. Comfort Cove Landfill	$72,588
15. Cottrell's Cove Landfill	$67,988
16. Fogo Island Landfill	$131,484
17. Gambo Landfill	$464,910
18. Gander Landfill	$1,990,829
19. Glenwood Landfill	$115,495
20. Grand Falls - Windsor Landfill	$593,817
21. Horwood Landfill	$168,319
22. Indian Bay Landfill	$206,971
23. Laurenceton Landfill	$63,423
24. Leading Tickles Landfill	$57,351
25. Lewisporte Landfill	$446,243
26. Little Burnt Bay Landfill	$68,529
27. Lumsden Landfill	$165,502
28. Main Point Landfill	$131,945
29. Millertown Landfill	$188,076
30. Musgrave Harbour Landfill	$63,475
31. New World Island - Virgin Arm Landfill	$339,571
32. Stoneville Landfill	$153,220
33. Twillingate Landfill	$207,113
34. New Wes Valley	$162,535
35. Norris Arm	$115,483
36. Peterview	$234,651
37. Point Leamington	$115,690
38. Point of Bay	$88,780
39. St Brendan's North	$108,963
40. St Brendan's South	$71,645
41. Terra Nova Regional Landfill	$479,933
42. Terra Nova Municipality	$74,509
TOTAL	**$9,005,709**

13.0 GLOSSARY

Backyard composting – The transformation of organic kitchen and yard waste into a beneficial soil amendment on the property of the generating resident. Traditionally, backyard composting has been undertaken by allowing a pile of organic wastes to naturally degrade. However, backyard compost units are now commercially available.

Compostables – Materials that can undergo microbiological decomposition, resulting in a humus-like end product that is primarily used for soil conditioning.

Construction and demolition (C&D) debris – Waste materials from the construction and/or demolition of buildings, usually including wood and metal scrap, brick, block and concrete rubble, wire, and packaging.

Hazardous waste – Waste materials that may cause a threat to human health or the environment. Federal and provincial laws regulate Handling and disposal of hazardous wastes.

Household hazardous waste (HHW) – Materials commonly found in the home that may cause harm to human health or the environment. These materials are often banned from municipal waste disposal facilities.

Industrial, commercial, and institutional (IC&I) sector – Includes industries (e.g. manufacturing), businesses, and institutions such as schools and hospitals. Municipal waste is often categorized according to whether it is generated by the IC&I sector or residential sector.

Materials recovery facility (MRF) – A facility where materials are processed to separate and recover recyclable materials from the waste stream.

Multi-material waste – Waste that is composed of more than one main category (e.g. paper, glass) of material. An example is a material that is comprised of both paper and plastic.

Municipal solid waste (MSW) – Commonly referred top as garbage, this material is handled by municipal collection and/or disposal services. It includes two main types of solid waste: residential or domestic and industrial, commercial and institutional waste.

Organics – Carbon and hydrogen-based materials that can be transformed into humus-like materials through microbiological processes.

Recyclables – Materials that can be separated from municipal solid waste and reprocessed into new products.

Residential sector – Householders, including those who live in detached dwellings, row housing, condominiums, and apartments.

Source separation – Classifying and segregating waste/resource materials by category, usually separating various classes of recyclable vs. non-recyclable items, usually done as the collection or pick-up point (e.g. residences, offices, commercial facilities).

Waste audit – A method of assessing the amount and type of waste generated by a specific organization or sector.

Waste diversion – A term used to refer to the diversion of wastes from disposal. Diversion depends on the 3Rs of waste management as part of a strategy to divert used materials from disposal.

White goods – Large bulky metal items, usually durable household appliances such as refrigerators, stoves, washing machines, and dryers.

Yard waste – Discarded materials from residential yards and gardens, such as lawn clippings, leaves, and prunings. These materials are primarily compostable and have been banned from disposal facilities in many North American jurisdictions.