Waste Resource Strategy Update

Halifax Regional Municipality

Stantec

January 2013

Executive Summary

The Halifax Regional Municipality (HRM) has over the last 15 years implemented an effective waste resource and reduction strategy. Its residential diversion rate from landfill has increased from approximately 5% in 1995 to 52% currently. Program implementation was guided by an *Integrated Waste Resource Management Strategy* report (1995 Strategy) which was developed by community volunteers. While the principles described in the 1995 Strategy remain valid today, most of the program elements have now been implemented.

Much of the physical infrastructure constructed to support the 1995 Strategy will be nearing the end of its useful life in the next five to ten years. HRM has retained Stantec Consulting Limited (Stantec) to review current programs and services and to recommend an updated strategy to guide HRM decision making over the next 20 years. A key element of this review is to compare local program costs to similar municipal operations. An example is the per tonne cost to operate the Otter Lake processing and disposal site. At a current cost of $170/tonne (including capital, operating and perpetual care), expenses at Otter Lake far exceed more typical industry costs of $50 to $100/tonne for all costs related to landfill disposal. Pre-processing of waste is rarely undertaken elsewhere.

While maintaining the original principles of the 1995 Strategy, the three stated goals of this review are as follows:

- *Reduce program costs through the implementation of service delivery efficiencies;*
- *Upgrade or replace necessary infrastructure to meet existing and near to mid-term capacity and regulatory requirements; and*
- *Maximize the opportunity for program revenue generation from recovery of and/or processing of waste resource materials and increased diversion.*

The following specific constraints were identified which restrict the range of program choices available to HRM over this planning horizon:

- Organic wastes are banned from landfill in Nova Scotia;
- The industrial/commercial/institutional (ICI) sector have no reasonable option currently available for processing organics except for HRM facilities;
- HRM by-law No. S-600 provides HRM with legal control of the import and export of waste generated within the municipality;

- Existing facility locations, capacities and operating agreements; and
- The current waste system in HRM is highly integrated with many interdependencies.

Based on a comprehensive review of HRM's complete waste resource systems, Stantec has generated the following conclusions:

1) The total diversion rate is high in HRM compared to other municipalities, but realistic opportunities exist to improve the recovery of residential and ICI recyclables and organics in accordance with provincial legislation.
2) The front-end processing (FEP) and waste stabilization facility (WSF) at Otter Lake do not provide a useful function compared to their stated purpose in the 1995 Strategy.
3) The landfill liner design specification in Nova Scotia is more stringent than most comparable state and provincial jurisdictions, and potential modifications could significantly reduce future capital costs.
4) An opportunity exists to significantly extend the life of the landfill at Otter Lake, and reduce the site per tonne capital costs by increasing the finished grade by 10-15 metres.
5) The two composting operations in Halifax and Dartmouth do not provide a sufficiently finished product to meet applicable guidelines which become effective in the near future.
6) Composting facilities are at capacity and additional processing capacity is required in the short and longer term.
7) Alternative composting technologies may improve the processing of ICI organics.
8) Collection programs are cost effective and meet most customer needs however there are opportunities to improve diversion by increasing the frequency of collection.
9) Opportunities exist for more collaborative use of resources with other waste management regions in Nova Scotia.
10) Energy-from-Waste and developing waste reduction technologies are not considered appropriate investments for HRM at this time.
11) Overall program costs in HRM are high and represent a greater financial burden on both the private and public sectors compared to similar communities.
12) HRM would benefit from the creation of a centralized waste resource campus, rather than having facilities at four different locations in Halifax and Dartmouth. Development can be staged over time to match the end-of-useful-life of current infrastructure and

incorporate new elements for HRM such as outdoor windrow compost curing pads; permanent educational and household special waste facilities; and the development of a materials transfer capability.

Stantec has developed recommendations for an updated HRM waste resource strategy (Waste Resource Strategy Update) to guide program and service implementation over the next 10-20 years. Consistent with the three stated goals of this assignment, recommendations have been grouped into three sections below. The following list identifies issues representing fundamental change. Other more minor recommendations are included within the body of this report. As discussed previously, an integrated waste system such as that currently operating in HRM includes many program interdependencies. The following recommendations cannot necessarily be addressed in isolation, and contingent activities are noted where applicable.

Opportunities for Cost Reductions

A1 – Closure of the FEP and WSF by the end of 2013

The FEP and WSF do not function in a manner envisaged in the 1995 Strategy. These facilities were intended to stabilize organic wastes and produce a low-grade compost product. Few organics are now actually processed, and the multiple shredding of the waste prior to disposal may actually increase the generation of landfill gas over the short term in the period before gas collection systems can be installed. This may contribute to additional odours from the site. Implementation of this recommendation is contingent on HRM implementing a separate collection for white goods (stoves; refrigerators) rather than the current practice of loading these items in with the regular curbside waste and then removing the appliances from the waste at the FEP. The annual cost to operate the FEP and WSF is reported to be $8.9 million per year. Most of this amount could be recognized as sustainable savings less any contractual commitments.

A2 – Request Modification of the Nova Scotia Landfill Liner Specification

The current landfill liner specification is more stringent than most comparable state and provincial jurisdictions. Given the context in HRM and Nova Scotia in the 1990s, this conservative specification was considered prudent at the time. However, the current specification results in relatively high capital construction costs which in turn lead to increased expenses for the ICI sector and HRM. Based on examples from other jurisdictions, HRM capital costs for liner construction could be reduced by approximately $3.4 million for a typical cell ($10.2 million over the remaining life of the site) if Nova Scotia were to adopt a specification consistent with most similar jurisdictions.

A3 – Extend Life of Otter Lake Landfill through Vertical Expansion

The current design for the finished elevation of the landfill will result in a landform that will be consistent with surrounding topography. While this approach has merit, an extension of approximately 17-23 years to the life of the landfill can be achieved by a 10-15 metre increase in the finished grade of the site. Given the potential benefit to the broader community and the remote locale of the site, Stantec recommends that HRM consider a vertical expansion of the landfill subject to input from the immediate neighbours of the landfill.

Upgrade and Replacement of Infrastructure

B1 – Create a Centralized Waste Resource Campus

Current infrastructure is located at four different properties in Dartmouth and Halifax. With the exception of the Otter Lake facility, sites are of limited size and prevent the consideration of co-collection of materials at the curb in a single truck. Stantec recommends HRM establish a large acreage waste resource campus (Campus) in a location of sufficient size to meet changing infrastructure needs (excluding landfill disposal) for on the order of 50 years. The benefits would include the potential to optimize collection routing and fleet size, lands for compost curing, a common location for infrastructure replacements when needed, and a location for contingency waste transfer. Possible components and timing are presented below.

- Secure lands, obtain approvals and complete site servicing 2013/2014
- Construct and operate compost curing pads 2014/2015
- Construct scales, offices and educational centre 2015
- Construct multi-use transfer facility for white goods/waste/MHSW 2015
- Construct anaerobic composter for ICI organics 2015/2016
- Construct replacement MRF 2017/2018
- Optional aerobic composting processing capacity 2018+
- Optional advanced waste reduction(gasification or other) 2020+
- Other long-term waste reduction infrastructure needs 2020+

B2 – Relocation of MRF to Campus

The existing MRF in Halifax is operating satisfactorily and equipment is suitable for current needs and until the expiry of a contract extension to 2019. As identified above, it is recommended that this activity be relocated to the Campus in anticipation of a 2019 contract start date.

B3 – Increase Organics Processing Capacity

The aerobic composting facility south of Halifax is not considered a strategic asset and could be decommissioned at the end of the current contract in 2019. Equivalent organics processing capacity for the Halifax collection zone is recommended to be realized at Otter Lake by repurposing the WSF. The Dartmouth organics processing facility can meet Dartmouth area needs until at least 2030 by constructing an anaerobic processing facility by 2015/2016 at either the current site or at an alternative location.

Maximize Program Revenue and Increase Diversion

C1 – Improve Recovery of Recyclables and Organics

Based on the results of annual waste composition studies completed recently by SNC Lavalin and CBCL, 30% of residential and up to 50% of ICI materials currently sent to landfill could be recovered as recyclables or compostable organics. This is an opportunity for HRM to optimize existing programs and increase diversion.

C2 – Control Curing and Sale of Finished Compost

Once organics are processed at facilities in Dartmouth and Halifax, the unfinished product is sold at a nominal fee of $1/tonne at both facilities. HRM has no control over the final maturation process and foregoes the potential for an increase in net revenue generation. The final maturation (also termed “curing”) process typically requires a period of up to one year in outdoor open windrows to meet CCME guidelines and become a saleable product. It is recommended that HRM control the final curing process to ensure guidelines are being met with its compost, and also to gain the benefit of enhanced product value at final maturation.

C3 – Improve Curbside Collection Frequency

Challenges with recovery of divertible materials at the curb are often linked to the frequency of collection. Whether the entire collection system is weekly or every 2 weeks, this does not change the amount of material to be collected on a monthly basis. Residents are far more likely to divert organics and recyclables if collection is performed on a weekly basis so that odour and storage constraints do not affect participation.

Table of Contents

Appendices

1.0 Introduction

1.1 BACKGROUND

Prior to 1995, the Metropolitan Authority responsible for waste management in the vicinity of Halifax offered only the most basic of waste management services to local residents and businesses. Only 5% of recyclable and compostable products were recovered with the remaining 95% of the wastestream being sent to landfill. Problems associated with the Upper Sackville landfill in the early 1990s led to the development of an Integrated Waste Resource Management Strategy in 1995 (1995 Strategy). The 1995 Strategy was prepared by a Community Stakeholder Committee (CSC) as a framework for detailed system planning and design. The issues related to the Upper Sackville landfill ultimately led to the transfer of responsibility for waste management on January 1, 1997 from the Metropolitan Authority to the Halifax Regional Municipality (HRM). HRM was created by the Province of Nova Scotia as a single-tier municipal government whose responsibilities included among other services, full responsibility for waste management within HRM.

During this period of fundamental change prompted by the 1995 Strategy, both HRM and the Province of Nova Scotia developed and implemented policies and programs which advanced the region to the forefront of municipal best practice for waste and recycling. Provincial and local bans on the landfilling of recyclable and compostable products established HRM and Nova Scotia as leaders throughout North America. HRM has continued to rely on the 1995 Strategy to guide its program planning. HRM currently diverts 52% of the municipal wastestream from landfill compared to 5% in 1995. In the words of the CSC volunteers who created the 1995 Strategy:

> *"This Strategy is designed to address the municipal solid wastestream, to achieve the maximum possible diversion of resources from disposal and to encourage citizens to adopt the necessary lifestyle changes to move from a consumer to a conserver society.*
>
> *The Strategy is designed to be flexible enough to incorporate new, environmentally sustainable technologies that will move us towards our ultimate goal of Zero Waste."*

Throughout the text of the 1995 Strategy, flexibility is mentioned several times as well as the need to adapt to changing conditions. Few areas of municipal service delivery have changed as rapidly as waste management over the last two decades.

Given that seventeen years has passed since the 1995 Strategy was developed, HRM has retained Stantec Consulting Ltd (Stantec) to complete a review of current programs and services, and to recommend opportunities for improvement over the next 10-20 year period. This review (Waste Resource Strategy Update) is timely as some of the current infrastructure is nearing the end of its useful life. A summary of current programs offered by HRM and the scope of Stantec's assignment are provided in the following sections.

1.2 SUMMARY OF EXISTING PROGRAMS AND SERVICES

HRM offers local residents and businesses with a package of programs and services that meets or exceeds those of comparable municipalities in North America. Of particular note, HRM and Nova Scotia have banned the landfilling of household and industrial/commercial/institutional (ICI) organics such as food waste and brush. Existing programs and services are highlighted below.

Residential Collection

- Weekly recyclables collection (biweekly in outlying areas)
- Bi-weekly food and yard waste collection (weekly in the summer in urban/suburban areas)
- Bi-weekly garbage collection

Processing and Disposal Services

- Recyclables processing for ICI sector (facility in Halifax)
- Organics for ICI sector ($75/tonne fee; facilities in Halifax and Dartmouth)
- Disposal facility at Otter Lake south of Halifax ($125/tonne)

Diversion Program Education and Communication Services

- Proactive outreach and inspection of high rise and ICI locations to support diversion programming
- Licenses and monitors diversion of C & D materials in HRM
- Audits and educational sessions for schools, community groups, and ICI sector.

With respect to the ownership and operation of waste management infrastructure, HRM has relied primarily on design/build/operate (DBO) arrangements with the private sector to construct and operate waste management facilities. HRM currently has no day-to-day role in operations on site. HRM staff provides management and coordination of residential collection, processing, and disposal services.

HRM's current waste management infrastructure is de-centralized at four locations as shown on Figure 1.1. Organics processing facilities operate under the DBO model in both Halifax (operated by New Era) and Dartmouth (operated by Miller). The Materials Recycling Facility (MRF) in Halifax is also operated by Miller but under a conventional provision of services contract as HRM owns the lands, buildings and equipment at the MRF. A municipal household special waste (MHSW) depot is also sited on the MRF property. The disposal facility at Otter

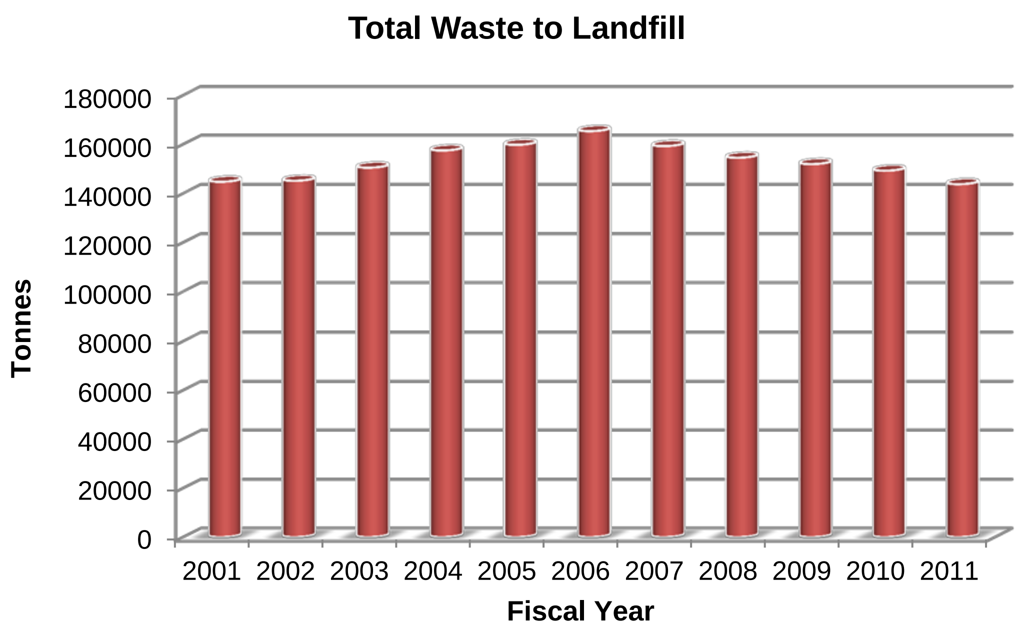

FIGURE 1.1
HRM Waste Facility Locations
Waste Resource Strategy Update
BEDFORD
DARTMOUTH COMPOST
DARTMOUTH
HALIFAX
RECYCLING
OTTER LAKE LANDFILL
HALIFAX COMPOST

Lake and associated front end processing units were created in the late 1990s under a "cost plus" DBO arrangement with Mirror Nova Scotia Limited (Mirror) which is still in effect.

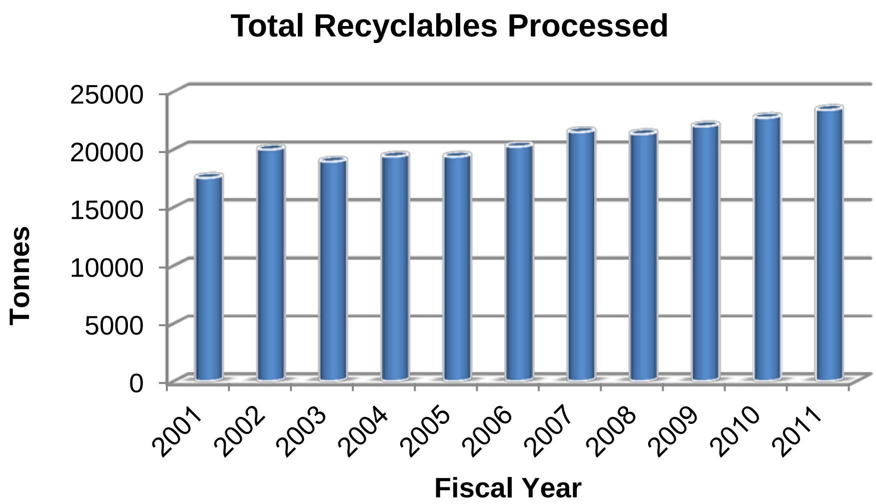
Specific details on each of the preceding programs and services will be provided in following sections as each program area is reviewed individually and also in the context of the complete waste management system.

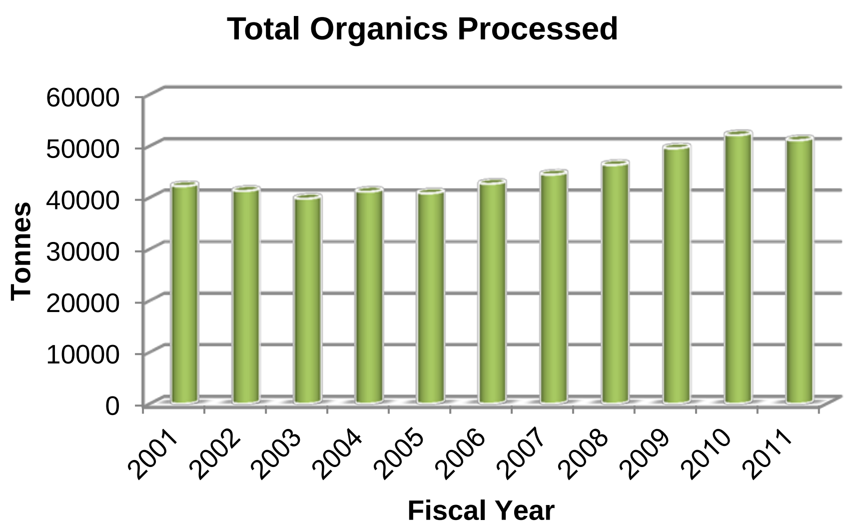
1.3 HISTORICAL TONNAGE DATA AND PROJECTIONS

HRM and its contractors have provided Stantec with historical tonnage data for programs and services relevant to this review. Stantec has completed a general review of the data for reasonableness, but has not independently reviewed the tonnage source documents. Where some data are clearly estimates, notes have been provided. The following graph illustrates waste sent to landfill since 2001.



Similarly, the following graphs show the progress achieved in diverting recyclables and organics from the wastestream.





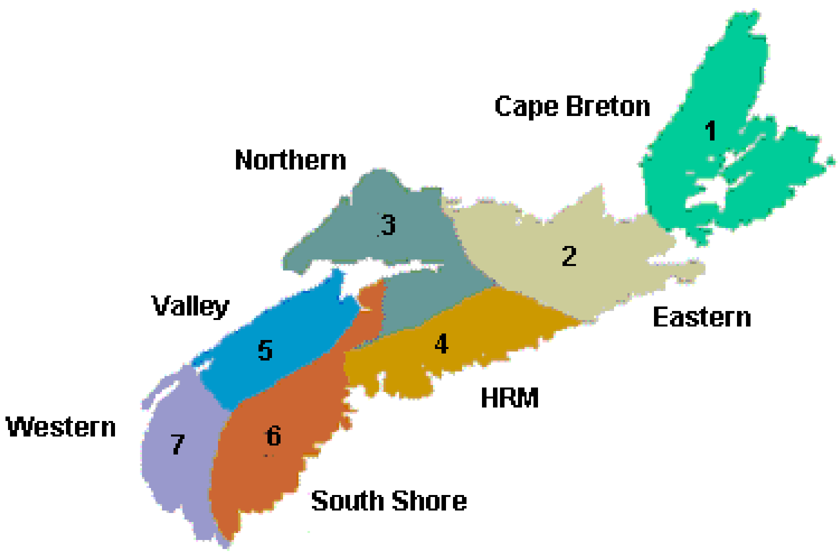
1.4 WASTE DIVERSION STATISTICS

HRM calculates waste diversion on a percentage basis for both the residential and ICI sectors, and as a combined statistic. Overall combined diversion is reported at 62% in 2011. Data specific to the residential and ICI sectors are described below.

The most recent data for the residential sector indicates that close to 52% of residential waste is currently diverted from landfill. Stantec independently calculated residential diversion using a different methodology (GAP) utilized by Waste Diversion Ontario (WDO) for equitably measuring performance for all Ontario municipalities. While Stantec utilized a slightly different methodology, the diversion estimate was in the same range as the HRM calculation.

Other municipalities are typically not able to calculate ICI diversion as waste exporting prevents the accurate measurement of disposal and diversion. Stantec has reviewed HRMs estimate of 66% diversion from the ICI sector and considers it to be a fair representation of local diversion in that sector.

With respect to performance as it relates to other municipal jurisdictions in Nova Scotia and the provincial target of reducing waste to the target of 300 kg/capita by 2015, HRM is in the middle of the group compared to other waste management regions even with a high concentration of industry in HRM. The Province of Nova Scotia generates an annual report on the tonnage of waste disposed on a per capita basis and diversion rate for the seven regions in Nova Scotia as shown below. The 53% diversion reported for HRM by the Province is slightly more than the 52% reported by HRM due to a minor difference in calculation method. The following table provides landfill tonnage per capita and the diversion rate for the time period of April 1, 2010 to March 31, 2011.

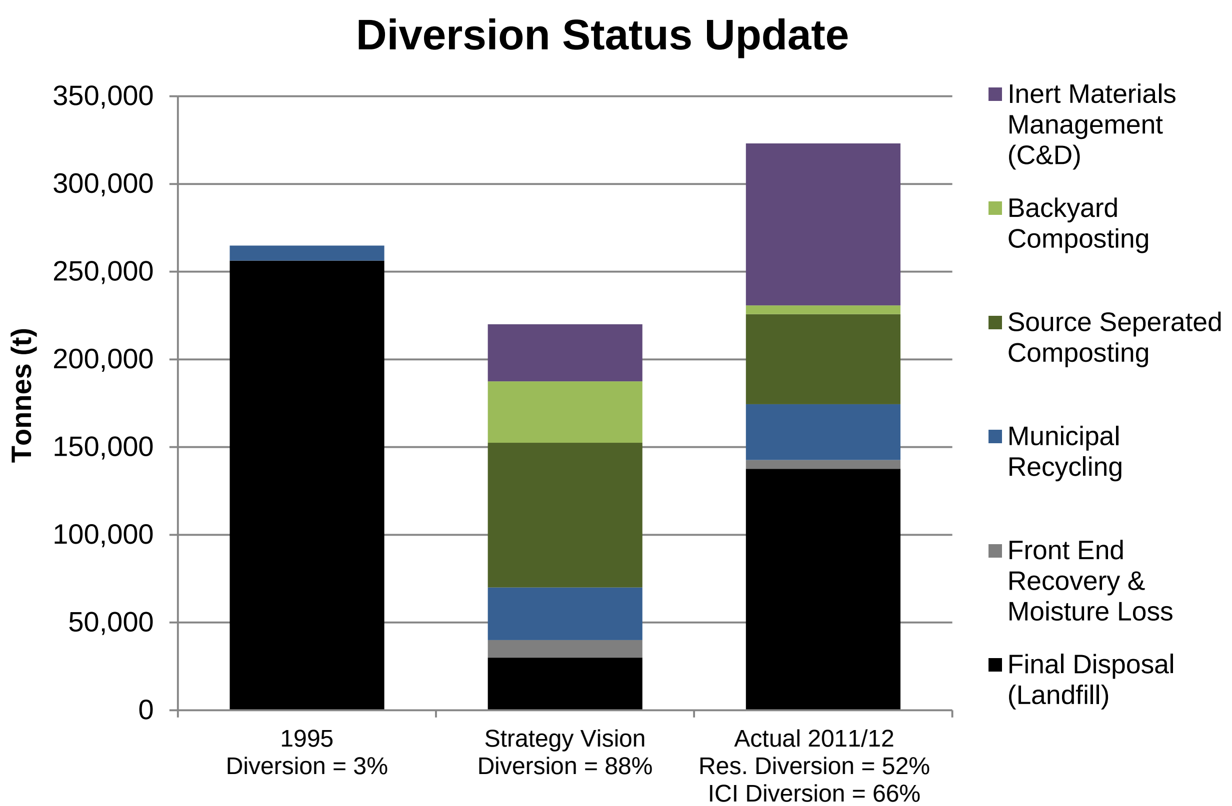


Region	Population (2011)	Tonnes per Capita	Diversion Rate
1 – Cape Breton	135,974	.413	38
2 – Eastern	74,215	.433	43
3 – Northern	81,485	.532	30
4 – HRM	390,096	.393	53
5 – Valley	75,524	.357	47
6 – South Shore	116,080	.328	48
7 - Western	51,125	.303	53

Note: Population data were derived from StatsCan, 2011 which provides data based on geographic zones inconsistent with provincial waste collection zones; Eastern, Western, Northern, South Shore and Valley regions were estimated based StatsCan data and with using Nova Scotia's Municipal Collection Zone Map (http://www.gov.ns.ca/nse/waste/muncollection.asp).

1.5 HISTORICAL WASTE DIVERSION PROJECTIONS

The following three graphs depict how waste tonnage was managed in 1995, projections (from 1995) of what a mature program based on the 1995 Strategy may achieve, and the reality of the current waste management system. As can be clearly seen below, HRM currently manages approximately 100,000 tonnes more waste per year than anticipated in the 1995 Strategy. It also warrants noting the reduction in tonnage to landfill between 1995 and present day.



Note: All graphs exlcude diversion of ICI fibres (43,000 tonnes currently) as that commodity was not included in the 1995 Strategy.

1.6 SCOPE OF STANTEC ASSIGNMENT

The overall goals of this assignment are as follows:

- *Reduce program costs through the implementation of service delivery efficiencies;*

- *Upgrade or replace necessary infrastructure to meet existing and near to mid-term capacity and regulatory requirements; and*

- *Maximize the opportunity for program revenue generation from recovery of and/or processing of waste resource materials and increased diversion.*

In order to meet the stated goals described above, the scope of Stantec's assignment includes a review of major elements of HRM's waste management system including:

- Waste processing and disposal;
- Landfill designs;
- Curbside collections;
- Organics processing;
- Recyclables processing;
- Materials transfer capability;
- Industrial/Commercial/Institutional(ICI) processing capacity;
- Energy from waste; and
- Opportunities for greater partnering across Nova Scotia.

For each major program area, Stantec is to complete three tasks if applicable:

A) Assess current system performance based on the original objectives and principles in the 1995 Strategy;

B) Compare HRM performance to industry best practices, benchmarks and legislative obligations if applicable; and

C) Generate options and recommendations for program improvement based on business case cost analysis.

As recommendations are developed, they are considered in the context of the entire integrated system to ensure that efficiency gains in one program area are not offset by unintended negative consequences in other areas.

2.0 An Integrated Approach to Waste Management

2.1 GENERAL

Prior to the 1990s, municipal waste management was a relatively straightforward logistical exercise. A single vehicle collected all waste placed at the curb and transferred the material to a local landfill. As recycling programs were rolled out across Canada in the early 1990s, a second vehicle going down the street was required and processing centres were constructed to sort the cans, glass, plastics and paper fibres. Many communities then added yard waste collection at the curb, with some including food waste organics. Other related programs include MHSW diversion, expanded deposit/return systems and educational efforts to promote greater waste minimization and diversion from landfill. The education and proactive inspection monitoring required by provincial legislation assists HRM in enforcing diversion requirements.

As can be imagined, this increase in complexity required integration of both program delivery and philosophical approach. The 1995 Strategy recognized the need for an integrated approach and HRM implemented one of the most comprehensive systems in that era. For over a decade HRM remained as one of very few municipalities in North America that diverted food waste organics from landfill. Only in the last 5-10 years have food waste organics been added to some of the more well developed municipal programs in Canada.

As Stantec was reviewing current HRM programs and opportunities for the future, the interdependencies of the various programs were considered. For example, modifications to collections programs can be constrained by the current location of processing infrastructure. The 1995 Strategy suggested that composting facilities be located close to the points of generation to encourage residents to become familiar with and accept composting. This led to the creation of organics processing facilities in both Dartmouth and Halifax which satisfied a philosophical objective of the 1995 Strategy, but nonetheless created a constraint for future decision making.

2.2 LIMITATIONS BASED ON CURRENT INFRASTRUCTURE

This review of the HRM waste resource system must consider the current location, age and condition of all existing physical infrastructure. As previously mentioned, HRM developed a de-centralized model with four primary locations for processing and disposal in the immediate Dartmouth/Halifax area. In general, the continued use of cost-effective infrastructure until near the end of its useful life is preferred unless there is major policy or operational benefits gained from pre-mature closure. However, Stantec will not rely solely on this general assumption and will compare other reasonable scenarios if the financial benefit of a particular approach is not already clearly established.

This is not intended to suggest that the lowest cost option will necessarily be the preferred and recommended option. As discussed, broader policy objectives will also be considered before final recommendations are made.

2.3 IMPACT OF HRM SOLID WASTE BY-LAW NO. S-600 ON ICI SECTOR

The above referenced municipal by-law has a unique provision adopted by Regional Council in 2002 which expressly prohibits the export of waste materials generated within HRM. Section 16.3 of the By-law is restated below.

"No person shall export or remove solid waste generated within the Municipality outside the boundaries of the Municipality and all such solid waste shall be disposed of within the boundaries of the Municipality and in accordance with this By-law."

A following section in the By-law clarifies that solid waste is defined as ICI waste (garbage), organics and construction and demolition waste, but excludes recyclables and special wastes such as sludges and biomedical wastes.

Stantec was advised that this provision of the By-law was challenged in court by private firms seeking to export waste, and that the By-law was upheld.

In plain language, ICI waste generators and haulers must use local facilities for organics processing and landfill disposal. Given that HRM owns the only sanitary landfill and contracts for the only organics processing facilities in the region, private firms are obligated to pay the fees specified by HRM. This type of restrictive provision is very rare in municipal By-laws. This concept is often referred to as "flow control".

Flow control was adopted in 2002 to support the HRM solid waste strategy approved by the HRM and the Province in the 1990s where HRM facilities were sized to accept all local waste, and also be confident that sufficient revenue would be generated to pay for those facilities. HRM controls the wastestream and has the ability to direct waste to facilities to economically support the program. HRM can direct waste to outside the region should it so choose. One drawback of this approach in HRM was that no private sector processing facilities were ever developed. This created a dependency which HRM must now continue to support.

If HRM were to deny access to ICI generators for organics processing and export was required, then the holistic concept of Section 16.3 would be called into question. ICI waste generators would also likely renew arguments that they be entitled to export garbage to the landfill of their choice beyond HRM.

While not a legal opinion, it is Stantec's observation that it would be difficult to modify the By-law to apply flow control selectively and only to HRM's advantage. That said, HRM must either commit to the current flow control model by constructing facilities to meet ICI needs, or allow ICI generators to manage their entire wastestream as they see fit and accept the consequences of the likely loss of revenue at the landfill and organics processing facilities. From a fairness standpoint, it is difficult to envisage a scenario beyond these two all or nothing alternatives.

Stantec has completed this assignment on the premise that no change in Section 16.3 is contemplated.

3.0 Otter Lake Waste Processing and Disposal Facility

3.1 EXISTING OPERATIONS

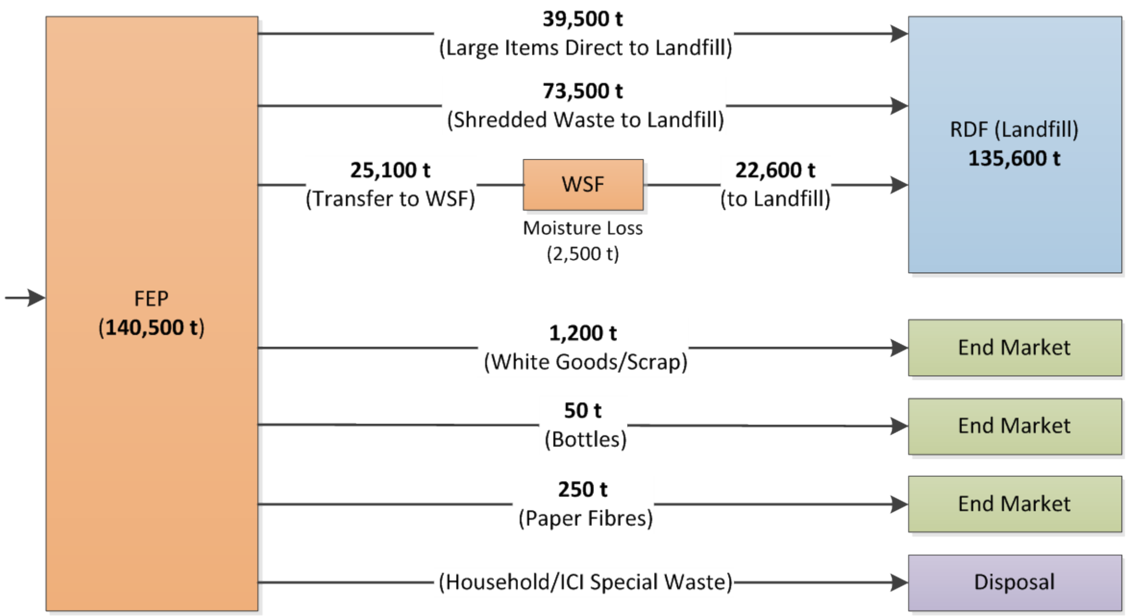
3.1.1 Front End Processing

All waste received at Otter Lake from both residential and ICI sources is weighed at an inbound scale and offloaded at a building described as a Front End Processing centre (FEP). Staff at the FEP removes white goods (household appliances) and other scrap metal from the residential and ICI wastestreams and segregates this scrap metal for recycling. Other large or bulky items such as couches, carpet and mattresses are also removed from the incoming wastestream and sent directly to landfill. Any unacceptable material such as propane tanks are also removed at this time. These activities are required as the initial stage of mechanical bag breaking at the FEP is not intended to process large items.

After removal of large items and white goods, waste passes through mechanical bag breakers and is screened with particles smaller than 50mm (2 inches) transferred by conveyer directly to the adjoining Waste Stabilization Facility (WSF) building. Particles between 50mm and 150mm (2 to 6 inches) are shredded and then transferred to the WSF. Material over 150mm (6 inches) in size passes over conveyers for final hand removal of any materials unacceptable for landfill. No significant effort is made to remove compostable materials such as wet paper, cardboard, or other recyclables from the conveyor lines.

The rationale for sending smaller particles to the WSF was the assumption that most compostable organics would be smaller than most non-compostable materials after coarse shredding. While this reasoning has some merit, the operational reality is that any smaller objects such as steel bottle caps and crushed glass, as well as plastic film, pass on to the WSF for stabilization rather than being sent to landfill. Likewise, larger compostables such as wet paper and cardboard are not sent to the WSF.

The following reflects the tonnage of materials entering and leaving the FEP and their destinations during 2011.



Material Flow through FEP, Calendar year 2011

HRM reports the annual cost to operate the FEP is $7.2 million. This amount includes some activities which would need to be retained if the FEP closed such as the scalehouse, roadways, and other shared services with the RDF.

All current operations at Otter Lake including the FEP are managed by Mirror under a long-term DBO contract with HRM. Stantec understands that the total staff complement at Otter Lake is approximately 100 staff. HRM owns the lands and buildings at Otter Lake. The scope of this assignment does not include an assessment of the Mirror contractual relationship except to acknowledge that any potential savings identified by Stantec need to be assessed further with respect to contractual obligations.

3.1.2 Waste Stabilization Facility

The WSF typically receives approximately 25,000 tonnes of organics and mixed waste per year after initial processing in the FEP. This operation is basically a conventional aerobic composting process utilizing a series of concrete channels and turning devices to maintain aerobic (with oxygen) conditions. Other municipalities such as the City of Guelph in Ontario installed similar technology in the 1990s to process food waste and other organics. This approach is effective at starting the composting process. Materials are retained in the composting channels for approximately 18 days and then sent directly to landfill.

The annual cost to operate the WSF is $1.7 million.

3.1.3 Residual Disposal Facility

The RDF is a conventional modern sanitary landfill equipped with a low permeability base liner, leachate collection underdrain, leak detection system, and landfill gas collection and flare system. Based on a review of background documents and a site inspection, Stantec is of the opinion that the RDF is generally well designed and operated, and efforts are taken to minimize nuisance impacts to the local community.

The annual cost to operate the RDF is $5.3 million.

3.2 COMPARISON OF CURRENT OPERATIONS TO 1995 STRATEGY

3.2.1 Front End Processing

The following is a direct excerpt from the 1995 Strategy related to the intended purpose and function of the FEP.

"The processing of mixed residues from both residential and ICI sectors is required to ensure that usable and/or inappropriate materials are removed before delivery to the residuals disposal facilities. Facilities for processing mixed residues are known as "front-end processing" facilities. The primary purpose of these facilities is to remove recoverable resources (i.e., recyclable and compostable materials) from the mixed residue stream. Their secondary intention is to remove substances, such as hazardous wastes, putrescibles and other materials that are banned from disposal at the residuals disposal facilities.

Recovered recyclable materials will be processed at the front-end processing facilities and routed to markets. Compostable materials that are recovered from the mixed residue stream will be processed in composting facilities separate from the source-separated compostable materials. While compost produced in these kinds of facilities is likely to be of lower quality than from source-separated composting, it will still be a valuable and useful resource."

The stated primary purpose of the FEP as noted above is the removal of recyclables and compostables from the mixed waste, with recyclables routed to end markets and compostables converted to a useful and valuable resource.

The context in which these statements were made is an important consideration at this point in time when evaluating whether these facilities are performing as intended. In 1995 there was no curbside collection of organics and it was in the early years of the curbside recycling program, although the 1995 Strategy contemplated the full-scale rollout of those programs. The current comprehensive province-wide deposit/return program had also yet to be implemented. That said, the wastestream in 1995 contained large amounts of both recyclables and compostables which the FEP was intended to remove.

Based on Stantec's review of historical tonnage data and an inspection of the actual operations, it is our opinion that the FEP does indeed process all waste received, but that there is little benefit gained from this activity as few recyclables are recovered, and no useful or valuable compost is produced. The only significant diversion achieved is the removal of white goods and scrap metal from the waste. Beyond this unconventional method of white goods recovery, the following represents the total tonnage of recyclables and compostables recovered for sale or beneficial use in 2011 from the 140,000 tonnes of incoming material to the FEP. Given that $7.2 million per year is required to operate the FEP, the 300 tonnes of recyclables recovered represents a particularly poor return on investment.

Pop Bottles:	50 tonnes
Paper Fibres:	250 tonnes

The secondary intention of the FEP was to remove special wastes, putrescibles(organics capable of biological decay) and other materials banned from landfill. Once again, it is important to consider the context of these statements in 1995. With respect to special wastes, there were very limited municipal household special waste (MHSW) programs in place at the time, and household cleaning and lawn care products were far more toxic than today. With respect to organics, again the likely intention was to divert the greatest amount possible.

Based on Stantec's review of historical tonnage data and an inspection of the actual operations, it is our opinion that the FEP does provide some minor diversion of household and ICI special waste, but that the secondary intention of the FEP is also largely unrealized today. The following is a list of the materials recovered from the FEP in 2011 that could be described as MHSW or ICI special waste. With the exception of fire extinguishers, propane tanks and batteries, the volume of other products is low with no pesticides or oil-based paints recovered. Propane pressure tanks are better described as an operational hazard given that the risk is related to pressure release after puncture or shearing of the valve.

Type	Container	Total (items)
Alkyd Paint	Bulk Drum	0
	Labpack	0
	Triwall	0
Latex Paint	Bulk Drum	0
	Labpack	0
	Triwall	0
Flammables	Bulk Drum	0
	Labpack	27
Pesticides	Labpack	0
Methylacetate	Tank	3
Methylene Chloride	Tank	5
Waste Oil	Bulk Drum	0
Oil Filters	Drum	1
Lithium Batteries	Drum	1
Aerosols	Labpack	27
Acid Batteries	Item	183
	Labpack	25
Dry Batteries	Labpack	21
Nicad Batteries	Labpack	0
Wet Batteries		2
Fire Extinguishers	Item	256
	Drum	6
Propane	Labpack	147
	Tank	316
Compressed Argon	Tank	0
Compressed Nitrogen	Tank	11
Compressed Gas	Tank	0
Assorted Specialty Gases	Labpack	3
Acetylene	Each	0
Helium	Tank	0
Freon	Tank	3
Carbon Dioxide	Tank	13
Halon	Tank	4
Total		1,054

3.2.2 Waste Stabilization

The WSF was considered as a component of the FEP in the 1995 Strategy but subsequently was treated as a separate entity by HRM given that the FEP and WSF were contained in separate structures on site, and staffing and equipment costs could be easily segregated.

As previously identified in Section 3.2.1, the 1995 Strategy recognized that the output from the WSF would be low quality compost, but it was anticipated that it would still be a valuable and useful resource. In contrast, the 1997 Agreement between HRM and MIRROR specifically identifies that all WSF output is to be placed directly into the RDF. The WSF has been operated as specified in the 1997 Agreement with all compost landfilled since facility commissioning.

It is unclear at this time why such a fundamental change occurred between 1995 and 1997. The change brings into question the rationale for the FED/WSF combination. An 18 day period in the WSF does not necessarily improve landfill performance with respect to gas, odour and leachate.

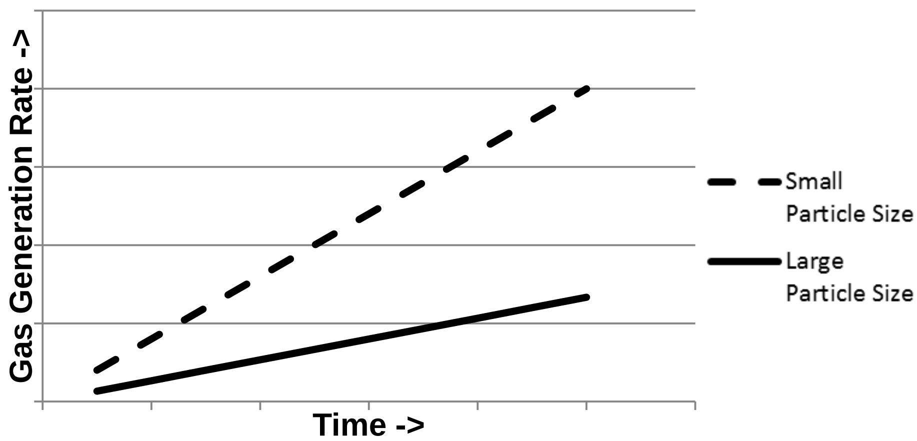
3.2.3 Residual Disposal Facility

The RDF, in contrast to the FEP/WSF combination, is operating as envisaged in the 1995 Strategy. The landfill is well organized, well maintained and with no obvious evidence of poor housekeeping practices. The environmental performance of the landfill has also been acceptable compared to the expectations in the 1995 Strategy.

The only significant deviation from that contemplated in the 1995 Strategy is that all output from the WSF is sent to landfill. A potential unintended consequence of this change is increased production of landfill gas in the immediate months and years after the WSF product is placed. The multiple shredding and mixing of organic waste in the FEP/WSF combination have in fact increased the potential for community odour impacts compared to a scenario where the FEP/WSF did not exist and all material was sent directly to landfill. This is due to the homogeneity and significant reduction in particle size of the waste which increases the surface area available for anaerobic bacteria (gas producing) to thrive as shown on the following graph[1].

[1] McBean, Edward A. et al, Solid Waste Landfill Engineering and Design, page 80, 1995

Landfill Gas Production vs. Particle Size



An analogy which may assist in the explanation of this phenomenon is the difference in time for a tree trunk to decompose, compared to an equivalent mass of wood chips created from the tree truck. An intact trunk has a limited surface area for microorganisms to process the wood, whereas the wood chips offer a significant increase in surface area which increases the opportunities for bacterial decomposition.

3.3 COMPARISON OF CURRENT OPERATIONS TO INDUSTRY BEST PRACTICE

3.3.1 Front End Processing/Waste Stabilization

Stantec has been unable to find a direct comparison to current operations at HRM in North America. The closest concept to the HRM system is in the City of Edmonton. Through DBO contractor TransAlta, a combined mixed waste and sewage biosolids processing facility was constructed in 1997. The original intended end use for the compost product was backfill for spent open pit mines owned by TransAlta. The facility was sold to the City in 2000 for $97 million and various modifications have taken place. The City's current plans are to modify the process to produce biofuels.

No other comparable municipalities have added the HRM preprocessing and composting stage to their waste management system. In terms of best practices, this approach was simply not adopted by others. With the benefit of hindsight, it is now clear that the FEP/WSF concept yields few benefits if curbside diversion programs are in place; has the potential for unintended negative impacts with respect to odour production at the landfill; and is very costly compared to the benefits achieved.

3.3.2 Residual Disposal Facility

As previously discussed, the day-to-day operations and condition of the environmental control systems at the RDF compare well with landfills of similar size and age. The design requirements for this landfill are more stringent than most comparable jurisdictions and this will be discussed in more detail in Section 4.

Presuming that a site has minimal environmental impacts and is well organized, in-place waste density assists in determining relative effectiveness compared to other similar sites. In-place waste density per cubic is a measure of the mass of residual waste in a given amount of landfill airspace. Given that landfills are generally permitted based on volumetric capacity, and fees are charged per tonne, a greater density of waste both extends the life of the landfill, and increases the total revenue generated over the life of the site. In-place density performance for the RDF is compared below to other industry standards.

HRM Otter Lake Density (cells 1-4): 765 kg/m^3

Industry Density Expectations for Large Sites with Different Compactors:

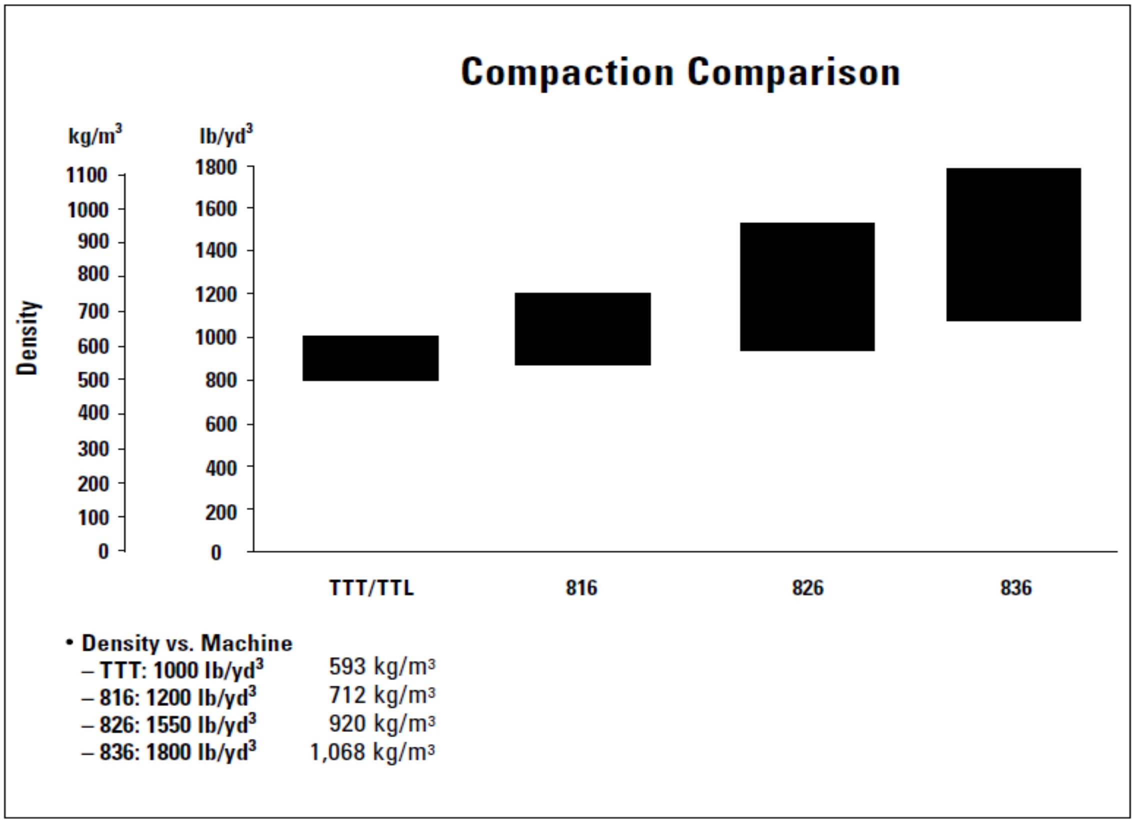
-25,000 kg Compactor: up to 700 kg/ m^3
-35,000 kg Compactor: up to 900 kg/m^3
-50,000 kg Compactor: up to 1,100 kg/ m^3

Typical year-to-year variability in density for a comparable municipal site (Waterloo Ontario) is shown below. HRM does not currently complete density calculations on an annual basis.

-2006;	837	kg/ m^3
-2007:	1079	kg/ m^3
-2008:	849	kg/ m^3
-2009:	808	kg/ m^3
-2010:	847	kg/ m^3

As can be seen from the above data, density is highly dependent on the mass of the compaction equipment utilized. The Waterloo example shows typical year-to-year variation. The initial filling of a cell is at a lower density, but very high density can be achieved as a cell reaches maximum height due to the combined effects of settlement and active compactive effort. Given that cells 1-4 at Otter Lake have only a 10 m depth of waste, performance to date is considered satisfactory.

The following graph was supplied by Caterpillar to show the relative performance of their landfill compactor units. HRM utilizes the 826 model at Otter Lake and is achieving compaction at the mid-range expected for that particular piece of equipment.



A second measure of operating performance is the capital and operating costs of a particular landfill. While the total annualized capital and operating costs/tonne for a site is reasonable performance measure. It should be noted that the following factors can greatly influence cost per tonne performance.

- *Relative Size of Site* – As a general rule, the larger the landfill, the lower the unit cost per tonne. There are tremendous economies of scale in landfill construction and operations. Scales, equipment and personnel are more effectively utilized when waste volumes are larger.

- *Local Soil Conditions* – There are some modern landfills that rely solely on clay base liners constructed from on-site materials. This greatly reduces capital costs for cell construction.

- *Leachate Treatment* – The ability to pump leachate to a local wastewater treatment facility greatly reduces both capital and operating costs compared to either on-site treatment or hauling to an off-site treatment facility.

The costs to construct and operate the RDF are noted below.

Otter Lake RDF	Operating Costs:	$22/tonne
	Capital Costs:	$47/tonne
	Total	$69/tonne

The operations of the FEP/WSF/RDF are highly integrated and HRM operational costs for the RDF do not necessarily include all items necessary to operate a standalone landfill. The $22/tonne may be understated. Capital costs are highly variable year-to-year. Stantec utilized an average annual capital cost of $7 million and a tonnage estimate of 150,000 tonnes/year to calculate this cost.

In terms of landfill operation, the operating cost per tonne as reported by six similar municipalities are noted below. It should be noted that landfill operations cost data is highly variable based on the tonnage received which changes from year to year. The following values are intended to be used to establish relative performance only. Data is reflective of 2010 or 2011 costs. Also, municipalities have different methods of allocating capital and operating costs, administrative expenses and general municipal overhead. Small landfills also typically have higher per tonne costs, but an overall small budget.

Greater Victoria, BC:	$46/tonne
Essex-Windsor, ON:	$15/tonne
Halton Region, ON:	$38/tonne
Brant County, ON:	$37/tonne
Waterloo Region, ON:	$30/tonne
Fredericton, NB:	$71/tonne

A more reliable method to establish the true all-inclusive cost of constructing and operating landfills is the published tipping fee at privately owned sites. A survey of average fees charged in 2012 for several US sites where design and environmental controls apply are noted below[2]. Lower fees than those stated are typically offered for larger customers as the following rates apply to single loads.

US National Average:	$45/ton (imperial ton)
Michigan:	$41/ton
Maine:	$84/ton
Ohio:	$42/ton
New York:	$49/ton

A recent cost example in Ontario is in Peel Region. Peel Region has accepted an offer for transportation and disposal of waste at an all-inclusive cost of $68.54/tonne. Round trip transportation of approximately 500 km is included in this total. While not precise, based on this distance, a tipping fee of $35-40/tonne can be inferred.

[2] Waste & Recycling News, July 9, 2012

3.4 OPPORTUNITIES FOR OPERATIONAL IMPROVEMENTS

3.4.1 Front End Processing/Waste Stabilization

Given the context of waste management in HRM in 2012, the FEP/WSF combination has far less relevance than when the 1995 Strategy was developed. Few materials are currently diverted from landfill through the FEP. Stantec has developed the following options for consideration by HRM.

Option 1 – Maintain current operations
Option 2 – Improve recovery of recyclables in FEP
Option 3 – Close and decommission FEP/WSF
Option 4 - Repurpose FEP/WSF to process source separated organics

Option 1 is considered unsatisfactory moving forward given the $8.9 million per year annual cost, and the lack of any meaningful recovery of recyclables (300 tonnes) or any usable compost. White goods can be more effectively segregated at the curb than removed from the mixed waste. While the precise amount of household and ICI special wastes removed is difficult to determine (total container volumes are recorded, not actual volume of product present) more effective means to divert special wastes are available to HRM. The multiple handling and shredding of FEP waste also can cause special wastes to be released from containers and absorbed by other materials destined for landfill. If even a small percentage of projected savings were dedicated to alternative special waste diversion methods, HRM could greatly enhance current programs. The total mass and toxicity of special wastes is also much different today than in 1995. Latex paints and other water-based products are in far more common use today than the solvent based products of the past. Residents are also making use of more "green" household cleaning products and lawn care strategies. This evolution is supported by recent data supplied by HRM and presented in a previous section. Stantec supports the recovery of special wastes in all municipalities, but suggests that the FEP is not the most effective means to achieve this goal.

Option 2 is also not considered feasible given the minor opportunity for improvement and the costs required to operate the FEP. In order for recyclables to be marketable, they must be separated into like commodities and be free of dirt, glass shards or other foreign matter. The two stage shredding process damages recyclables and causes contaminants to adhere to the containers or paper fibres. As previously stated, only 300 tonnes of recyclables were removed from 140,000 tonnes of incoming waste in 2011. Once recyclables are soiled, they are no longer acceptable to end markets.

Option 3 would result in the short term loss of recovery of a small tonnage of recyclables and special wastes. However, eliminating the shredding and composting processes will reduce the potential for odour incidents at the RDF and provide considerable budget capacity to enhance at-source recovery efforts of recyclables and special wastes. The potential multi-million dollar savings could enhance education for at-source recovery, and also provide potential tip fee or tax levy relief. Stantec recommends implementation of Option 3 by the end of 2013, if HRM elects not to implement Option 4 below.

Option 4 involves the elimination of the current function of the FEP/WSF by the end of 2013, and repurposing the WSF to process source separated organics (SSO) during peak periods beginning in 2014. Final curing of compost would also occur at Otter Lake. In 2019, the WSF would serve as the primary processing centre for the Halifax collection zone. The existing organics processing centre in Goodwood south of Halifax would be decommissioned in 2019.

3.4.2 Residual Disposal Facility

There are opportunities to optimize the design and reduce capital costs at the RDF which are detailed in Section 4. The most significant opportunity for operational improvement at the RDF is to improve the utilization of the permitted landfill airspace. This can be achieved by increasing the density of waste per cubic metre of airspace. Gains in density have a direct and proportional impact on the life of the landfill. For example, a 10% increase in density will extend the remaining life of the landfill by 10%. Aside from greater diversion of waste at source, improving density is the best opportunity to reduce future landfill needs. Options for improving in-place density are presented below.

Option 1 – Consider advantages and disadvantages of larger compaction equipment at the next procurement opportunity

Option 2 – Utilize spray-on or other low volume consumption alternative daily covers whenever feasible

Option 3 – Utilize current WSF output exclusively as daily cover conditional on operational feasibility

All options presented above will contribute to improved waste density. Stantec recommends that HRM consider the implementation of some or all of the options presented. The first two options both require an increase in capital and operating costs with two potential long-term gains; deferred costs for cell construction, and deferred costs to develop a new disposal facility. No financial gain will be realized in the short-term.

The following is an example of the financial benefit accrued when increased density results in the deferral of new cell construction by one year. Assumptions used to calculate the Present Value of the two construction scenarios are listed below.

Current Year:	2012
Originally Planned Construction Year:	2017
Construction Year After Deferral:	2018
Construction Cost (2012$):	$15 million
Interest Rate:	3%
Inflation Rate:	1.5%

A financial gain of approximately $200,000 would be realized if cell construction was deferred one year.

4.0 Landfill Design

4.1 BACKGROUND

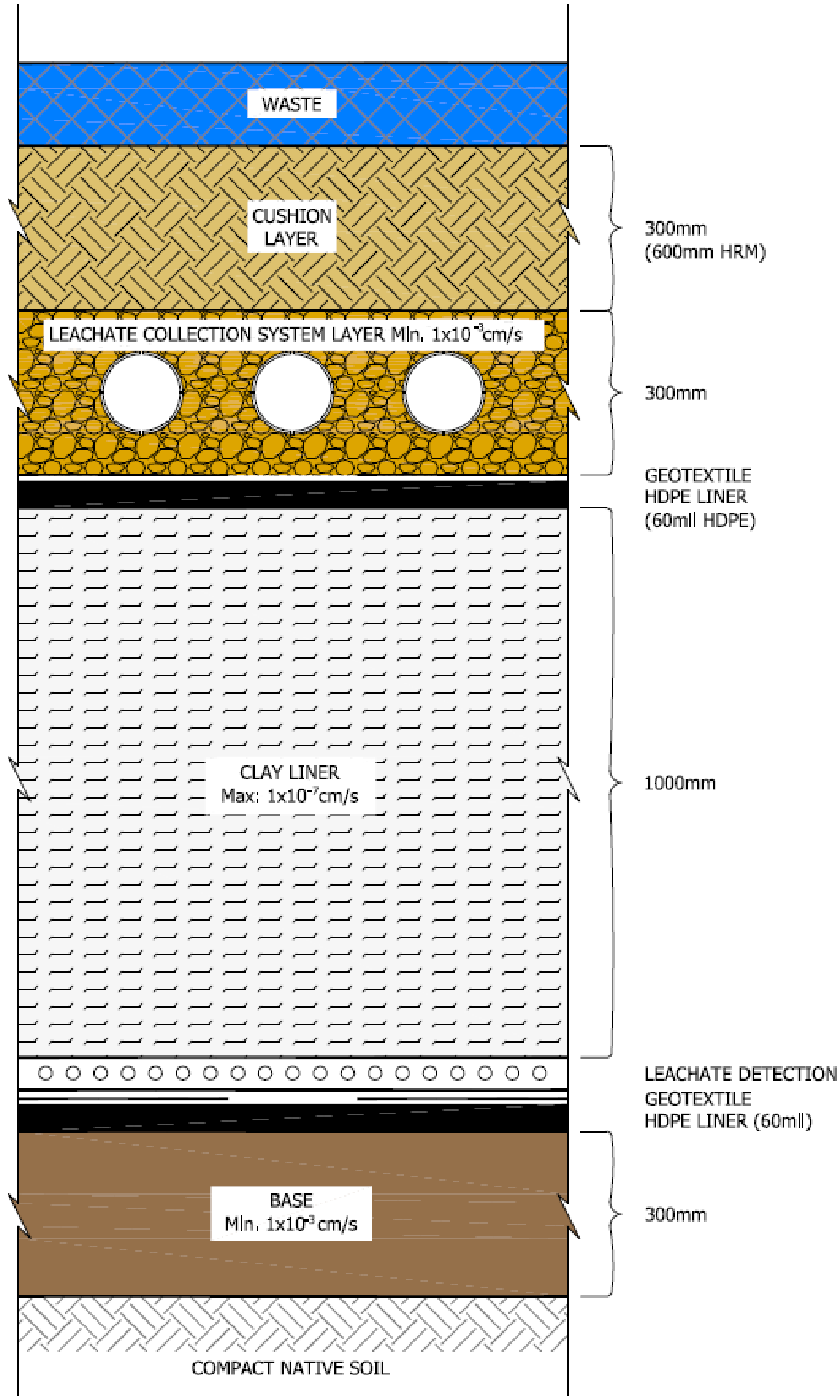
There are two design issues at the RDF which significantly affect the cost/tonne of operating the landfill. The first issue relates to the design specification for the landfill liner. Current provincial requirements for liner design are more stringent than most comparable jurisdictions. Section 4.2 describes opportunities to achieve landfill liner capital cost savings.

The second design issue affects both the expected life of the landfill and the overall capital cost/tonne for the RDF. The maximum vertical elevation of the RDF is consistent with the surrounding topography. Section 4.3 describes the potential net benefits of increasing the final elevation of the RDF.

4.2 LANDFILL LINER

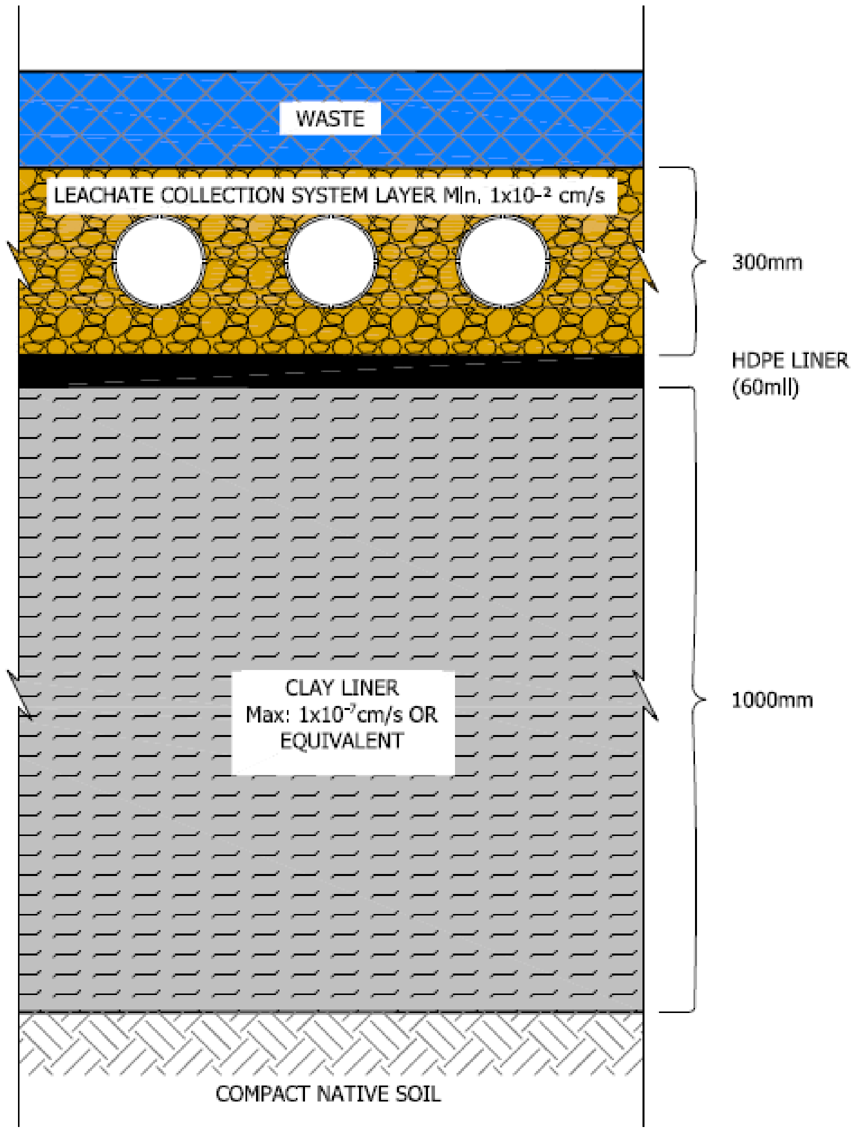
4.2.1 Current Nova Scotia Standards

The Province of Nova Scotia stipulates the design specifications for landfills in the province. All public and private landfill owners must conform to this specification. An illustration of the Nova Scotia base liner profile is shown below. Based on local conditions, designers have discretion to develop equivalent components when suitable materials are not reasonably available.


WASTE
CUSHION LAYER
300mm (600mm HRM)
LEACHATE COLLECTION SYSTEM LAYER Min. 1x10^{-3}cm/s
300mm
GEOTEXTILE
HDPE LINER (60mil HDPE)
CLAY LINER Max: 1x10^{-7}cm/s
1000mm
LEACHATE DETECTION
GEOTEXTILE
HDPE LINER (60mil)
BASE Min. 1x10^{-3} cm/s
300mm
COMPACT NATIVE SOIL

4.2.2 Liner Standards in Other Jurisdictions

Stantec compared the current Nova Scotia standard to ten other provinces and states and the USEPA. The complete comparison is illustrated on Drawing 01 in a plan pocket at the back of this report. Most standards reviewed have a specification similar to that shown below.



4.2.3 Applicability of Other Standards to HRM

Given the environmental impacts seen at the Upper Sackville landfill in the 1990s, it is understandable that Nova Scotia would endeavor to develop one of the most stringent design standards in North America. While this standard is no doubt highly protective of the environment, there are certain design elements which are costly and which could possibly be described as redundant or unnecessary given 15 years of operating experience with the current specification. The experience of other jurisdictions is also relevant to HRM and Nova Scotia as all provincial and state governments have now recognized the need to protect groundwater resources from contamination, and have implemented policies and standards which they deem to be adequately protective based on field experience and empirical evidence. All landfill liners but one (British Columbia) shown on Drawing 01 have a primary composite containment system consisting of a layer of re-compacted clay with a permeability of 1 x 10-7 cm/s or less, with a synthetic high density polyethylene (HDPE) liner placed above the clay with typical thickness of 60 mils (0.060 inches or 1.5 mm). All standards also have a leachate collection system directly above the composite liner.

The Nova Scotia standard differs from most in that a “cushion layer” is required above the leachate collection system, and a “leak detection” system is required below the clay/HDPE composite liner.

The Nova Scotia standard also includes a 300mm high permeability base layer under the leak detection system. Its purpose is not entirely clear but it may be intended to reduce hydraulic pressure beneath the leak detection system from an elevated groundwater level. Modern sites are rarely placed near the water table so the precise purpose and function of this layer cannot be definitively confirmed. Stantec does not propose eliminating this component pending clarification from the Province of Nova Scotia.

4.2.4 Opportunities for Design Refinement

Regardless of the relative thickness of a clay and HDPE liner system, the maintenance and ongoing proper functioning of the leachate collection system has a significant impact on the environmental performance of a modern landfill. As rain falls onto an active landfill cell and filters through the waste, leachate is generated. This leachate migrates to the base of the landfill cell where it is collected in perforated HDPE collection pipes embedded in a clear stone drainage blanket which slopes towards the collection pipes. If all pipes are flushed regularly and the stone drainage blanket is properly specified to resist clogging, leachate is quickly removed and little hydraulic pressure is exerted on the clay/HDPE liner system located below the leachate collection system. If the collection pipes foul, the leachate level will build up within the cell thereby increasing the hydraulic head or pressure on the composite liner. This situation can cause seeping of leachate from the sideslopes of the landfill into surface water channels, and increase the potential for the base liner to be compromised.

Twenty years ago, many municipal landfills operated with no base liner at all, and no form of leachate collection system. All leachate passing through the waste eventually discharged to surface water or the groundwater regime. Some of these sites installed buried leachate collection pipes along the perimeter of the landfill, but those retrofits were not completely effective.

All modern designs are highly protective of the environment compared to recent past practice. All systems described from other jurisdictions now include similar underdrains with layers of stone and collection pipes over 100% of the base of the landfill(leachate collection systems), with a low permeability liner below the collection system. This standard approach has proven to be effective at limiting groundwater impacts.

Stantec does not recommend any change to the Nova Scotia specification for the leachate collection layer, or the primary composite liner system of clay and HDPE. Where Stantec does see the opportunity to refine the current Nova Scotia design, is with respect to the “cushion layer” and “leak detection” system.

The cushion layer is required in few jurisdictions. The purpose of this layer is to provide a barrier to prevent the initial layer of waste from damaging the leachate collection system and the liners below. All landfill owners/operators share this concern. However, the operating methodology employed during the initial phase of waste placement within a new cell can equivalently protect the newly installed infrastructure. If the initial lift of waste is a relatively thick (5m) layer of loosely placed, bagged residential garbage with no intensive compaction, the leachate collection system can be adequately protected. A requirement for a minimum 300 mm stone layer directly over the top of the collection pipe, and no soil placed as daily cover until a 5m depth of waste has been achieved will complete the initial stage of landfill development while protecting the critical leachate collection and liner systems.

For the reasons presented above, Stantec recommends the HRM request the Province of Nova Scotia reconsider its requirement for a 300mm cushion layer.

Aside from confirming that the current RDF liner system is working effectively, the multi-layer leak detection system does not enhance the environmental performance of the site. This type of leak detection system is more typically required at hazardous waste sites where the potential impact of leachate migration is far more severe than at a modern municipal landfill. Detection of a small amount of leachate would also not necessarily warrant any action other than continued monitoring. Excavating and replacing liner systems at landfills of this size is rarely undertaken. A program of enhanced monitoring and groundwater containment are more frequently implemented if required.

The site operator reports that the leak detection sumps at the RDF are pumped out on a regular basis but that they believe the source of this water is not from the leak detection system. Water sample analytical results generally confirm this assumption but Stantec is not able to state with certainty that this is indeed the case without further investigation. Stantec suggests that HRM review the design and operation of these sumps and modify if needed to isolate these sumps from surface water or other sources.

If HRM can confirm that the leak detection system is not in a material way contributing to the presence of water in the leak detection sumps, then Stantec recommends that HRM request the Province of Nova Scotia reconsider its requirement for a leak detection system.

4.2.5 Financial Impacts of Liner Modifications

Based on the suggested changes to the Nova Scotia landfill liner specification, and HRM's most recent cost data on the construction of a new landfill cell and base liner, Stantec has developed the following cost comparison. As can be seen below, approval of a revised base liner could result in savings of $3.4 million in capital costs compared to current practice based on a typical 5 hectare cell. Three cells remain to be constructed at Otter Lake.

Cost of Cushion Layer per cell:	$1,270,000
Cost of Leak Detection per cell:	$2,130,000
Potential Savings per 5 ha cell:	$3,400,000

As a consequence of eliminating the existing 600mm cushion layer in the final 3 cells, an additional 90,000 m^3 of landfill capacity (150,000 m^2 x 0.6m) would be gained. This represents approximately six months of landfill site life extension. This added capacity will ultimately increase the total revenue generating tonnage placed in the landfill, but will not result in a revenue gain in the short term.

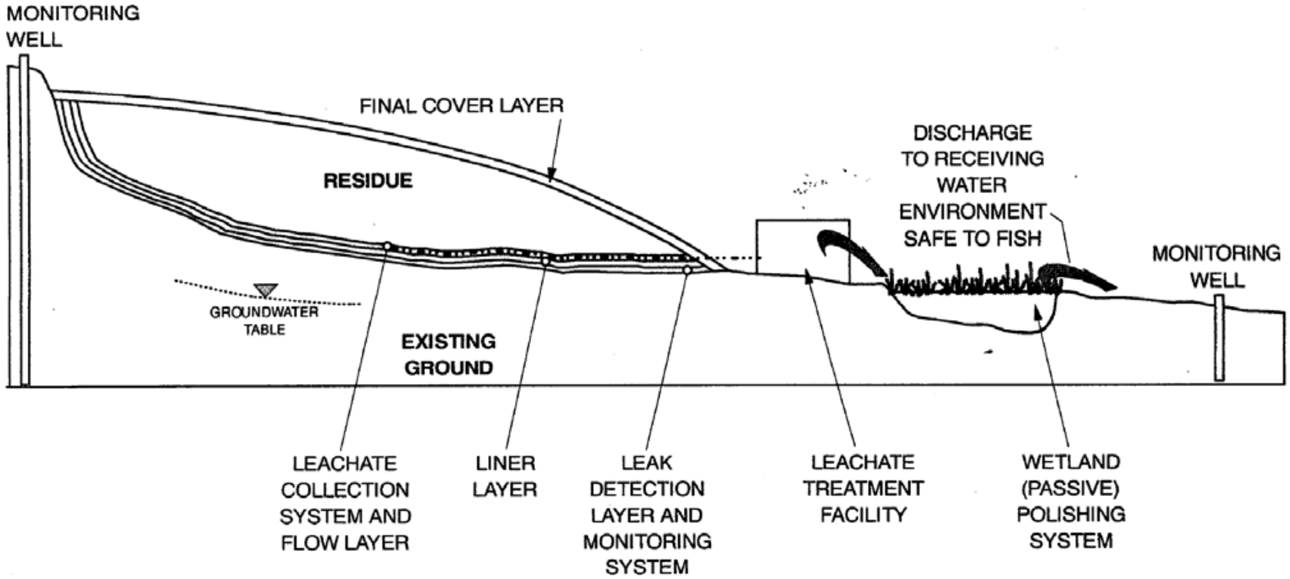
In summary, design modifications as suggested would result in the following positive impacts for HRM while maintaining a protective environmental control system consistent with other jurisdictions.

Reduced Capital Costs (2012$)	= $3.4 million for 5 ha cell base liner = $10.2 million total over remaining landfill life
Gained Landfill Capacity	= 90,000 m^3 = 6 months extension to landfill site life
Increased Revenue	= During the 6 months of landfill site life extension

4.3 LANDFILL CAPACITY

4.3.1 Current Limitations

The current maximum elevation of the RDF is 113m above mean sea level (amsl). The elevation selected during the initial site development creates a landform which blends with the local environment. The following illustration presented in the 1995 Strategy very closely reflects the current design of the site.



Integrated ~~Waste~~/Resource Management Strategy. Halifax County/Halifax/Dartmouth/Bedford. March 1995.

This type of profile is very rare in modern landfill design. Most current design concepts establish a landfill footprint (base area), then landfill capacity is maximized by increasing the vertical elevation of the site based on 4(horizontal) to 1(vertical) side slopes. Depending on the areal extent of the landfill footprint, a final elevation of 20-30m above the surrounding topography is not uncommon.

4.3.2 Impacts of Vertical Modifications

Dillon Consulting (Dillon) recently completed a two part assessment of a possible vertical extension of the RDF. The first letter report dated September 17, 2012, identified sightlines to the top of the landfill from residential properties in the vicinity. The second letter report dated September 26, 2012 provides an estimate of the volumetric gain in landfill capacity if the maximum elevation were increased by 1m, 5m, 10m and 15m. Both Dillon letter reports are provided in Appendix A.

Briefly, the September 17, 2012 Dillon report indicates that the landfill is currently visible to the public from the Bayers Lake Industrial Park, from apartment buildings in Clayton Park and houses in Timberlea.

This magnitude of setback from the RDF (as shown in photographs in the September 17, 2012 Dillon report) and visual buffering is rare. Technically, there is no engineering impediment to increasing the elevation of the landfill. Any increase of the current maximum elevation will result in an extension in the life of the landfill, and an increase in revenue from the additional material received. However, this increase in elevation will in some way increase the visual impact of the RDF on the local community. In general the current operation is well confined and in Stantec’s opinion, not a major negative presence in the local community. This opinion is obviously subjective and others may have a differing opinion. Stantec's opinion is based in part on visual impacts of other similar sites in other communities.

In Dillon's September 26, 2012 report, they indicate the following gains in landfill capacity and site life revenue for vertical expansions of 5, 10 and 15m.

Increase maximum elevation by 5m = 1,820,000 m^3 capacity gain
= 10 year extension in life of landfill

Increase maximum elevation by 10m = 3,170,000 m^3 capacity gain
= 17 year extension in life of landfill

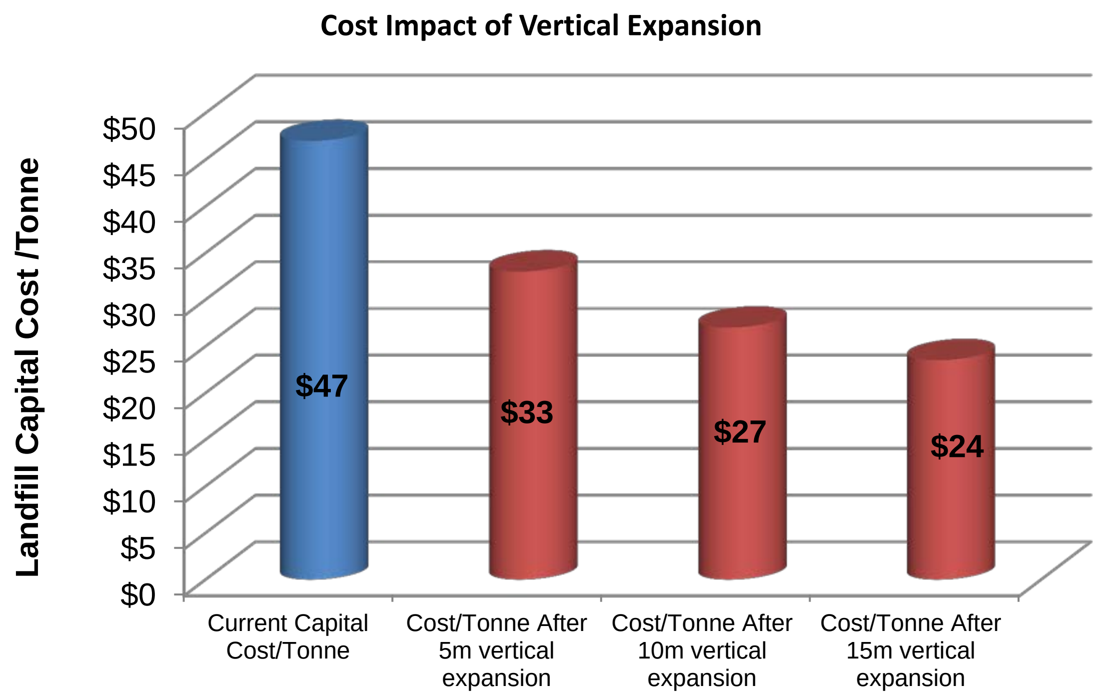
Increase maximum elevation by 15m = 4,280,000 m^3 capacity gain
= 23 year extension in life of landfill

4.3.3 Recommended Process to Modify Vertical Design

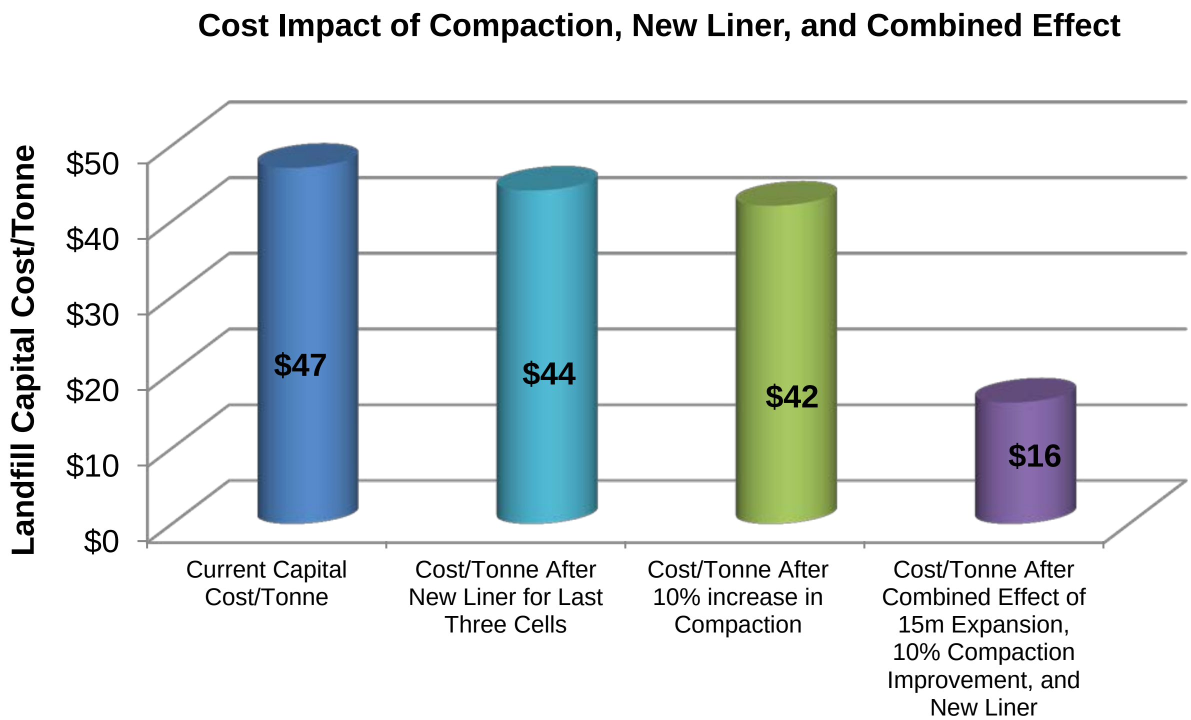
Based on a potential capacity increase of up to 4.28 million m^3, an extension in the life of the landfill of up to 23 years, and an associated revenue gain with no significant increase in capital cost, Stantec recommends that HRM consider a 10 to 15m vertical expansion of the RDF subject to meaningful local community input on the issue. To put this potential volumetric increase in context, the total design capacity of all nine cells at the RDF is 4.24 million m^3, with over 2 million m^3 remaining. The final decision to expand the RDF vertically or to maintain the current design limits must weigh the broader community benefits of significantly extending the life of the landfill at minimal capital costs, compared to the impact of the increased visual presence of the RDF on its immediate neighbours. There are no technical constraints with either a 10 m or 15 m vertical expansion.

4.4 COMBINED IMPACTS OF LANDFILL CHANGES

Previous sections have discussed the individual impacts of changes to the density of the landfill, the base liner design, and the maximum elevation of the landfill. This section attempts to describe the impact of these changes on the basis of a capital cost per tonne. Capital costs generally refer to major one-time costs for "capital" construction. Landfill cell base liner and road construction are examples of capital costs. The current capital cost per tonne is estimated to be approximately $47/tonne. The following graph shows the revised capital cost per tonne for the landfill for the three vertical expansion scenarios. The reason for the dramatic change in capital cost per tonne is that no additional base liner or roads are required to expand vertically. Therefore, if the approved volume of the landfill doubles due to vertical expansion, the capital cost per tonne will decrease by roughly half.



The following graph shows the individual impacts of a revised base liner and increased compaction. Increased compaction has a direct and proportional impact on capital costs for a landfill cell. For example and as shown on the graph, if compaction increases by 10% the capital cost per tonne is reduced by 10%. The revised base liner for the final 3 cells (cells 7,8,9) may result in savings of $10.2 million, but the cost per tonne impact across the entire landfill may be smaller than expected given that two thirds of the cells are already constructed. The final bar graph on the right shows the potential capital cost per tonne if all options are implemented in combination. This lower cost is more typical of costs at similar sites.


Cost Impact of Compaction, New Liner, and Combined Effect
Landfill Capital Cost/Tonne
$50
$40
$30
$20
$10
$0
$47
$44
$42
$16
Current Capital Cost/Tonne
Cost/Tonne After New Liner for Last Three Cells
Cost/Tonne After 10% increase in Compaction
Cost/Tonne After Combined Effect of 15m Expansion, 10% Compaction Improvement, and New Liner

5.0 Opportunity to Create a Regional Waste Resource Campus

5.1 CHALLENGES OF CURRENT DE-CENTRALIZED MODEL

The current decentralized model for waste infrastructure is challenging whenever changes to the collection program are contemplated, and whenever certain facilities are operating at capacity or are in need of upgrading. For example, in the Dartmouth collection zone organics are delivered to a processing facility in a Dartmouth industrial park, while garbage is delivered to the Otter Lake facility south of Halifax. A common practice today is for garbage and organics to be collected in the same truck with split compartment percentages ranging from 70/30 to 50/50. This approach is not feasible in HRM given the distance between the two drop locations.

Another example of the challenges associated with decentralized infrastructure is when a certain facility reaches capacity. The current MRF in Halifax is in a location that cannot be easily expanded or retrofitted. A change in location would impact all 8 collection contracts, and a new facility would need to be fully commissioned before the existing facility could be decommissioned.

Scattered operations also necessitate underutilized scales at each location, operated by different contractors, and potentially utilizing different scalehouse software packages. This challenges HRM to maintain effective recordkeeping across all facilities and programs.

HRM staff is also not located at any of the four primary processing centres in the region. This limits the opportunity for oversight and quality control of operations. It also limits the potential for an enhanced promotion and education program. A single site could support a permanent education centre where multiple facilities could be toured.

A possible future need for HRM is outdoor windrow composting pads to improve the quality of the compost product when leaving HRM control. Siting such a compost curing facility is a challenge as there is no obvious existing location prepared to expand services, and a new parcel of land would again exacerbate current challenges with material movement.

These challenges are not insurmountable, but they do complicate operational decision making especially related to collection contracts and delivery of materials. For example, if a single site received all collected materials, modifying collection strategies would be simplified as the delivery point would be the same.

5.2 FLEXIBILITY OFFERED BY WASTE TRANSFER CAPABILITY

Within the scope of this assignment Stantec was to assess the feasibility and flexibility offered by a waste transfer facility. Part of the reason for this assessment was the shutdown of operations at Otter Lake caused by an extreme weather event. Receiving at Otter Lake was suspended for several days as damage to the electrical systems supplying the FEP/WSF were repaired.

This topic was included in this section of the report as there is some inter-relationship with the development of a waste resource campus.

The severe weather event which suspended receiving at Otter Lake caused HRM to react to an unexpected situation. Disposal arrangements in other jurisdictions were quickly secured and trucks were re-routed on an interim basis. HRM has formal agreements with disposal facilities for receipt of waste in the event of another similar circumstance. The locations and fees to be paid (excluding trucking) are summarized below.

- Chester Landfill $80/tonne
- Queens Landfill $80/tonne

These types of fee arrangements are generally set at higher pricing levels than what could be negotiated for ongoing disposal contracts, but quoted rates are still considered very reasonable under the circumstances. In addition to the two sites noted above, a private disposal facility in West Hants is very close to the main population centres in HRM and would not represent a major inconvenience to waste haulers in an emergency situation.

Suspension of service at Otter Lake has occurred only once in 15 years and is unlikely to become a regular occurrence. An arrangement with the landfill in West Hants could mean that in the event of an emergency, most loads can be delivered directly for disposal while only incurring a roughly one hour increase in round trip travel time. In planning for future similar emergencies, HRM may wish to develop a protocol whereby collection contractors and the public are advised that no large items (mattresses/furniture/white goods) will be collected. This will reduce the volume of waste requiring disposal in the short term relieving some of the demand on collection contractors.

Constructing a transfer building and maintaining an on-call fleet of transfer trailers solely to address the very rare suspension of service at Otter Lake is not considered feasible especially when short term disposal capacity is available in West Hants. Depending on the location of the transfer site, it is questionable whether there would actually be any operational advantages or savings even during the emergency event.

An order of magnitude capital cost estimate to establish a standalone transfer capability is $5 million and can vary depending on the transfer trailer fleet size and on-call arrangements. Loading equipment and qualified staff would also need to be immediately available to fulfill the stated purpose. The facility would need to be maintained to a high standard at all times to ensure proper operation in the event of an emergency. Given the proximate location of a landfill in West Hants, Stantec does not recommend any further consideration of a standalone transfer facility.

If HRM at some point chooses to revisit its waste disposal strategy and export waste to other jurisdictions on a long-term or permanent basis, then a transfer facility would likely become a key component of that revised strategy. Likewise, if HRM develops a multi-purpose waste resource campus, the transfer capability can be easily integrated into the site-wide operation.

The concept of a local transfer facility to manage waste and other materials even if Otter Lake was still operating was also reviewed. This concept would involve individual collection tracks offloading waste, recyclables and organics at a given location and reloading materials onto trailers to haul to the final destination. Given the density of population in the immediate Halifax/Dartmouth/Bedford area and the decentralized processing facilities, it was determined that there was limited value in this approach at this time.

5.3 OPPORTUNITY TO CO-LOCATE INFRASTRUCTURE OVER THE LONG-TERM

Many of the challenges noted in Section 5.1 would be alleviated if HRM were to develop a location which had sufficient lands to co-locate multiple operations and HRM staff. Given that several facilities are at capacity and nearing the end of their useful life, it is timely to consider this concept. There is no particular need to rush implementation, but planning must begin in the near future to address the logistical challenges of developing the campus.

In Stantec's opinion, a decision regarding maintaining the current de-centralized model, or transitioning to a campus concept is a critical first step to modernizing current programs and services. Many of the recommendations in the following sections are contingent on the selected location for new or expanding infrastructure.

5.4 20-YEAR CONCEPT PLAN FOR REGIONAL WASTE RESOURCE CAMPUS

5.4.1 Scope of Regional Waste Resource Campus

Current infrastructure is located at four different properties in Dartmouth and Halifax. With the exception of the Otter Lake facility, sites are of limited size and prevent the consideration of co-collection of materials at the curb in a single truck. The benefits would include the potential to optimize collection routing and fleet size, lands for compost curing, a common location for infrastructure replacements when needed, and a location that could serve as a contingency transfer point for waste in the event of disruption at Otter Lake. Possible components for a new "greenfield" campus and timing are presented below.

- Secure lands, obtain approvals and complete site servicing 2013/2014
- Construct and operate compost curing pads 2014/2015
- Construct scales, offices and educational centre 2015
- Construct multi-use transfer facility for white goods/waste/MHSW 2015
- Construct anaerobic composter for ICI organics 2015/2016
- Construct replacement MRF 2017/2018
- Optional aerobic composting processing capacity 2018+

- Optional advanced waste reduction(gasification or other) 2020+
- Other long-term waste reduction infrastructure needs 2020+

5.4.2 Siting Considerations

A campus as described above would have considerable land needs. While the structures and operational areas are likely to only need 10-20 hectares, buffering needs would increase the minimum total required area to 30-40 hectares depending on the precise location of the property.

One possible location is the existing 300+ hectare Otter Lake facility. While Otter Lake may not be an ideal location for all infrastructure needs, many current operations could be relocated to that site especially if the recommendation to close the FEP and WSF is adopted.

The local geography in the Halifax/Dartmouth area limits suitable locations to lands east of the urban area. A transportation study has been completed to evaluate impacts of changing delivery points from the current locations, to a hypothetical location east of Halifax/Dartmouth. The study concluded that there would be little benefit gained.

Part of the difficulty in establishing a new “greenfield” campus is land availability. HRM would need to evaluate available lands and the likely community acceptance of such a concept. While 40 hectares (100 acres) is considered as a minimum, additional lands would provide enhanced community buffers. The exact process required to site and develop a new campus cannot be confirmed at this time as the actual proposed location will dictate the scope of community engagement and development planning needs.

5.4.3 Staging Plans Based on Current Infrastructure and Contracts

Likely timing for development of a campus is shown in a previous section. Proposed timing was based on current infrastructure needs and contract expiry dates. For example, the MRF is in satisfactory condition to continue operations until 2019 when the processing contract expires. That permits HRM to refine its long term recycling strategy until 2016 when procurement for a new facility should commence.

The suggested timing is preliminary only and HRM may wish to conduct a more thorough planning and scheduling process if the campus concept is endorsed by Council for further consideration.

5.5 DEVELOPMENT COSTS

Stantec has prepared the following estimate for greenfield development costs associated with the waste resource campus concept. Land acquisition costs have not been specified as the cost of more rural properties is not considered to be a large percentage of the total site development costs including all operational infrastructure. For example, if the MRF is relocated to the campus, revenue from the sale of the MRF building and property in the industrial park will offset campus land purchase costs.

Development costs are based on full build-out of the property and can be staged. Operational waste processing infrastructure is shown with no cost as upgrades are required and actual locations do not materially affect the cost of the upgrade.

Site Preparation and Earthworks	$340,000
Water and Sewer Services (excludes treatment)	$550,000
Stormwater Control	$500,000
Street Construction	$3,200,000
Landscape/Fencing	$550,000
Electrical/Other(on site only)	$250,000
New MRF	N/A
New Composting Operations	N/A
Scales	$700,000
Office/Education Centre	$3,000,000
Engineering	$1,000,000
Estimated Development Cost	**$10 million**

5.6 REGIONAL WASTE RESOURCE CAMPUS AS CORNERSTONE FOR 20 YEAR STRATEGY

HRM is at an important point in the evolution of its waste management programs. There has been no major change in program direction since the 1990s and decisions made in the near future will dictate operations for at least the next two decades.

The scope and timing of this assignment did not permit an extensive evaluation of candidate sites or an examination of collection zone configuration based on a particular campus location. The de-centralized location of infrastructure in Dartmouth and Halifax, combined with the complications of bridge crossings, makes the evaluation all possible scenarios onerous.

The benefits of a campus concept cannot be fully quantified financially at this time. For example, if in 10 years HRM wishes to pursue waste gasification, then the campus concept would simply enable the new plant to be located on a large acreage site complete with scales, site services and delivery of the wastestream already organized at the property. Similarly, when the existing compost processing facility in Dartmouth is at end-of-life, a portion of the campus will already be reserved and prepared for the new plant utilizing then-current technology.

As can be seen since the 1995 Strategy was developed, much change has and will continue to occur in waste management. Planning for future flexibility is a prudent step in the short term to ensure that HRM is not unduly bound by numerous and unrelated contract commitments.

6.0 Materials Recycling Facility (MRF)

6.1 EXISTING MRF OPERATIONS

The HRM owned MRF is located at 20 Horseshoe Lake Drive, Bayers Lake Business Park and is co-located with HRM's household special waste depot. The daily operation of the MRF is contracted out to Miller Waste Systems, who also provide recyclable materials marketing services as part of the operations agreement. The MRF is operating in a manner envisaged by the 1995 Strategy. However, the recovery of recyclables from the wastestream is typical and there are opportunities for increased recovery which will be discussed in later sections.

This facility is a two (2) stream processing operation with two sorting (processing) lines; one for co-mingled fibres and one for co-mingled containers and a baler with two feed conveyors (one for the fibre materials and one for the container materials). In HRM's municipal curbside collection program, residential recyclables are collected in a two-stream plastic bag collection system. The co-mingled containers stream consists of mixed plastics, metal, glass, multi-material containers and film plastic placed together for collection in transparent blue bags or clear bags. The containers stream has recently (September 2011) been expanded to include a full range of plastic packaging. The co-mingled fibres stream consists of various mixed paper placed together for collection in grocery or retail type bags (or sometimes in a separate blue or clear bag) plus corrugated cardboard placed for collection in armload sized bundles or sometimes flattened pieces placed together in small boxes. Boxboard is collected in the organics program.

Material from the Industrial, Commercial, Institutional (ICI) sector is also received and processed at the MRF. This consists mostly of blue bags of co-mingled containers and some mixed paper.

The MRF building and original processing equipment was constructed and installed in 1991. The building is 21 years old and is approaching the end of its functional life (usually 25 to 30 years). The processing equipment in the MRF has undergone both upgrades and replacement since 1991. Most notably there were upgrades in 1999 when a new mechanical bag breaker and eddy current separator were added to the co-mingled containers processing line. A new fibre processing line, which included a star screen for newspaper separation and a garbage compactor for residue were also installed. A new baler was installed in 2004. These installations are also approaching the end of their functional life (usually about 10 years of service).

The co-mingled containers processing line was upgraded in 2009-2010 with improvements to accommodate the addition of more plastic packaging types to the blue bag program. Upgrades also provided for increased sorting efficiency, improved capture rate of recyclable materials and reduced amounts of residue sent for disposal. The 2009/10 improvements included installation of:

- a new incline conveyor
- elevated pre-sort structure and platform
- plastic film transfer conveyors
- film plastic baler
- pre-sort conveyor
- transfer conveyor and new chutes
- residue transfer conveyor and new residue compactor
- glass disk screen
- additional bunkers (for the additional plastics)

The MRF has an estimated annual capacity of 28,000 tonnes per year (TPY) of throughput of recyclable materials. The annual capacity is based on the equipment and layout of the facility operating on one shift per day (8 hours per day) Monday to Friday. The facility is currently operating at about 90% capacity, processing about 24,500 tonnes of residential and ICI recyclable materials in 2011/12.

The operating agreement with Miller is based on a per tonne fee (charge) for the materials delivered to the facility. The operating fee is based on a sliding scale for the amount of recyclable materials delivered for processing. As the amount of material that is delivered increases above set thresholds, the cost per tonne paid out decreases. This sliding scale is a common type of arrangement for a processing operations service. The decreasing operating fee is due to economies of scale being realized with the higher throughput. As more materials are processed through the facility (within design parameters) the fixed costs for the MRF are spread over a greater tonnage which lowers the operating price on a per tonne basis. The current agreement is structured on 2000 tonne per year steps for pricing breaks. The agreement also has set incremental fees for the processing operations for additional services if they are implemented. The 2011/12 operating fee was $101.84/tonne.

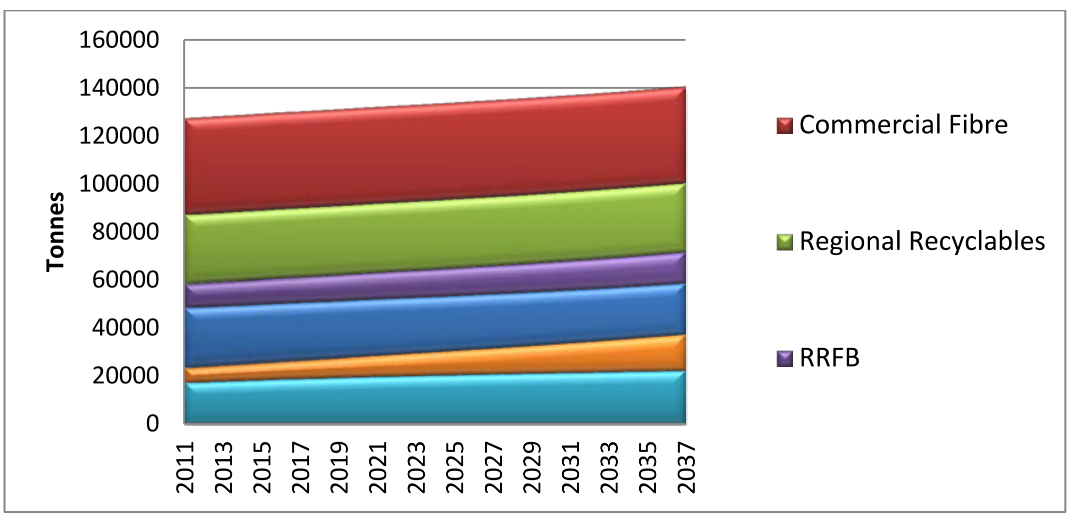
The sale of commodities from the MRF provides an offsetting revenue stream for HRM. The revenue varies due to the changing value of different commodities, which move up and down based on market forces. The revenue from the marketing of the materials is split with the operator as part of the agreement on a 75%/25% basis between HRM and Miller.

6.2 OPERATIONAL LIMITATIONS

Based on population projections alone the amount of recyclable material generated over time will grow from the current and approximate 17,500 TPY to about 25,000 tonnes of residential source materials (2037). If HRM continues to process ICI source recyclable materials along with residential recyclables, this current combined 24,500 TPY will rise over the planning period to somewhere in the order of 40,000 tonnes. There is also an additional and approximate 9,000 tonnes of residential recyclables and 16,000 tonnes of commercial source recyclable currently being received for disposal at Otter Lake. If HRM increases its diversion efforts through mechanisms described elsewhere in this report, the existing MRF will not suffice. The existing MRF also inhibits HRM from adopting a regional approach to recyclable materials processing in the province. Based on HRM's current capture rate of 127.44 kg/hhld/year, and notwithstanding capture rates will vary by community, for order of magnitude purposes this would represent 28,705 TPY available for processing from those outside of HRM if HRM served the entire province. A cost-benefit assessment would need to be undertaken to determine the feasibility of this from a transportation standpoint, that is, transfer and haulage operating and capital costs. This regional concept is discussed further below.

The current MRF does not handle any deposit return containers other than those received in the blue bags. If HRM were to manage these materials they would need to store and bale an additional 4,200 TPY and in a regional context an additional combined total of 10,000 TPY. Combined totals from all material sources described are shown below for the planning period. A further 40,000 tonnes of fibre (2011-2012) material not currently processed by HRM but by the private sector is also shown to demonstrate all available recyclable material tonnage.

Projected Recyclable Material Generation Over Planning Period (2011-2037) All Material Sources



Note: Due to varying population growth/decline rates for other municipalities in the province, Stantec has assumed a constant population growth rate over the planning period.

While operating hours can be extended to accommodate additional tonnage to the MRF, there is insufficient storage capacity to accommodate the same and the site is not suitable for expansion of the MRF to any significant extent. A detailed traffic flow assessment would also need to be undertaken to assess impacts associated with additional collection vehicle and transport trailer flow through the site in an already busy retail area.

6.3 COMPARISON OF OPERATIONS TO 1995 WASTE RESOURCE STRATEGY

The 1995 Strategy outlined four (4) key points as it related to recyclable materials processing:

1. The existing MRF would be utilized to process source separated residential containers
2. Source separated ICI source containers will be accepted.
3. Residential paper fibres will continue to be processed. If container volume were to bring the MRF to capacity, additional fibre processing would be developed.
4. Modifications to the existing facility would be delayed in order to determine the net volume and materials mix impacts of:

    a. Residential recycling program volumes based on participation and compliance
    b. Impact of provincial deposit regulation
    c. Volume of ICI containers
    d. Anticipated capacity utilization resulting from the designation of the MRF as a regional processing facility for containers captured in the provincial deposit program.

The 1995 Strategy addressed the concept of a dedicated Fibres Sorting Plant when additional capacity was required. A dedicated fibres sorting plant would be utilized to process the residential fibres collected by the municipality as well as that from ICI sources. The 1995 Strategy called for HRM to monitor private sector provision of processing capacity and if sufficient capacity was not developed, HRM would consider a joint public-private sector venture of some nature to ensure capacity needs were met. The 1995 Strategy further envisaged that HRM would be in control of its residential recycling program and infrastructure (processing) to handle collected materials.

HRM has fulfilled these objectives with respect to its MRF operation. HRM owns and so has a degree of control over operations. The facility has accepted and processed all collected residential recycling materials as well as those from ICI sources as originally envisaged. The MRF has been modified and upgraded accordingly to meet recycling program needs and as volumes have increased due to increased participation and material capture; most recently upgrades to accommodate plastics recycling. Private sector paper fibre processing capacity was also developed.

The regionalization concept was not realized in that the province did not utilize the MRF as part of its deposit program. HRM still, however, has an opportunity to address the concept of regionalization as it relates to the processing of recyclable materials from other municipal jurisdictions in the province and this is discussed further below.

6.4 COMPARISON OF CURRENT OPERATIONS TO INDUSTRY BEST PRACTICE

Best practices in recycling and operations are researched and employed across Canada. The Ontario Extended Producer Responsibility (EPR) funding program for municipal blue box programs has necessitated substantial efforts toward increased municipal program efficiency to lower costs. As such, a number of key findings for Ontario are discussed in this section as applicable to HRM.

The following table provides a comparison of various Key Performance Indicators (KPIs) between HRM and a number of other municipalities where data could be obtained.

	Halifax	Durham	Halton	Simcoe	Hamilton	Ottawa	London
Population	390,328	621,500	487,418	282,112	528,504	917,570	385,680
Total Single Family Households	140,821	185,024	147,203	125,920	150,231	259,243	115,537
Total Multi Family Households	23,000	22,635	29,019	0	59,734	117,854	50.100
Total BB tonnes marketed	17,946	45,743	43,776	24,060	39,841	62,961	26,247
Method of Collection	Bags	Boxes, bags not accepted	Boxes, bags not accepted	Boxes	Boxes no bags	Boxes, bags discouraged	Boxes, no bags
Frequency of Collection	Weekly some bi-weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly
Type of Collection	Two Stream	Two Stream	Single Stream	Two Stream	Two Stream	Two Stream	Two Stream
Capture Rate BB material (%)	63	77.3	85.3	68.9	71.1	62.6	57.3
Capture Rates (kg/hhld/yr)	127.44	215.85	244.54	191.55	189.33	164.44	154.47
MRF	Own	Own	Contract	Own and Contract	Own	Contract	Own
MRF Operation	Contract	Contract	Contract	Municipal & Contract	Contract	Contract	Contract
Processing Cost (All in)	$101.84	$113	$73	$34	$92	$86	$161**
Total Revenue	$2,128,259	$11,160,160	$8,995,391	$15,576,594	$24,291,817	$1,815,404	$779,345
Revenue per Tonne	$88	$147	$197	$168	$157	$41	$32
Total Waste Generation	131,448	229,630	194,787	112,808	214,897	337,894	149,900
Waste Generation per Cap	336.96	369.48	399.63	393.65	406.61	368.22	388.66

1. Population and number of households from WDO for Ontario municipalities.
2. Recycling Information from WDO Ontario municipal datacall for 2011.
3. Blue box capture rates are for 2010.
4. HRM capture rate does not include multi-residential sector that are collected by others and counted in with commercial recycling tonnage.
4. Waste Generation and per capita generation are based on GAP waste flow analysis for residential stream.
5. ** NOTE: WDO data shows a high amortization in year one of the MRF operation of over $20 M based on their standardized accounting method - London's processing fee is about $86.00/tonne.

Revenue Notes:

1. HRM revenue from R330 – Materials Recovery Facility spread sheet
2. HRM per tonne revenue calculated based on the total tonnage in facility (24,318) not just residential tonnage
3. Ontario revenue information is residential material only, no ICI

The cost that HRM is paying for the processing of the materials is $101.84 per tonne processed. In addition to the operating fee charge, there are additional (incremental) fees for additional services that have been implemented. The additional $3.39 per tonne for the expanded plastics recycling has been added to the operating fee. Along with the additional operating fee, there is also a capital amortization charge that HRM will incur at the end of the current contractual arrangement. Processing costs for comparable municipalities range widely but typically in the order of $75 to $100 per tonne which usually includes a revenue sharing arrangement where the full revenue is realized by the municipality from the sale of the materials. HRM's processing fee is in line with the industry but in the case of revenue only 75% comes back to HRM. While it is understood that revenue share provides an incentive for the operator to market commodities at the highest price, it cannot be high enough to apportion any significant risk to the contractor. Considerations including receipt of 100% of the revenue can be undertaken with the next Design, Build, Operating (DBO) contract to be let by HRM.

It should be pointed out that the revenue per tonne for HRM is showing lower than for some of these comparable municipalities, however Ontario does not have a beverage container return program and so all of those higher value commodities like aluminum and #1 PET are processed at Ontario MRFs, associated revenue recovered and reported in their revenue per tonne. In HRM's case this is reported as a separate revenue item ($301,393 in 2011/2012) which equates to an additional $12.39/tonne (based on all inbound tonnes not just residential which in fact the majority would be sourced from). This revenue represents HRM's 50% share of the deposit bearing beverage containers refund and handling fees. Further and as discussed above many Ontario municipalities receive 100% revenue share for the sale of their recyclable commodities.

Another operational expense that is incurred is the rebate to the operator for the disposal of the residue from the MRF operations. The rebate paid to the contractor is based on a sliding scale as to the residue rate of the operation with a higher percentage of the cost covered the lower the reside rate is. The residue rate for the processing operation was 9.26% for 2011/12. This resulted in 2,252 tonnes of material having to be disposed at the RDF at a cost of $258,980 (based on $115/tonne). As outlined in the contract, the contractor (Miller Waste Systems) pays for the disposal, but HRM rebates a percentage of the fee to offset the disposal charge. The rebate is on a sliding scale to incentivize the contractor to limit the residue, and at 9.26% HRM rebated 65% of the cost. This amounted to $168,337 which translates to an additional $6.92 per tonne.

The residue rate of 9.26% is high for a two-stream program. For example, the Region of Durham facility (two stream, municipally owned, contracted operation, processing 50,000 TPY+) in 2011 had a residue rate under 5% and the City of London facility had a residue rate of 4%. There are two main aspects that contribute to the residue rate of a facility. The first is that the inbound collected materials may have high rates of contamination, which have to be sorted out as garbage and non-recoverable recyclable material and/or there is some aspect of the operation that is allowing recyclable materials to go through processing but end up in the residue stream. An additional factor for HRM is the allowance of bags for recyclable materials collection and containment. Notwithstanding the evolution of bag breaking technology materials can still get caught up in the bags and get lost as non-recovered residue in the process. Bag based MRF operations are also generally more expensive than non-bag based operations because of the additional processing equipment required and normally more manual sorting. It is not readily apparent to what extent any of these factors might be contributing to the residue rate.

The rebate that HRM provides the contractor for residue disposal is not a common feature for similar programs, municipally-owned facilities that are privately operated. The common (best) practice is for the contractor to bear the full cost of the disposal of the residue from the operations. In the agreements, there are targets set for capture of recyclables processed at the facility to ensure efficient facility operations, and have an upset limit on the contamination level of the incoming material (usually 5%). If the contamination level of the incoming material exceeds the upset limit, then compensation is provided to the processor to offset the cost of disposal of the excess contamination. The contractor will be penalized if they do not meet the capture rates for materials by having to pay for the residue disposal, as well there is a surcharge added for the lost revenue from the recyclables not captured and disposed of. The amount and quality (make up) of the residue stream is continually monitored, usually by regular audits, to ensure that recyclables are not ending up in the residue stream, to provide an indication as to the quality of the inbound materials and detect any aspects of the operation that may not be functioning properly.

Best practices in MRF operations range from facility design and degree of mechanization to matters of MRF standard operating procedures. In HRM's case the matters of specific operating procedures are not so relevant for discussion as are broader future facility design features to accommodate HRM's long term processing needs. HRM's current MRF employs various best practices including appropriate degree of mechanization versus manual sorting, the employment of appropriate technology, and is operating quite well. Matters discussed above; residue rates, revenue share, processing fees, and continued use of bags should be addressed in HRM's next DBO and/or operating contract.

From a broader perspective there are three key and relevant best practices that HRM can apply:

- Applicability of single versus two stream processing.
- Larger facilities have improved operating cost structures and efficiencies.
- Regionalization is a consideration to increase the volume of materials for the facility.

6.5 TWO STREAM VERSUS SINGLE STREAM PROCESSING

HRM has the opportunity to determine whether or not they should continue with a two-stream containers and fibres collection program or shift to single stream collection and processing over the long-term. There is no definitive "best practice" in this regard in that there are numerous factors that affect which is most suitable; tonnes per year throughput that dictate costs, market tolerance for contamination, opportunities for co-collection of materials at the curb, other curbside collection programs.

Single stream collection has most often (in Canada) been implemented in concert with the introduction of curbside organic waste collection programs to minimize the number of sorts (and containers) at the curb. That is, a number of municipalities (Peel, York, Halton, Toronto) shifted from two-stream to single stream recycling with organic waste program implementation. Almost all larger municipalities in Canada (Winnipeg, Edmonton, Montreal) have or are adopting (Regina) a single stream program and others continue to evaluate the option (Hamilton, Ottawa). This is also the trend in the United States and is the predominant form of processing now in many states including but not limited to New York, Wisconsin, California, Colorado, Maine, Vermont and Illinois. Single stream recycling is convenient, can result in additional material capture, is most appropriate for automated cart collection programs, can result in greater efficiencies in collection if collected on its own in that trucks completely 'pack out' with the material. There is no risk of one side of the truck 'packing out' before the other as in the case of two-stream recycling collection programs. Single stream processing provides greater flexibility to accommodate different collection methods including co-collection of other materials (garbage or organics) at the curb if receiving facilities for these materials are proximal to each other.

Single stream recycling can also attract greater participation in multi-residential and commercial sectors where there may be storage and space limitations for sorting containers, especially in the context of mandatory organics separation. It's also very applicable in the context of regionalization of recyclable materials processing in that transfer of single-stream materials from one jurisdiction to the other is more efficient than what would be the case with the current two-stream recycling system. From a processing perspective single stream MRFs can also receive and process recyclables collected in any manner, that is, recyclables that are collected completely co-mingled (single stream) or with any lesser degree of separation (two stream or more). A two stream MRF cannot effectively handle single stream material.

In general single stream processing does have a higher capital cost than comparable two-stream processing, however there are operational cost savings that can be realized with single stream as well as higher operating efficiency (productivity). A recently undertaken "Study of Optimization of the Blue Box Materials Processing System in Ontario" (Continuous Improvement Fund: Steward Edge and Resource Recycling Systems, June 2012) provides cost modeling for blue box recycling processing facilities. The cost modeling is based on the development of a new "greenfield" facility, taking into account all costs for building, equipment, capital amortization, operations costs, etc. The following table shows a number of cost scenarios that were developed as part of that study and based on facility size (throughput) and sorting methodology (two-stream or single stream).

	Two-Stream	Two-Stream	Single Stream	Single Stream	Single Stream
Number of Shifts	1	2	1	2	1
Tonnes per Year	23,000	46,000	23,000	46,000	35,000
Throughput tonnes/hour	14	14	14	14	20
Capital Cost	$8.7 M	$8.7 M	$9.4 M	$9.4 M	$13.5 M
Productivity tonnes/hr/sorter	0.6	0.6	0.75	0.75	1.00
Capital Cost per tonne	$37	$18	$41	$20	$41
Operational Cost per tonne	$109	$98	$98	$83	$85
Total Cost per tonne	$146	$116	$139	$107	$126

Note: 1. Total Cost per tonne includes capital amortization cost. 2. Materials to be processed do not include plastic film, expanded polystyrene and plastic laminates.

Single stream processing is a viable option for HRM especially in the context of driving greater capture of recyclable materials known to be in the refuse stream received at Otter Lake from both residential and commercial sources (combined in the order of 25,000 TPY). This more convenient collection program could drive higher diversion and higher tonnage to a new single stream MRF. HRM's current capture rate for recyclable materials is in the order of 63% which when compared to other municipal jurisdictions is low. The benefits of increased tonnage to the MRF are discussed further below.

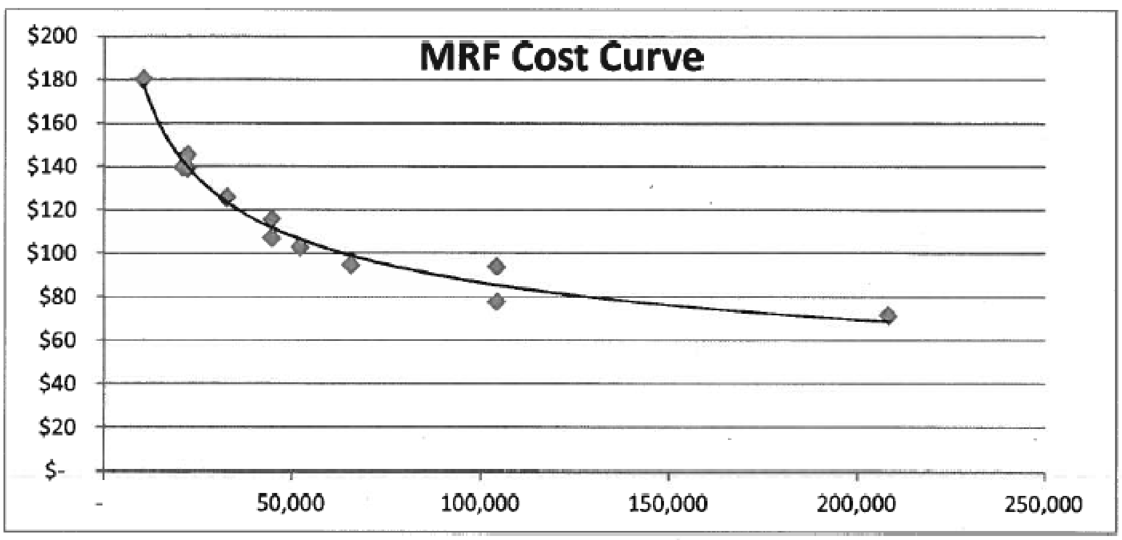
6.6 REGIONALIZATION

Regionalization of materials recycling facilities has come to be considered a better practice in municipal recycling because of the reduced need (cost) for smaller MRFs dotted across various jurisdictions, like Nova Scotia, that process only relatively small tonnages (and typically at a high cost per tonne) and the economies of scale associated with a larger regional MRF. For HRM to realize economies of scale more material would have to be sourced to be processed at a new MRF. This can be accomplished by driving added diversion as discussed above but also through regionalization; that is, processing recyclable material generated in other municipal jurisdictions. While this needs more consideration, the construction of a MRF by HRM that requires additional capacity for a surrounding region could be only incremental in nature. The cost modeling above shows that a 23,000 TPY single stream MRF has the same capital cost as a 46,000 TPY single stream MRF because the MRF is simply operated over two shifts. Overall cost per tonne (for both operating and capital are lower for all facility users). The simple modeling exercise provides order of magnitude differences in cost between various two-stream and single-stream scenarios and for illustrative purposes. It is probable however that with double the tonnage, the capital cost would be somewhat higher with respect to tipping floor area for storage (double the material received during the same receiving hours), possibly bale floor storage/space (building footprint) requirements and wear and tear on equipment will occur faster, but again, these costs are incremental when considered on a per tonne basis.

There is a particular benefit in regionalized single stream processing operations as opposed to dual stream operations to realize savings for transfer of materials for those municipalities within a reasonable transfer distance of HRM.

Research and practical experience has demonstrated that larger processing facilities have improved operating efficiencies, and lower cost per tonne than smaller facilities. A comprehensive study undertaken for Waste Diversion Ontario, the Blue Box Program Enhancement and Best Practices Assessment Project – Volume 1 – July, 2007 by KPMG and R.W. Beck determined that 40,000 tpy is a minimum size to begin to realize operating efficiencies and cost savings, and that as facilities do get larger, the operating cost per tonne decreases. HRM will process in the order of 40,000 TPY with no program changes by the end of the planning period, could process in the order of 60,000 TPY with significant increased diversion efforts and if HRM operated a regional MRF could process somewhere in the order of 80,000-90,000 TPY. This does not include processing of any additional commercial fibre or RRFB materials.

MRF Operating Cost by Tonnage Processed



As tonnage/volume throughput increases, there is better utilization of what is necessary and fixed infrastructure and the ability to use greater mechanization/technology which drives efficiencies. This applies not only to receipt of additional volume through other municipal sources in the context of a regional MRF but also as it relates to the current practice of processing a portion of ICI sector recyclable materials which has enabled the existing MRF to operate at near capacity and so with greater efficiency. Without ICI sector materials the fixed overhead costs associated with the MRF would still be realized, e.g. building maintenance, mobile equipment costs, administration, equipment maintenance, etc., only spread over less tonnes for a higher overall cost per tonne for HRM.

For example the City of London, Ontario which is similar to HRM in size, has recently (2011) constructed a new 75,000 TPY MRF. The City projected that it would require 40,000 TPY of capacity within 15 years (currently they generate 29,000 TPY). This is a similar prediction for HRM (current 25,000 TPY up to 40,000 TPY over the planning period with continued commercial recyclables processing and without any added diversion efforts). The decision to build the much larger facility than needed was based on being able to provide the excess capacity to other municipal programs (regionalization) and the larger size offered opportunities to install more mechanical sorting technology to improve efficiency (such as optical sorting). The result is the cost that what London now pays (they contract out the operation, similar to HRM) for processing is below what they were paying for the contracted services they had prior to the new facility. Also the tipping fee that other municipalities are offered for processing is lower than they were being charged by their processors due to the economies of scale at the new facility (in the order of $90-95/tonne).

The City of London is a good example of a MRF regionalization initiative and is a good model for HRM to adopt should this initiative be carried forward. The City also received $4,500,000 from the Ontario Continuous Improvement Fund (CIF) as part of a $15 million, 75,000 TPY two-stream Regional MRF undertaking. HRM should seek provincial funding to support any kind of regional undertaking as well. The initiative was undertaken based on preliminary estimates that suggested the Regional MRF would save $10 to $15 per tonne ($0.75 to $1.1 million per year) in net system costs. The City let a MRF design, build & operating RFP with two key options: for a London only facility and for a regional facility. This enabled them to fix the costs associated with either concept and to negotiate partnership agreements for a regional facility based on what could be determined to be reasonable cost-sharing arrangements. HRM could adopt a similar approach in this regard however discussions with other municipalities should ensue sooner than later to assess their program status, tonnage projections and timing with respect to the ability to commit. It should be noted that while London constructed the MRF for two-stream processing (to accommodate the City's two-stream collection system) they constructed the MRF to be able to later retrofit the front-end to accommodate single-stream processing should that be deemed more suitable in the context of a Regional MRF.

6.7 OPPORTUNITIES FOR OPERATIONAL IMPROVEMENTS

There are some short-term changes that can be undertaken to improve system efficiencies but moreover many underlying considerations that can be taken into account when planning or developing options for a new recyclable material processing facility in the future.

6.7.1 Short Term Addition of Boxboard to the Recycling Program

** Calculation is based on:
The 2011/12 tonnage 24 318 plus estimated recovery of 40% of available boxboard (based on waste audit data there is 3842 tonnes of boxboard in waste stream) = 1,540 tonnes; 24,318+1540 = 25,858 * $4.42= $114,292.00

HRM should now consider the addition of boxboard to the current recycling program and it was one of the additional services detailed in the operating agreement. This would move the facility closer to exceeding the operating capacity, but should be manageable in the short term. There would be an additional cost to HRM in the order of $4.42/tonne as well as an expense of $52,900 (based on adding boxboard in 2013 and ending the agreement in 2019) to buy out the improvements to the MRF needed to handle the material. If boxboard was removed from the organics to the recycling program, that would amount to an increase of approximately $114,000 per year for the incremental processing charges above the current rate**.

There would be a revenue realized from the sale of boxboard which would offset some of this additional processing cost, but the amount would depend on how the material is marketed (mixed into existing products or as a separate grade) and the commodity value (which varies). An additional consideration for adding boxboard to the recycling stream is that it would remove that material from the organics stream (at an average processing cost of $150 per tonne x 1540 = $231,000). Not including revenue, this implies a savings of somewhere in the order of $117,000 per year. Also there would likely be an improvement in the residential diversion rate for HRM, as the capture rate for boxboard is currently estimated at 25% while in the organics stream. The balance goes unrecovered at Otter Lake.

6.7.2 Construction and Operation of a New MRF – New Location in Mid to Long Term

It is recommended that HRM continue to operate the existing MRF only until the end of the operating contract (2019) because of the various disadvantages associated with continued operations beyond 2019:

- Limited space available for expansion
- Potential value of the sale of the property given adjacent retail land use
- Greater maintenance required for upkeep of older equipment over time; equipment would need to be replaced over the long term
- Limited opportunities for regionalization
- Limited if any opportunity for co-locating with other waste management operations
- Site may not accommodate additional traffic associated with tonnage growth over time; new diversion initiatives

If a waste management campus can reasonably be developed, then ideally a new MRF would be co-located with other waste management infrastructure for the reasons outlined in Section 5. However, a MRF can also be reasonably sited by itself (e.g. on industrially zoned property in a central location within HRM). Operations are almost exclusively indoors and issues associated with MRF operations; litter, noise can be managed accordingly. Obtaining approvals for a new MRF should be a fairly straightforward process.

The major advantage in maintaining status quo operations in the short term and developing a new facility in the mid-term is that it gives HRM the opportunity to evaluate and site the most appropriate processing option; single stream or continued dual-stream processing and with and without a bag-based program. As discussed above it also presents an opportunity for regionalization of the new MRF, again to increase operating efficiency and offer lower processing cost for HRM as well as other municipalities.

A MRF can feasibly be constructed and operational within two to three years but formal procurement should be undertaken no later than 2016.

6.7.3 Flexibility in Operations in the Mid to Long Term

A new MRF should be appropriately designed to accommodate HRM's long term processing needs but another consideration is that a new MRF should have flexibility in processing operations to adjust to the ever changing recyclable materials make up. The overall proportions and the actual materials included in the program have changed significantly over the past 15 years. The major trends that are being observed are the decrease in the amount and weight of fibre in the recycling stream. Newspaper is decreasing dramatically, with some increases in the amount of cardboard and mixed fibre materials to be handled.

A current trend for recyclable materials composition is greater composition of plastic packaging/ made from different resins that will have to be separated and processed. While the weight of the container stream will not increase significantly with the changes the volume and actual number of containers will increase. The use of technology, such as optical sorting, and new facility process flow should allow for easy transition to add, take away or mix different items as circumstances dictate.

Single stream recycling can support this need for flexibility and also offers greater flexibility and convenience in the delivery of processing services across a range of sectors; residential, multi-residential, commercial and in a regional context.

6.8 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Based on the review of the HRM recycling operations, the following conclusions can be made:

- That HRM is meeting the objectives and principles laid out in the 1995 Solid Waste/Resource Management Plan Strategy for the processing of recyclable materials.
- The current MRF is operating very close to its single shift operating capacity, but it is reasonable to expect that boxboard can be added to the program with limited short term impact.

- There are 'economies of scale' benefits to HRM by processing recyclables from the ICI sector.
- Removing boxboard from the organics stream and adding it to the recycling stream could save HRM (not including revenue) somewhere in the order of $117,000 per year.
- The MRF is nearing the end of its operational life expectancy, both building and the majority of the equipment in the MRF.
- The recent upgrades have allowed for the processing and capture of more packaging (plastic) recyclables.
- The single shift capacity limit will be exceeded within the next 3 to 5 years due to increasing population growth and enhanced capture of recyclable materials.
- There is capacity to handle the short term growth for recyclable material processing by expanding the operating hours (utilizing a second shift).
- There is limited to no footprint space available at the current site to expand the MRF to allow for expansion and upgrades to handle longer term growth.
- A larger sized MRF is required for the longer term needs of HRM.

6.9 RECOMMENDATIONS

- In the short term to 2019 continue with status quo operations with the exception of the addition of boxboard to the program.
- In the short-term and in concert with the objectives discussed in Section 8 commence with promotion and education initiatives and modified MRF operations to eliminate boxboard from the organic wastestream - 2013
- Between 2013 and 2016 evaluate concept and opportunities for provincial and/or federal funding for a new regional MRF.
- Between 2013 and 2016 determine to implement single stream or dual stream processing option however preliminary considerations show that capital costs are only slightly higher in higher tonnage ranges for single-stream recycling as opposed to the current program, operating costs can be significantly lower, single-stream can provide greater collection efficiencies and drive greater diversion across all sectors. These factors suggest that HRM would be well suited to a single stream recycling program.
- Based on tonnage predictions as presented in Section 6.2 and the unknowns associated with a number of factors: real increased capture rates associated with increased diversion in the residential sector, additional capture for HRM (from current fibre processors) from the IC&I sector because of the convenience of single-stream recycling, and whether or not a regional MRF concept will be applied in the province, it is recommended that HRM consider the construction of a single-stream MRF with an initial (one shift) capacity of 35,000 TPY to manage increased tonnage associated with long term population growth. The MRF can simply be operated with increased hours, e.g. 10

hour shifts or over two shifts to accommodate any tonnage increases as described. It is estimated the MRF would cost in the order of $12M to $14M and operating costs would rnage in the order of $100-$130/tonne (lower cost per tonne with increasing tonnage).

- In 2016 commence with formal procurement process for new MRF; approvals, equipment fabrication, construction, commissioning by 2019.
- Include known ‘best practices’ in the new procurement process and the development of new operating contract arrangements; residue, revenue, recovery rates, by 2016.

7.0 Organics Waste Processing Facilities

7.1 EXISTING OPERATIONS

HRM was the first municipality in Canada to implement an organics program in 1998 in response to a provincial ban on organics disposal in landfills. In order to address the ban HRM, in September 1996, let an RFP for Organics Composting Facilities; specifying that two facilities would be required to handle 30,000 TPY of source separated residential organics (with additional 10,000 TPY surge capacity) and produce marketable compost. These facilities were constructed on HRM owned land.

The first facility, owned and operated by Miller Composting Corporation, is located at 80 Gloria McCluskey Ave. in Burnside Business Park. This facility utilizes the Ebara open channel in-vessel technology and was constructed for a capacity of 25,000 TPY.

The other facility, owned and operated by New Era Technologies, is located at 61 Evergreen Pl. in Ragged Lake Business Park (Goodwood). This facility utilizes a multi-container in-box system (Stinnes Enerco enclosed aerated container system) with a separate tip floor, processing facility and curing building. It too has a capacity of 25,000 TPY and both plants have a weekly capacity limit of 480 tonnes per week.

Both operators utilize aerobic technology to process organics for about three months onsite and then send the material to a secondary final curing site at Elmsdale Landscaping Ltd. located at 113 Elmsdale Rd, Elmsdale where the material is cured in windrows for between six months and a year prior to use/sale. Both Miller along with New Era, currently sell the compost for approximately $1/tonne and including transportation costs to Elmsdale. There are no provisions for any final product to be made available to HRM for municipal or for community use purposes.

The following materials are accepted in HRM's Green Cart program:

- Fruit & vegetable peelings
- Table scraps, meat, fish, bones
- Dairy products
- Cooking oil & fat
- Bread, rice, pasta
- Coffee grounds, filters, tea bags
- Eggshells
- Boxboard & Soiled Paper
- Paper towel rolls
- Food napkins
- Paper towels and soiled paper

Residents are not permitted to use plastic bags in the Green Cart including those labeled 'biodegradable' or 'compostable'.

Residents may "top up" their green cart with Leaf and Yard Waste (LYW); excess LYW can be placed out with the green carts in orange or clear plastic bags or kraft paper bags. There is a

20 bag limit with a 25 kg (55lb) maximum weight per bag. Branches must be tied in armload-sized bundles with a maximum of 5 bundles accepted, each not exceeding 34 kg (75 lb), 1.2m (4 ft) or 0.2m (8 in) in diameter.

The following materials are acceptable:

- Grass, leaves & brush
- House & garden plant waste
- Sawdust & wood shavings

Since the implementation of the program the amount of organic waste being captured has steadily increased with corresponding decreased amounts of waste being landfilled at Otter Lake. The success of the program has exceeded the capacity of the two original processing facilities, forcing HRM to look elsewhere for overflow capacity and capacity for peak LYW and Christmas tree processing.

In 2011/2012 the residential and commercial sectors produced a combined 51,328 tonnes of organic waste; 34,713 tonnes from the residential sector and 16,615 tonnes of organics from the ICI sector. Organic waste materials received at these facilities that exceed capacity are shipped without processing to Fundy Compost at a cost of $143,500 per year (fiscal year 2011/2012) or in the order of $64/tonne.

During peak LYW season (spring and fall), extra LYW material is diverted from the composting stream and directed to an alternate windrow site through separate contract. Separate collection of this material, as well as a separate Christmas tree collection program was intended to reduce the impact of the peak surge periods on the two primary composting facilities.

In order to manage all organic waste HRM has the following contract arrangements:

- Organics processing contracts with Miller and New Era which end in 2019 with residual buy-out provisions.
- Processing of separately collected LYW material by Kel-Ann Organics commenced in October 2010 for a two year period with an optional one-year extension.
- Processing of Christmas trees by Owen Davis & Sons Contracting Ltd. commenced in December 2010 for a two year period with an optional one-year extension.
- Processing of additional organics during peak season by Fundy Compost commenced in April 2010 for a two year period with an optional one-year extension.

Fundamental to the successful operation of these facilities is their ability to meet 2005 Canadian Council of Ministers of the Environment (CCME) Guidelines for Compost Quality.

Nova Scotia Environment (NSE) revised their Composting Facility Guidelines in 2006 to reflect the revised 2005 CCME Compost Quality Guidelines. These guidelines were again revised in September 2010. Although the Guidelines only deal with aerobic facilities (LYW Composting Facilities under 10,000 tonnes, In-vessel Composting Facilities, Open Windrow Composting

Facilities and Secondary Curing Areas), Anaerobic Digestion (AD) facilities must apply 'best management practices' of the Guidelines including quality control criteria for end products, should digestate be composted. The NSE Guidelines also set out the requirements for composting facility operation and compost classification and use.

While the NSE Guidelines set out numerous requirements as they relate to facility design, leachate, surface and ground water management, odour control, separation distances etc., one component of the Guidelines creating a challenge for Miller and New Era is Section 4 (e) of the guidelines that specifies that "*for immature compost to be transported to a secondary curing* area, it must achieve one of the following maturity requirements:

i. Cured for at least 21 days and must not reheat above 20^{o}C
ii. Cured for at least 21 days and organic matter is reduced by at least 60% by weight; or
iii. Able to germinate 90% of cress seed vs. control and has a plant growth rate of compost/soil at least 50% of control.

If the compost achieves one of the above requirements, it may be accepted at an open windrow composting site as specified in Section VI of these guidelines."

NSE has extended the use of the previous 1996 CCME Guidelines for Compost Quality at existing facilities to allow time for comprehensive testing of existing Nova Scotia composting facility produced compost. The extension was intended to allow time for completing comprehensive testing and the identification of required program changes to meet guideline standards by 2015.

HRM must develop and submit a plan to the Province by January 2014 detailing the revised program plans, where required, to implement potential modifications, process or facility upgrades and/or technology changes to achieve compliance with the 2005 guidelines. Compliance with the guidelines is just one of the drivers of the review of HRM's waste management programs.

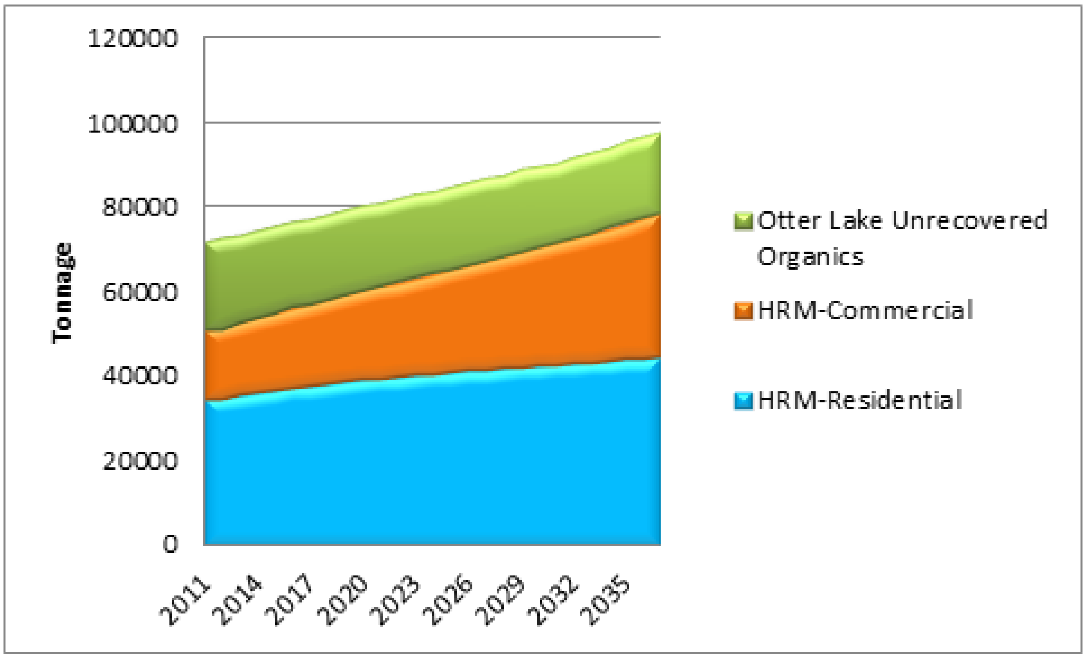
7.2 OPERATIONAL LIMITATIONS

HRM is facing two major issues associated with the successful adoption of the organics program by both the residential and ICI sector. The volume of organics generated has exceeded the capacity of the two original processing facilities and both facilities are struggling to meet 2005 CCME guidelines. This section discusses those issues.

7.2.1 Lack of Capacity

The two organics processing facilities, originally constructed to process 25,000 TPY each, are at full capacity. It is estimated based on population growth and waste generation trends that some 80,000 TPY of organic waste will require processing by the end of the planning period if both residential and ICI organics continue to be processed by HRM. This does not include any estimates associated with increased diversion initiatives that HRM might undertake and discussed elsewhere in this report. That is, it is also estimated (2012) that an additional and approximate 25,000 TYP of organics from these sectors is lost to disposal (in the order of 7,500 TPY from the residential sector and the remaining 12,500 TPY from the ICI sector and not including boxboard currently in the organic waste program). Projected tonnage over the planning period is shown below. Current operating practice includes the shipment of overflow organic waste from Miller and New Era to a third party which is not sustainable (practical nor cost-effective) as these volumes increase over time. A number of potential solutions to this are discussed below.

Projected Organic Waste Generation Over Planning Period (2011-2037)



7.2.2 Compliance with CCME Guidelines

The HRM compost program is currently non-compliant in terms of consistently meeting newly adopted Canadian Council of Ministers of the Environment (CCME) guidelines for compost maturity prior to transfer to unmonitored open windrow sites for final curing. These maturation guidelines are intended to manage pathogens within SSO and minimize the potential for odour prior to transfer to a secondary curing site.

In 2008, NSE contracted HMJ Consulting Limited assess nine composting facilities with respect to their ability to meet the compost maturity standards specified in the 2006 *Nova Scotia Compost Facility Guidelines*. Of the nine facilities, only one failed the temperature rise test, and three failed the respiration test. HRM contracted for a similar set of tests to be conducted at the Miller and New Era composting facilities on outgoing processed compost material and the transferred material to a secondary final curing open windrow site operated by Elmsdale Landscaping. These tests were conducted at the six month and one year maturity points for compost over four (4) sampling periods in 2010 and 2011. The results of the tests indicated that the compost leaving the phase one facilities had greater respiration rates than that allowed under the 2005 CCME guidelines[3].

The two organics processing facilities are required to meet the original 1996 Guidelines as they were built under the 1998 NSE Compost Facility Guidelines that adopted those 1996 CCME Guidelines. Both facilities can continue to meet the 1996 requirements but neither facility can consistently meet the requirements of the 2005 CCME guidelines. Miller has been undertaking a number of studies and adjustments to their process and New Era has proposed replacement of their Stinnes Enerco enclosed aerated container system (discussed further below).

7.3 COMPARISON OF CURRENT OPERATIONS TO 1995 WASTE RESOURCE STRATEGY

The following excerpts are taken from the 1995 Strategy related to the intended purpose of HRM's source separate organic waste processing program.

"Source separated composting is a significant component of the Integrated Resource Management Strategy. In fact, source separated composting is essential to meeting or exceeding the diversion targets, as these targets cannot be achieved with source reduction and recycling alone."

The composting system should also include the collection of unrecyclable paper; the paper will improve the composting process and enhance the purity and quality of the finished product.	✓This was implemented but is discussed further below as problematic; the practice is not actively promoted by most municipalities.
Some portion of the organics from the ICI sector can be delivered to the municipally sponsored composting facilities.	✓ HRM has encouraged and processed organics from this sector.
As a long-term strategy, it is desired that centralized source-separated composting will increase, and that both the portion of the wastestream routed through the front-end processing facilities, and ultimately disposed of in the residuals disposal facilities will decrease.	✓Program has been successful in reducing the amount of residuals requiring processing.

[3] CBCL Limited, Results of RFP for Professional Consulting Services for Sampling and Testing Compost, January 2012

Multiple sites and compost operators will be encouraged.	✓ Two main processing facilities in operation, along with a number of smaller operators to process peak materials.
The system will encourage ICI activities in source reduction and will promote on-site ICI composting	✓Community group support for waste reduction initiatives, trialed on-site systems
The charging system adopted for ICI wastes will be designed to encourage this.	✓ HRM implemented a differential tipping fee structure for this sector.
Facilities should be located close to the centres of generation.	✓ One facility in Halifax and one in Dartmouth.
A number of small facilities may be designed to work synergistically, thereby creating less overall nuisance if problems arise.	✓ / X Completed but in essence increases overall buffer zone requirements; both facilities have experienced nuisance issues; economies of scale are also better realized with larger facilities but transportation must be factored in.

The program has met and exceeded the goals of the 1995 Strategy and in some ways is a victim of its success.

At the time of development of the 1995 Strategy, it was envisioned that material generated by residents would be collected and processed at a number of smaller facilities, located in such a fashion that residents would become familiar with composting activities. Ultimately, two processing facilities were constructed in Halifax and Dartmouth but both facilities have created off site impacts that have had to be addressed from time to time and through operating and infrastructure modifications.

It was not originally envisioned that HRM's facilities would process all ICI organics but the system has evolved this way for many reasons including the provincial ban on organics from disposal, HRM's solid waste by-law #S-600 Section 16.3 which prohibits both garbage and organic waste generated within HRM from being exported from HRM, and due to the significant efforts HRM has made to enforce and promote the program.

The success of HRM's program has driven the existing system to capacity. Not unlike the MRF, HRM's organic waste processing facilities were driven to capacity by the ICI sector. Without that sector's organic waste HRM would have operated these facilities at far less than capacity for many years but again and like the MRF, would still have realized the same overhead costs to operate but without any offsetting tipping fee revenue from that sector.

Overall, the program has fulfilled the intent of the Strategy having implemented all original recommendations and having diverted a significant amount of organics from the landfill from both residential and ICI sectors.

7.4 COMPARISON OF CURRENT OPERATIONS TO INDUSTRY BENCHMARKS

7.4.1 Organics Waste Program Performance Comparison to other Municipal Jurisdictions

The number of organic waste processing facilities in Canada is ever increasing as municipalities look for capacity to process materials from either existing or newly implemented municipal organic waste collection programs. While composting has historically occurred all across Canada in most cases this has been for leaf and yard waste or in the case of British Columbia also the composting of municipal bio-solids. While BC is now heavily focused on processing municipal organics and other larger jurisdictions are also starting to implement these programs (e.g. Calgary and Winnipeg) the most aggressive and longest running programs are found in Nova Scotia and Ontario. As Ontario has aggressive provincial reporting programs and as various municipalities in Ontario represent a similar sized jurisdiction as HRM the focus of this section is on performance comparisons between Ontario municipalities and HRM. HRM's performance as it relates to other municipal jurisdictions in Nova Scotia who are also subject to the provincial landfill ban on organics was discussed previously in Section 1.4. It is appreciated that for most of these comparisons there can be no direct 'apples to apples' comparison given the high degree of variation in demographic and geographic (e.g. rural versus urban) characteristics between municipal jurisdictions however relative performance with respect to broader program indicators can be generally discussed.

The following table provides an overview of some key indicators for comparison to HRM's program. Information was taken from council reports from various municipalities, municipal survey work, and WDO Gap Analysis for Ontario municipalities. It is important to note that although other municipalities have entertained/are entertaining organics bans at their landfills, HRM is the only municipality in Canada that has implemented and enforced that form of regulatory compliance. Organics diversion in Ontario, for example, is driven more by overarching principles of sustainability coupled with the practical lack of landfill capacity issue, that is, the difficulty in siting new landfill capacity due to both cost and historical public opposition and not as the result of any regulatory requirement. This distinction partly explains HRM's high organics diversion rate in comparison to most of the other municipalities profiled below.

Key Performance Indicators for Various Municipalities (2010)

	Halifax	York	Durham	Halton	Simcoe	Hamilton	Ottawa	Notes
Population	390,328	1,061,983	621,500	487,418	282,112	528,504	917,570	1
Total Single Family Households	139,341	283,491	185,024	147,203	125,920	150,231	259,243	
Total Multi Family Households	23,000	34,890	22,635	29,019	0	59,734	117,854	
Total tonnes generated (residential)	51,116	92,048	50,668	54,131	23,131	49,627	63,203	
SSO	31,902	53,090	27,593	26,786	11,459	37,696	53,348	
LYW	2,645	38,957	23,075	27,345	11,581	4,762	9,855	
Average weekly curbside participation rate (%)	90	85-90	70	77		71		
SSO Residual Rate (%)	6.4 -7.7	15	4	7-8		~5		2
Year SSO Program Commenced	1999	2004	2003	2008	2008	2006	2010	
Frequency of Green Cart Collection	Biweekly, seasonal weekly	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly	3
Capture Rates (kg/hhld/yr)	248	318	151	179	103	200		
% residential organics diverted	27.01	22.35	21.68	26.38	24.79	20.87	15.9	
Total residential diversion rate (%) (2010)	52	52	52	54	59	48	39	4
Organics Processing Fees ($/tonne)	153.22	121 - 158	n/a	~82	~90	n/a	~90	5
LYW Processing Fees ($/tonne)		~66						

1. Population and number of households from WDO for Ontario municipalities.
2. Residual rates for HRM include material from both the residential and ICI sector as the residue rate could not be isolated; it is highly likely this residue rate is lower for the residential sector alone.
3. Certain areas of HRM have weekly collection in July and August. Edmonton does not have separate collection – Garbage is collected weekly March to October and every 10 to 12 days from November to February.
4. Diversion rates for Ontario municipalities from WDO.
5. Processing fees for York and Toronto from Council Reports. Processing costs for HRM from Appendix G Table of Expenditures, Revenues and Net Cost per Tonne Recent 6 Years (includes cost of processing for peak LYW, Christmas trees, surplus SSO).

HRM's program compares quite favourably to other municipal programs. HRM's participation rates are high and overall per household capture rates are significantly higher than most. York Region's capture rate is quite high however it should be noted that that program allows for heavier pet waste and diapers/sanitary material in their program and at the time these data were gathered (2010) allowed the use of small grocery style plastic bags for collection (noting their residue rate of 15%). The percent of organics diverted by HRM is higher than every other municipality considered in this comparison. HRM is the only major municipal jurisdiction that does not offer all year round weekly collection of organic waste and the overall average processing cost per tonne realized is significantly higher in comparison to most other jurisdictions. The overall diversion rate for HRM is in line with other municipalities.

7.4.2 ICI Sector Organics

Most municipalities across Canada have rolled out the Green Bin program to the single-family residential sector, which remains the primary focus for most jurisdictions. Some municipalities offer collection and processing of organic waste from the multi-family and/or ICI sector, subject to municipal by-laws and on existing collection routes, however, provision of service to these sectors is being phased in over time. The majority of ICI waste including organic waste is collected and managed by the private sector and processed at privately-owned and operated facilities.

HRM, as required by the Provincial landfill ban on organics and administered through the By-law Number S-600, diverts a considerable amount of waste from the ICI and multi-family residential sector. During fiscal 2011/2012, 51,238 tonnes of source separated organics were diverted from landfill, of which 16,615 tonnes, or 32%, consisted of waste from the ICI (and some multi-family) sector.

By comparison, in 2011, in the City of Toronto, only 20% of waste from multi-family residences was diverted.[4] The City of Toronto offers twice weekly Green Bin collection from those commercial customers approved under the Yellow Bag program (smaller commercial establishments) for $320.00/year with a charge of $62.15 for each 35 gallon organic bin. The City estimates there is another 60,000 to 70,000 tonnes of green bin waste available once all multi-family and schools are on board (currently only 8% of multi-family buildings have Green Bin service). It is anticipated this waste will be processed at the facilities currently being constructed. It is unknown what the uptake of this program is for the ICI sector. This program is available mostly to smaller ICI generators who are not eligible for bin service or do not generate enough waste to warrant front-end bin service and are on an established collection route.

The City of Hamilton is actively targeting Multi-residential facilities to increase diversion and participation[5]. They are also implementing a Green Cart program for all municipally owned and operated facilities in order to increase waste diversion rates which have stagnated since the

[4] http://www.toronto.ca/garbage/residential-diversion.htm

[5] City of Hamilton, Report PW11096b, Multi-Residential Waste Diversion Plan and Green Cart Program for City Buildings.

implementation of the Green Cart Program in 2006. The City of Hamilton has rolled out recycling and green cart programs to all multi-residential facilities (approximately 1,000 buildings). Participation rates were initially high, but have fallen to 69% in 2011 with an estimated capture rate of 18%. Contamination rates are 46%. The City recognizes that additional outreach activity is required to maintain and improve the performance of the program and has developed a plan to achieve better results; the City is also developing an enforcement strategy, possibly incorporating garbage limits and performance standards as an additional way to obtain compliance.

An example of another Canadian municipality who has regulations controlling disposal of organics is the Regional District of Nanaimo (RDN). In 2005, RDN banned commercial organics from their landfill. RDN's organics, as well as those from surrounding areas are processed at a facility utilizing in-vessel bio-reaction technology, which was recently upgraded to convert organic waste to energy solutions (heat and electricity[6]). The plant is currently processing over 90 TPD of organic waste and LYW from commercial and residential sources. In 2006, 4,178 tonnes of commercial food waste and compostable paper was diverted from the landfill[7], this amount has increased to approximately 6,000 TPY. The commercial sector must arrange for service provision and provide their own containers. Tipping fees for commercial waste (as posted on the operator's website[8]) are as follows;

- grocery/food waste: $90.00/tonne,
- fish waste; $45/tonne;
- LYW: $45/tonne

With the intent of eventually establishing a total ban on organics from landfill, RDN has conducted a residential pilot study and has rolled out a Green Bin program to single family homes in Nanaimo and surrounding areas.

In summary, it is evident that no municipality is providing the level of service that HRM provides to the ICI sector. HRM processes a significant amount of ICI waste at a reasonable cost (tipping fee approximately $75/tonne) and diverts a considerable amount of ICI waste from their landfill. HRM diverts approximately 16,000 TPY of a total estimated 28,000 TPY generated in this sector representing a capture rate of 57%. HRM has achieved what many other municipalities in Canada are now attempting to do as it relates to diversion of waste from ICI sector generators within their jurisdiction.

7.4.3 Leaf & Yard Waste (LYW) Programs

Part of the scope of this report is to consider the separation of all leaf and yard waste from the Green Bin program for collection and processing (discussed in Section 7.6.1.). As Stantec undertook a survey of municipalities in Ontario in 2010 with SSO programs and part of that

[6] http://www.iccgroup.ca/index.php/technology2/waste-to-compost-wcompost/nanaimo-facility
[7] http://www.rdn.bc.ca/cms.asp?wpID=1068
[8] http://www.iccgroup.ca/index.php/technology2/waste-to-compost-wcompost/nanaimo-fees-a-schedules

survey was focused on LYW programs that research is discussed for HRM comparative purposes. Of those municipalities surveyed almost all, except some of the larger municipalities (Toronto, Durham, Niagara, London, York Region) compost their own leaf and yard waste at their own landfill or other municipally owned sites. Most of these municipalities are quite small and don't operate Green Bin programs. Where they do they have integrated the Green Bin material into their LYW windrow operation when the Ministry of Environment has permitted.

The City of Guelph (7,250 tonnes/year) and Niagara Region (28,800 tonnes/year) contract LYW composting. Niagara combines much of their LYW with their Green Bin program. Only 5,700 tonnes per year approximately is processed separately. Guelph has historically processed LYW separately but now intends to allow residents to add that material in their new Green Bin program to be phased in between 2011-2013. Peel Region also permits LYW in their Green Bin program and like Niagara contracts the processing of the balance (separate seasonal LYW).

York Region, Toronto, Durham and Halton Regions do not allow LYW in their Green Bin Programs and contract for private sector capacity to compost that material.

The City of Hamilton initially allowed residents to top up their Green Cart with LYW and/or setting out bags of LYW along with their Green Cart but they found that as the quantity of organics requiring management at their composting facility increased that LYW would be better collected separately and processed at an open windrow site and that capacity should be saved for the Green Cart program. The City is actively encouraging residents to place LYW separate from the Green Cart so it can be collected separately. Collection costs in 2009 were approximately $182/tonne.

Much like HRM the City of Ottawa allows LYW in their Green Bin program, however also provides separate LYW collection to residents weekly during peak seasons and bi-weekly for the remainder of the year. The City's contract with Orgaworld allows for the processing of up to 540 tonnes/day of material, however historically, during peak LYW production periods, more than 700 tonnes is collected daily. To manage the excess LYW material, during peak LYW production seasons, the collection contractors use a separate collection vehicle to collect the LYW separately from the Green Bin organics, and deliver the material to the City's own composting pads.

The table below provides a brief summary of leaf and yard waste processing capacity requirements, and processing fees for a few municipalities in Ontario to give HRM an idea of processing fees for LYW only in the jurisdiction noting that some also include the cost of haulage. HRM itself has a current contract for excess LYW that costs in the order of $28.00/tonne.

Existing Leaf & Yard (L&Y) Waste Programs in Ontario (2010)

Municipality	Current Tonnage	Current Processing Fee
City of Toronto	100,000	$45.00 - $52.00/tonne
York Region	31,200	$66.00/tonne
County of Norfolk	1,100	$50.00-$55.00/tonne including haulage
City of London	22,000	$48.00/tonne

In summary, there is really no 'best practice' as it relates to the management of LYW waste as part of a Green Bin/Cart program. Each municipality has its own logistical and infrastructure and cost related reasons for processing LYW either in or out of the Green Cart; e.g. Hamilton because of capacity issues and Toronto in part because they have elected anaerobic digestion. Others have long since had their own landfill site facilities for LYW processing like Halton and within their jurisdiction while their Green Bin waste must be exported for processing. It makes no economic sense for them to combine these wastestreams.

7.4.4 Compost Materials Marketing

The following provides some background on how other jurisdictions market their finished compost. All facilities discussed with the exception of TRY Recycling (LYW only) receive SSO or an SSO/LYW blend. This information was obtained through surveys (2011) of composting facility operators in Ontario. The majority of respondents indicated that the markets for their final product are agricultural; landscaping; soil blenders; and landfill final cover.

- All Treat Farms indicated that compost is marketed in both bag and bulk throughout various retailers in Ontario. Potting soils and soil amendments are marketed through garden centres and major retailers. Bulk is sold to topsoil blenders, soil manufacturers and garden centres.

- TRY Recycling indicated that their finished compost products are marketed to national brands for distribution as bagged compost or mixed as TRY-soil mixes. Compost is also marketed to independent landscape contractors, private homeowners through residential sales outlets, and to municipalities or governmental bodies such as the Ministry of Transportation for use in planting, bed stabilization projects, etc.

- Orgaworld, for both their facilities in London and Ottawa, markets their finished product through Orgapower Compost Corporation, primarily to the agricultural industry.

- Walker Industries markets their finished compost at a retail outlet on-site to residents and landscaping contractors.

- The Miller Group, through their Miller Compost division, actively markets finished compost to the residential and commercial sector through direct and online sales. They market finished compost at $3.99/bag or $20/yd^3 and also create soil blends, mulch, and top dressing using compost. These products are available for ordering online and are available for pickup in Ontario only.

A brief overview of some of the end-markets for finished compost for those municipalities who do not depend on merchant capacity is presented below:

- The City of Toronto sends its digestate to All Treat Farms for processing and does not market any finished product.
- The Region of Peel sells bulk compost through their CRCs for 3.5 ¢ per kilo or $35 per tonne; delivery is offered for a fee at certain times of the year. Peel also sells compost to the agricultural sector.
- The City of Hamilton sells finished compost to area farmers.
- The City of Edmonton markets their finished compost, Second Nature, as a bagged product (30L bag sold for $6.00/bag available at all eco-stations and at the Edmonton Waste Management Centre) and through a variety of outlets, including retail stores and landscaping supply companies, markets bulk compost, bagged compost, garden mix and bulk delivery.

In general, compost that is less mature is marketed to the agricultural industry. Less mature, potentially more odorous compost is sold to the agricultural sector who, in general, are not willing to pay the price that more mature, stable compost can command for retail sales. More stable, mature compost is typically blended with soil for consumer use.

7.5 OPPORTUNITIES FOR OPERATIONAL IMPROVEMENTS

7.5.1 General

Stantec has evaluated a number of potential options with respect to meeting HRM's long term organic waste processing capacity requirements; both in the context of managing increased tonnage due to growth and to accommodate any efforts toward increased diversion of organic waste. Long term capacity requirements are also addressed with respect to the fundamental need to meet 2006 CCME composting quality guidelines.

Consideration of the various options is predicated on the use of existing, and already permitted composting infrastructure. HRM has already made substantial capital investment in existing facilities, in some cases quite recently, and where deemed feasible the continued operation of this infrastructure is recommended as part of the long term system, that is, the next 20 year planning horizon.

Options and combination of options discussed in this section include the use of existing infrastructure either through continued use or by re-purposing, the use of other technology options (specifically anaerobic digestion) and changes to the feedstock for existing facilities including the removal of LYW, ICI organics, boxboard and the inclusion of bio-solids.

HRM is interested in exploring options for regional partnerships; this will have been discussed in other sections of the report (e.g. in the context of a Regional partnership for a MRF), however regional partnerships for organics is discussed below.

7.5.2 Options to Meet Both Short Term and Long Term Capacity Needs

There are a number of options which could be implemented in the short-term to provide additional capacity to meet long term processing capacity needs and that will support necessary compliance with CCME. These include:

- Continued Operation of Miller Ebara and New Era Sites to 2019
- Repurposing the WSF at Otter Lake (end of 2013)
- Construct and operate compost curing and storage pads (2014/2015)
- Construct and operate an anaerobic digestion facility (2015/2016)

7.5.2.1 Continued Operation of Miller Ebara and New Era Sites to 2019

In the short-term, it is envisioned that the Miller and New Era facilities will both continue to be operated as other recommended changes are made to HRM's organics waste processing system and as discussed in detail below. These facilities are operating reasonably well and in the case of both Miller and New Era there have been some fairly significant and very recent capital upgrades paid for by HRM as a portion of the operating per tonne fees.

The more immediate concern with respect to these facilities (e.g. well before the 2019 end of operating contract date) is their ability to meet CCME guidelines. Both operators have put forward operating/infrastructure change concepts to address this problem.

Miller would need to employ added aeration for material prior to being loaded into the Ebara vessel, an additional curing area with aeration to provide the capacity to meet the minimum 21 day curing requirement and upgrades to the bio-filters to handle additional air from the additional curing area. It is estimated these upgrades/facility modification will cost in the order of $1,200,000 (and assuming difficult to process boxboard and ICI organics are directed elsewhere relative and the new curing area requirement would be lower).

New Era Technologies has proposed the use of HotRot technology as an upgrade and expansion to address both compliance with CCME Guidelines and the need for increased processing capacity. HotRot is a fully-enclosed high-rate in-vessel composting system which claims to produce neither leachate nor foul odours during processing. The technology proposed requires a 5/6 day processing period through the HotRot composting unit(s) followed by a minimum three-month curing period in aerated windrows. Each HotRot 3518 unit is typically able to process between 10.5-11.5 TPD. The composting units have central shafts passing longitudinally through the main vessel which rotate periodically to provide mixing and aid aeration. Primary aeration is provided by air injection nozzles positioned along the length of the hull. Excess air is continually drawn from the composting vessel and treated through a set of bio-filters. The estimated capital cost to accommodate existing through-put is in the order of $7,100,000.

In the short term if HRM initiates the recommendations discussed below just over 10,000 TPY per facility could be directed elsewhere leaving each facility in the order of a 15,000 TPY of clean residential source organic waste to process[9]. The removal of these more difficult to process materials could have a significant positive impact on compost quality and material testing should occur post-implementation to determine that impact prior to any significant capital investment (e.g. in 2015 and as part of the HRM plan necessary for 2014) unless there are other factors that determine necessary and sooner investment.

The continued operation of these facilities to the end of their contract term enables HRM to manage population growth and increased organics tonnage during that time period, manage additional tonnage associated with any new diversion initiatives, construct and transition ICI organics to a new anaerobic digestion facility, gives sufficient time to repurpose the WSF as discussed below and to determine if either the Miller Ebara or the New Era facilities are necessary past 2019. Further, these facilities are older and any required long term infrastructure replacement requirements (past 2019) should also be determined sooner than later.

HRM has an opportunity to ensure sufficient processing capacity over the planning period with the combined use of a new anaerobic digestion facility and the use/repurposing of existing aerobic composting facilities. Some 80,000 TPY could be captured for processing by the end of the planning period and there is another 20,000 TPY in the wastestream that could be targeted for diversion. Preliminarily, between the WSF, New Era, Miller and a new AD facility HRM would have an approximate 125,000 TPY of processing capacity. While it is clear that not all these facilities may be necessary to support HRM's long term needs various and more detailed considerations are necessary in the very short term (by 2014) to determine which combination of facilities is optimum from a system efficiency (e.g. collection, locating of curing and storage) and cost-effectiveness standpoint; capital costs for new facility and for existing facility upgrades in both the short and long term; negotiation of revised minimum annual tonnage throughout ("put or pay" terms with Miller Ebara and New Era and new processing fee negotiations. Existing and new facility capacity is determined as follows:

Miller Ebara	25,000 TPY
New Era	25,000 TPY
WSF Re-Purposed	49,000 TPY
New AD Facility	27,000 TPY

[9] Note that if the anaerobic digestion process described below does require aerobic composting of digestate then 4,000 TPY would need composting and could be composted at the Miller Ebara site.

As such, any of the following options would likely meet HRM's long term capacity requirements and in no particular order of preference:

1. Miller Ebara, New Era, new AD Plant
2. WSF, Miller Ebara, New Era
3. WSF, new AD Plant
4. WSF, Miller Ebara OR New Era

It should be noted that in any consideration that HRM owns the sites that both Miller and New Era are operating on and that those may also have potential to be re-purposed as part of the system, for example, if HRM can't find a suitable size property for a campus a MRF could be relocated to one of these sites depending on size and other factors.

7.5.2.2 Repurpose the WSF

The existing WSF is no longer an asset to HRM's landfill operation. An opportunity exists for HRM to repurpose the WSF to compost clean, source separated organic waste.

The WSF was designed to meet an annual processing requirement of 49,100 TPY of solid waste. The WSF has 14 bins with a capacity of 30m^3 per bin per day which allows for 420 m^3 per day (189 TPD based on original density calculations). The retention time originally envisioned for the WSF was 21 days with the FEP operating at its average design capacity.

The WSF is comprised of a 4,784 m^2 facility with 4 main processing areas (receiving, agitated bin system, intermediate screening and curing area, load out area).

In order to utilize this facility for clean organic waste processing some reconfiguration may be necessary at the FEP and the front portion of the WSF. The FEP tipping floor could still be utilized and there is existing and suitable equipment like the shredder, conveyors and the screens however only coarse shredding may be necessary (a second screening may not be necessary and that occurs with the current operation). The front end of the system should be configured to address anticipated degree and type of contamination, continued inclusion of boxboard (discussed below), and any other factors that may affect design.

A detailed engineering review should also be undertaken to assess the capability of the WSF to process clean organic materials over a new long term (e.g. 20 year) period from the perspective of any new equipment that may be necessary (e.g. additional turning units, upgraded misting system, upgraded structural to accommodate much higher moisture levels and the like) as well as other equipment replacement that may need to occur over a new long term period. A bio-filter adequacy assessment should also be undertaken.

A detailed mass balance calculation should also be determined based on current waste composition once determined (with or without boxboard, with or without ICI source waste as discussed below) and associated density with respect to new anticipated retention times, through-put and so plant capacity. Determination should be made with respect to these requirements as they relate to CCME Guideline compliance. It is reasonable to expect that a re-purposed WSF, given its design, would be able perform in accordance with CCME. The design of this facility is identical to the now decommissioned Guleph, Ontario facility which consistently met CCME guidelines for its entire operating life (1996-2006). An order of magnitude cost to operate the WSF for composting purposes is estimated to be in the range of $55-$75/tonne.

7.5.2.3 Compost Curing Pads

As part of a Regional Waste Resource Campus concept, compost curing pads could be constructed and operated to provide HRM with greater control over the process, finished product and marketing. Currently, all immature compost is sold to and cured by Elmsdale. HRM has no control over the process, nor is HRM able to access any finished product for beneficial end-use (by residents, for municipal use etc.) and cannot derive any revenue for the end-product.

In the context of using existing Miller Ebara and New Era facilities for continued aerobic composting and in the event that those facilities may not meet CCME Guidelines through other endeavours (feedstock changes, capital upgrades) the HRM owned site could be constructed in a more robust way (covers, leachate, ground and surface water controls etc.) to receive immature compost from those processors to be brought to final maturity at the HRM site. (In this case that material would have to be transported and received as unfinished compost). This option could be considered in the context of relative capital and operating cost.

It is anticipated that in 2013/2014, the process of securing lands, obtaining approvals and completing the site servicing could be completed. Capital costs associated with this facility are discussed in Section 5.0.

Capacity for curing the compost produced by the aerobic processing facilities is required, as well as additional capacity for contingency and future growth.

HRM's original intent was to derive revenue from finished compost, it was estimated that would be in the order of $5-$10/tonne. That revenue has never been realized. It is understood that HRM receives no finished compost back for various end-uses. Many municipalities have a condition for a certain amount of finished product to be made available to the community as well as for municipal operations.

There is revenue potential from finished compost which would offset a nominal portion of processing costs; typically municipalities do not make a lot of money from finished compost. Use of finished compost is seasonal takes sufficient space to store quantities of finished compost for extended periods of time until it is required for gardening seasons. A new and sufficiently sized curing and storage area would provide that opportunity for HRM.

Many municipalities also have "compost give-a-way days" for residents to promote and reinforce the importance of the program and to thank residents for their efforts. These events are often timed to coincide with other events such as "Earth Day" or are combined with other initiatives such as food drives or other charitable organizations.

If HRM remains with the status quo (composting residential and ICI organics) and composts approximately 51,000 tonnes of organic material, this would result in around 6,000 tonnes of finished compost (this does not account for the removal of boxboard which is recommended). . Had HRM realized revenue from the sale of finished compost and assuming an average of $7.50/tonne as originally envisioned this amounts to a current $45,000/year. Local sellers of finished compost have recently quoted in the order of $22.00/cubic yard. At an assumed average of 900 lbs (408 kgs)/cubic yard for finished compost this equates to $54.00/metric tonne. At 6000 finished tonnes per year this would equate to somewhere in the order of $324,000/year if all material could be sold.

A curing and storage area would be an ideal addition to HRM's system particularly in the context of a new Waste Resource Campus and if at Otter Lake even more ideal if the WSF is repurposed as discussed above. If the WSF is repurposed for aerobic composting than all composting, curing and storage could occur on one site with no secondary transfer necessary. This would put HRM in compliance with CCME Guidelines and would enable efficiencies in the composting system including but not limited to cost-effective materials movement on the same site from composting to curing and stockpile areas of the site. Excess leaf and yard waste collected could also be composted on the same pad and/or fed into the aerobic composting process as necessary.

7.5.2.4 Anaerobic Digestion Processing Facility for ICI Sector Organics

The water content and level of contamination in organics from the ICI sector have been identified as issues for processing and achieving compliance with CCME guidelines using current aerobic processing technology. Anaerobic digestion technologies are now, and very recently, being constructed (as opposed to aerobic composters) to process wetter, less homogenous (than residential) and/or more contaminated organic waste materials.

One example is Canada Composting Inc. that operates the Dufferin Organics Processing Facility in Toronto utilizing single stage, wet, mesophilic BTA technology. The Dufferin facility has a capacity of 25,000 TPY and opened in 2002 to coincide with the launch of Toronto's Green Bin program. The City chose this technology due to a compact size which allowed the facility to be located within the City, the ability to remove fine contaminants and plastics, achievement of significant mass reduction which reduces transportation costs and carbon footprint. Toronto's program accepts a wide variety of materials from both the residential and ICI sector, resulting in a challenging mixture of organics, plastics (reported to be up to 15%) (grocery bags are accepted for containment of organics in both single family and multi-family sectors) and other contaminants requiring processing.

The City of Toronto is currently constructing a new 55,000 tonnes/yr wet AD facility at its Disco Road transfer station utilizing the same technology. The Dufferin facility is planned to be expanded from 25,000 TPY to 55,000 tonnes TPY once the Disco Rd facility is operational. Toronto's plan for biogas utilization is for the generation of biomethane which will be used in city buildings and for waste collection vehicles. It is anticipated that the processing of 110,000 tonnes/yr of SSO will generate 13.6M m^3/yr of biogas.

In light of issues with processing ICI source organics and the capacity issues associated with the Miller Ebara site, Miller undertook a search for more suitable technology for processing this waste. Miller's investigation included a review of anaerobic digestion technologies and came to favour the technology provided by Finsterwalder Umwelttechnik GmbH & Co., located in Germany. The technology has been successfully utilized in two facilities in Austria and England. The actual company, Finsterwalder Umwelttechnik, was founded in 1997 and their technology is distributed in North America by Yield Energy (offices in Toronto and Washington).

The technology employs two treatment steps for the organic waste as follows;

1. Primary removal of physical impurities by BIOSQUEEZE - The waste is crushed and blended with minor amounts of water to obtain a total solid content of 25% which allows the first separation of contaminants to take place. Contaminants can be composted, dried or disposed of.

2. Secondary removal of physical impurities through use of floor scraper and skimmer - The liquid/slurry fraction is heated and fed into the digesters where additional separation of contaminants takes place utilizing floor scrapers to remove grit and skimmers to remove floating plastic. Biogas is produced in the digester, biogas can be used for electricity and heat in a CHP (combined heat and power) or it can be cleaned and injected in the natural gas grid as RNG (Renewable Natural Gas). Another product resulting from the anaerobic digestion process is digestate which can be used as a liquid fertilizer.

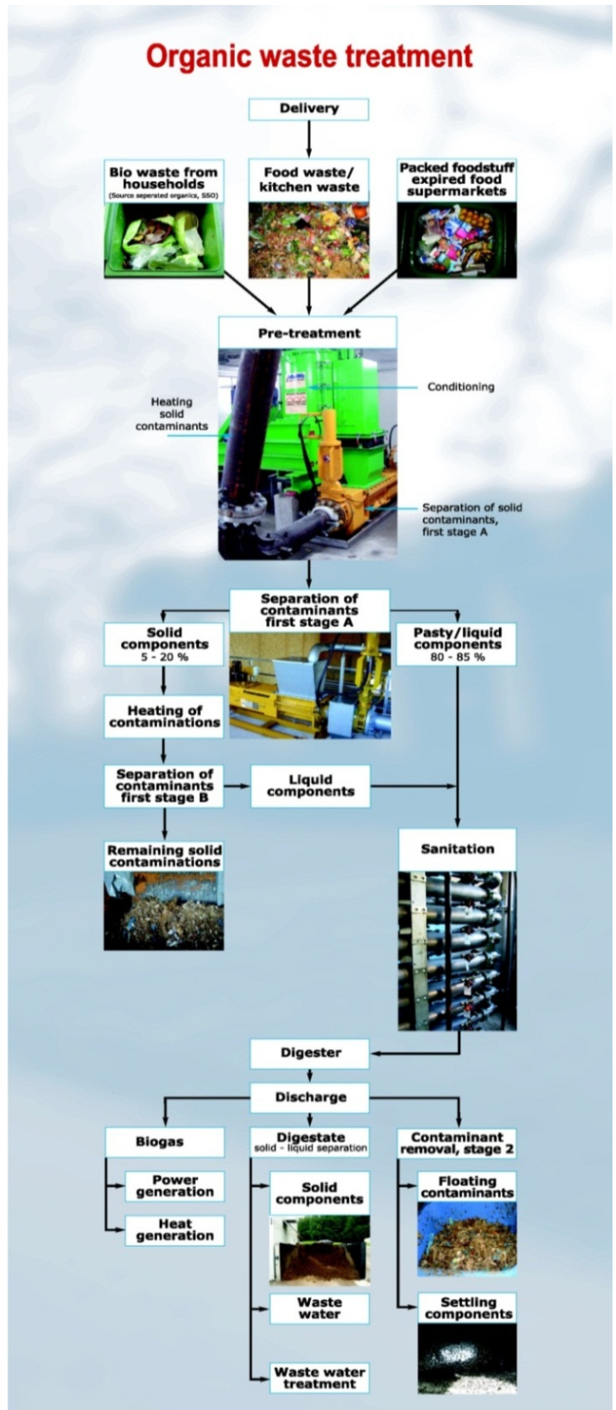
> Finsterwalder Umwelttechnik GmbH & Co technology has been utilized for the new Langage facility in England which has a permitted capacity of 20,000 TPY, initially processing 16,000TPY; 3,000 tonnes farm slurry, 1,000 tonnes factory waste, 12,000 tonnes food waste.
> Source: wrap.org.uk (Langage farm case study)

This technology results in an end-product (digestate) which is much more concentrated compared to the digestate produced through other wet anaerobic digestion systems. Liquid digestate could be used for agricultural applications. The digestate is very clean and stable due to the long retention time and removal of contaminants through the skimming and scraping systems. Preliminary discussions with farmers indicate some willing to host on-farm storage tanks which will store the digestate; a stable, low odour, pathogen free high nutrient "manure like" product. It is more cost effective to truck the liquid digestate to storage facilities (tanks) built at the farms than it is to dewater, compost the solids and treat the liquid from the dewatering through a treatment plant. Utilizing the digestate as a nutrient in a sustainable farming model is consistent with Nova Scotia's Homegrown plan (http://www.gov.ns.ca/agri/elibrary/homegrownsuccess.pdf).

If all organics from the ICI and Multi-family sectors (also typically more contaminated) were to be processed, an initial facility could be designed to process 27,000 TPY, producing about 24,000 m³ of liquid digestate per year. In the future, should additional capacity be required, the facility could be expanded in increments of 9,000 tonnes for digester volume. Agreements would only be required with three (3) mid-sized farms to consume all the digestate produced; approximately 1,000 acres of corn per year would be required to use all digestate. If the digestate is approved for use on organic crops there is an opportunity for increasing the revenues from the farmer. The digestate could be approved by CFIA as a product and sold as a fertilizer to farmers.

A facility can also be supplied that does dewatering, solids composting and water treatment but the capital and operating costs would be higher, somewhere in the order of an estimated $15 per tonne. If dewatering is necessary and wastewater treatment facilities are constructed instead of delivering to farms approximately 4,000 tonnes of cake/solids could be composted at the existing aerobic composting facility. There are some advantages if anaerobic digesters are constructed at the existing Miller Ebara site or at the Otter Lake site with a repurposed WSF:

- The site is already approved for the processing of organic waste; it would be potentially easier and more expeditious to obtain an amendment to the current permit than to get a new site approved.
- Material can be fed into either facility as it is received, that is, more contaminated and wet material to the digesters and cleaner material to the existing aerobic composter.



Overview of Anaerobic Facility Waste Treatment Process

- Additional capacity for contingency purposes would be available, that is if one side of the system was interrupted the other could still be used if necessary.
- Efficiencies in already existing infrastructure and equipment (e.g. truck scales, operating staff, loaders etc.)

The conceptual area requirement for this facility is approximately two (2) acres. It should be noted that there are other items that may increase the size requirement (e.g. flare separation to digesters and other buildings, property lines can increase sizing depending on local requirements).

Based on a 27,000 t/year AD facility it is estimated that enough biogas will be produced for approximately 1MW of electrical power. Miller is applying for the COMFIT rate for the electricity; however, at present, the Nova Scotia COMFIT program does not clearly identify/list anaerobic digestion facilities. Miller has received verification from NSE and Department of Energy that the project would meet their requirements for green energy rates (in comparison, in Ontario, green energy rates are $0.147 per kWhr of power produced – this would return about $1 million per year in electricity revenues above what the plant would consume itself). At present, the biomass COMFIT rate in Nova Scotia is $0.175 per kWhr; however, it is unknown if this rate would apply to the AD facility. This requires more formal communication between HRM and NSE.

Miller has indicated that if the facility is not eligible for funding through COMFIT, the biogas can be cleaned up to pipeline natural gas grade for injection into the grid. This option would enable the marketing of green “natural gas”, similar to what Bullfrog Power has done across Canada. Alternatively, HRM could replace their existing brown gas purchases. Several municipalities are starting to consider the benefits of running their garbage or transit fleets on natural gas in which case they could consume the green cleaned up biogas produced at the facility. HRM would acquire associated GHG reduction credits.

Based on some preliminary work that Miller has done to date, the capital cost for biogas clean up technology to treat the biogas the facility would produce is more expensive and the revenues received when compared to green electricity rates are lower. The final decision whether to utilize the biogas in a CHP to generate electricity versus cleaning the biogas and injecting it into the natural gas grid would be determined by final consideration of the green energy rates received. These matters would need to be addressed through discussion with Miller or in a formal Design, Build, Operate (DBO) Request for Proposal (RFP) process for a new anaerobic digestion facility. There may be further synergies with respect to biogas production if it were to occur at a facility at Otter Lake.

Further to aiding HRM in the achievement of CCME Guidelines the use of an anaerobic digestion process may enable greater diversion of organics from multi-family and ICI sectors as the tolerance for contamination is much higher. There is an opportunity to target organic waste still being delivered to Otter Lake but as we “reach deeper into the garbage bag” the organics material presented is even harder to manage (the materials easiest to separate have already been separated in the context of the material ban); those materials will have high moisture content and have physical impurities that are difficult to remove in an aerobic composting system (glass, film plastic and other packaging) and that is more applicable for an anaerobic digestion system, an anaerobic digestion system can complement the existing aerobic composting system in place. This program could drive additional organics from Otter Lake which would be complimentary to repurposing the FEP and WSF.

Stantec developed an estimate for the anaerobic digestion technology discussed above. To be conservative Stantec included costs that would be associated with low rate composting and curing of digestate (as opposed to storage and management on farm as discussed) and with a robust cover system and including windrow turners, screening equipment etc. The Stantec estimate was in the order of $25,600,000 with $4,400,000 of that dedicated to aerobic composting and curing. Stantec is in no way endorsing this or any particular technology for application by HRM. It is however recommended that HRM, along with other agencies discussed in this section, continue discussions with respect to the feasibility of applying this technology. At minimum if HRM intends to pursue this option they should conduct their own due-diligence review of the technology intending to be applied through site-visits and the determination of suitability, demonstrated ability (e.g. length of time operating), application for an approximate 27,000 TPY and 'lessons learned'. The proponent should also provide a detailed engineering and cost proposal for HRM and it should undergo a third-party engineering review. Alternatively HRM could engage in a more formal Request for Expression of Interest (REOI) process and then if more suitable a Request for Proposal process for a new anaerobic digestion facility at a new Waste Resource Campus or at another HRM owned site if more appropriate.

7.6 CHANGES TO FEEDSTOCK TO AEROBIC COMPOSTING FACILITIES

As part of this review, HRM wishes to examine changes to the feedstock to the two organic waste processing facilities to identify options for cost savings and/or operational efficiencies. Accordingly, discussion about removing certain materials (LYW, boxboard, ICI waste) from the feedstock as well as adding material to it (biosolids) is presented below.

7.6.1 Removal of LYW

HRM currently collects LYW either in the Green Carts or along-side the Green Cart in bags. Additionally, there is some separate collection of bagged LYW during peak seasons. HRM is interested in exploring the option of removing more LYW from the residential Green Cart so that it may be processed separately. The removal of LYW from the residential organics stream would reduce processing costs since this material could be more cost-effectively composted at an open windrow site. These costs are usually in the order of $45.00-$50.00/tonne compared to the current average processing fee at Miller and New Era of $153.00/tonne.

Further to the opportunity for more cost-effective processing is the potential to reduce the current strain on capacity at both Miller and New Era. It is estimated that somewhere in the order of 9,500 TPY of LYW is generated each year with in the order of 6,500 to 7,000 TPY processed through these facilities on an annual basis. Overflow organics capacity is necessary

(2150 TPY in 2011/2012) for a portion of the year and currently provided by Fundy Compost ($64.00 plus net HST per tonne in 2011/12, so $143,500). The cost for processing separate LYW during peak seasons (3,100 TPY in 2011/2012) is an additional $57,900 for 2011/12 with delivery to Kel-Ann Organics. While LYW would continue to be processed separately and for much less cost (more akin to the cost/tonne charged by Kel-Ann), overflow of organic waste from New Era and Miller could be avoided.

A significant amount of LYW is currently set out in separate bags alongside the Green Cart, collected with the Green Cart material and sent to Miller and New Era for processing. A certain portion of LYW material could remain in the Green Cart (i.e. 'top-up' material) as it is beneficial to the process to have some LYW collected and processed along with food waste. LYW processed along with organics can help support proper C:N ratio and can act as a bulking agent depending on composition. However, the LYW material set out in separate bags next to the Green Cart could be collected separately from Green Cart material and could be sent to a separate composting pad for processing (it is unknown the exact proportion of LYW in the Green Cart versus set out at the side but if the ration were 50:50 this would represent approximately 3,500 TPY). Additional LYW could be diverted to New Era or Miller on an 'as needed' basis.

Alternatively HRM could place a full-on ban of LYW in the Green Cart program and still deliver to these facilities on an 'as needed' basis. If 7,000 TPY of LYW were diverted from the Green Cart program this could represent in the order of $700,000 ($100 less per tonne for processing) in operational savings on an annual basis (not accounting for the cost of directing some materials to New Era and Miller) as well as the avoided cost (currently an approximate $171,000.00 per year) of managing overflow organics.

In the case of Otter Lake and if the WSF is re-purposed it would be ideal to have an adjacent/near composting pad for LYW in that LYW needed for composting organics could be stockpiled and fed into the process as needed and the remainder could be conventionally windrow composted. Further synergies exist with respect to the joint operation of a LYW composting pad near a compost curing and stockpiling area (shared staff, equipment; loaders, windrow turners, screeners, shredders and the like). This scenario further creates an opportunity for co-collection of organics and LYW (separate compartments) for delivery to a single location. Discussion with respect to collection of LYW is provided in Section 8.0.

The benefit of freeing up capacity at New Era and Miller is the opportunity in the shorter term for HRM to make more practical use of these facilities through increased household organic waste capture that would result with various initiatives described elsewhere in this report (e.g. weekly collection of organics on a year round basis).

7.6.2 Removal of ICI Organics

As discussed above material from the ICI sector is a very wet stream and can be highly contaminated. Removal of this material (approximately 30% of current feedstock is ICI source organics) from the existing aerobic composting facilities to anaerobic digesters (discussed above) would leave a lighter and more homogenous feedstock which would positively contribute to meeting compost maturity requirements per CCME guidelines.

7.6.3 Removal of Boxboard

HRM actively promotes the inclusion of boxboard in the organics stream, rather than in the blue bag program. This material has a high lignin content which slows down the maturation process as it is fairly dense and does not break down as quickly as food waste. The boxboard increases the C:N ratio. In the survey undertaken by HMJ Consulting Ltd. as part of the *Compost Maturity Study*, boxboard was mentioned as a material causing operational difficulties and contributing to issues regarding quality by two of the nine respondents. In a case study authored by Dr. Paul Arnold for the University of Acadia Institute of Case Studies, the challenges of producing unrestricted use compost by Miller Composting included a discussion on feedstock and contamination. In this case study, the inclusion of woody yard wastes and paper products were reported to increase the C:N ratio to between 300 and 400 which suppresses microbial activity and slows down the rate of decomposition. This requires the material to have a longer residence in the compost bed of 120 days instead of the designed residency of 80 days.

The requirement for extended retention times combined with the volume of material requiring processing can result in material not getting sufficient residence time in the beds and associated decomposition to be compliant with CCME guidelines.

Removal of boxboard from the organics wastestream would therefore likely contribute to the ability of these processing facilities to meet CCME Guidelines.

Additional benefits of removing boxboard from the organics stream were discussed in Section 7.0 – Materials Recovery Facility with respect to potential cost-savings and diversion. HRM is only achieving a capture rate of approximately 25% for boxboard. Given the low capture rate and the issues boxboard is causing for processing facilities, HRM should consider removing boxboard from the Green Cart and collecting it with other Blue Bag materials. This would alleviate the issue in composting, likely increase capture rates and also generate some offsetting revenue through the sale of material. With sufficient promotion residents would likely very easily make the transition. Most municipalities in Canada promote boxboard in the recycling program instead of their Green Cart programs.

7.7 REGIONAL PARTNERSHIPS

With respect to other municipal partnerships for organics waste processing (e.g. in the context of HRM providing a regional composting facility(s)) there are a number of processing facilities that already serve jurisdictions within a reasonable haul distance from Halifax. Within approximately an hour's drive from Halifax are the Cities of Bridgewater, Lunenburg, Truro, and Kentville that generate SSO that could be processed by HRM. Bridgewater and Lunenburg are served by the facility in Lunenburg which was recently upgraded in 2010 so is likely to be operational for some time. A new facility is currently planned for Kemptown which will serve the

Northern Region so it is unlikely that additional capacity will be needed from HRM. The Northridge Farms facility serves the Valley Region (including Windsor and Kentville).

Fundy Compost, located in Brookfield approximately one hour away has excess capacity with the construction of the new facility in Kemptown (it had previously been composting material from Colchester County). Reportedly, 8,500 tonnes of capacity is available at this facility at the time of this report.

It appears that a regional partnership with another municipality is not a feasible option given the distances material would need to be shipped and the prevalence of SSO processing facilities in Nova Scotia, however partnership operations with these facilities for processing should continue to be an option for excess capacity or separate seasonal LYW processing in the event that there are no changes to the ‘status quo’ system.

7.8 CONCLUSIONS AND RECOMMENDATIONS

7.8.1 Conclusions

Based on the review of HRM organic waste processing operations the following broad conclusions can be made:

- There is a real opportunity to make use of existing processing infrastructure through upgrades and re-purposing to meet all of HRM’s long term organic waste processing capacity needs; both to meet demands associated population growth and commercial waste generation trends but also to divert additional materials from the garbage stream.
- There are various system upgrades and configurations, program changes that can be implemented to enable HRM to meet CCME Guidelines.
- Application of anaerobic digestion technology as part of the system can reduce the harder to manage organics from the conventional aerobic composting process to assist in meeting CCME Guidelines, achieve objectives as it relates to Nova Scotia’s Homegrown plan and also permit processing of additional organic waste currently being disposed of at Otter Lake.
- There may be real financial benefit to removing all or some LYW from the Green Cart program and there are particular synergies to this in processing if both are processed separately at the same site e.g. Otter Lake.
- Boxboard should be removed from the Green Cart program.
- There does not appear to be any opportunity for large-scale regional partnering for organics waste processing given the extent and age of infrastructure in the province.

7.8.2 Recommendations

- Evaluate the condition of the FEP and WSF for the purposes of long term aerobic composting of clean organic waste; necessary upgrades, new equipment, cost, timeline for modifications, 2013.
- Detailed evaluation of system configuration options and costs; opportunities and constraints:
  - Miller Ebara, New Era, new AD Plant
  - WSF, Miller Ebara, New Era
  - WSF, new AD Plant
  - WSF, Miller Ebara OR New Era
- Conduct due-diligence and determine detailed costs for a new anaerobic digestion facility, 2013-2014. A new facility could be operational in 2015.
- Determine site and construct and operate a secondary curing area to provide more control over the curing process and finished product; status quo until land secured, permits obtained and curing pads constructed.
- Undertake compost quality testing upon removal of boxboard and ICI source organics to determine compliance with CCME and next steps.

8.0 Collection Programs and Container Considerations

8.1 INTRODUCTION

The 1995 Strategy was not highly prescriptive with respect to collection contracts and details of collection. The emphasis at that time was to establish separate collections for recyclables and organics to maximize diversion from landfill. These separate collection activities were implemented in the 1990s and remain in place today. It can be simply stated the intended enhancements were implemented. The following sections describe the current program, compare the current program to municipal benchmarks, and present options and recommendations for improvement.

8.2 CURBSIDE COLLECTION CONTRACTS, ZONES, AND COSTS

8.2.1 Residential Collection Contracts

HRM currently provides curbside collection services to approximately 132,500 homes in eight defined collection zones. Recyclables, organics, and garbage are recovered in separate collection vehicles and delivered to the following facilities. All collection services are provided every two weeks except for weekly recyclable collection in the urban and suburban areas, and weekly organic collection in urban and some suburban areas in July and August.

- Organics – Dartmouth or Halifax Composting Facility
- Recyclables – Halifax Material Recycling Facility
- Garbage – Otter Lake FEP/Disposal

Financial data presented in the 1995 Strategy forecasted a minimum of $4M in capital and variable operating costs to be allocated to annual collection costs. However when the Strategy's finances were revisited, HRM council acknowledged and approved an estimated annual collection cost of $6.9M for 1998. Collection zones were determined in 1996 and have not been updated.

The current collection contracts commenced on July 1, 2008 and expire June 30, 2013. Five separate bidders were awarded contracts to provide waste collection services in eight collection zones within HRM. As seen in the table below, there are differences in the pricing put forward by the various contractors, as the collection zones differ significantly in the amount of serviced units, housing density, type of residential housing, and geographical area. For residential waste collection, costs were calculated on a per unit basis. A summary of the per unit as well as 5 year pricing at contract award is presented below.

Collection Zone	Proponent	Serviced Units	Price Per Unit/Year	5 Year Pricing (excl. tax)(1)
1 - Halifax	Waste Management	29,876	$80.48	$12,022,797.42
2 - Dartmouth	Waste Management	21,577	$81.03	$8,742,776.41
3 - Bedford, Hammond's Plains	Miller Waste Systems	10,407	$94.90	$4,938,350.02
4 - Western	Waste Management	14,708	$76.52	$5,627,502.57
5 - Sackville, Fall River	Miller Waste Systems	20,769	$85.49	$8,877,817.96
6 - Cole Harbour, Eastern Passage	Miller Waste Systems	13,228	$87.60	$5,793,766.28
7 - Preston, Lawrencetown	Leo J. Beazley	7,692	$161.66	$6,217,362.56
8 - Eastern	Eastern Shore Cartage	7,430 + 2 Waste Depots	$123.55 (including staffing 2 waste depots)	$5,706,409.72

i. Note: The 5 year pricing shown in the table is the price evaluation total which includes the sum of monthly and other unit pricing combinations over 5 years. Regular bi-weekly garbage and organics collection as well as recyclable collection is included along with estimates for the number of separate leaf and yard waste and Christmas tree trucks and the optional weekly organics services in all areas/zones. Seasonal weekly organics collection has been in place since 2004.

The table below documents blended collection (both curbside and condominium collection).

	2008-09	2009-10	2010-11	2011-12	2012-13 (projected)
Annual Collection Cost/ Serviced Unit	$83.81	$84.88	$89.19	$92.62	$95.87
Tonnes of all material collected/ serviced unit	.836	.842	.812	.805	.808
Cost/Collected Tonne	$100.25	$100.80	$109.84	$115.05	$118.65

8.2.2 Condominium Collection Contract

The current condominium collection contracts in three service areas have a term of November 1, 2010 to October 31, 2013. HRM services 8,333 condominium units (larger than 6 units). The curbside collection services and condominium collections services are tracked at the HRM waste facilities as residential materials including garbage, organics and recycling.

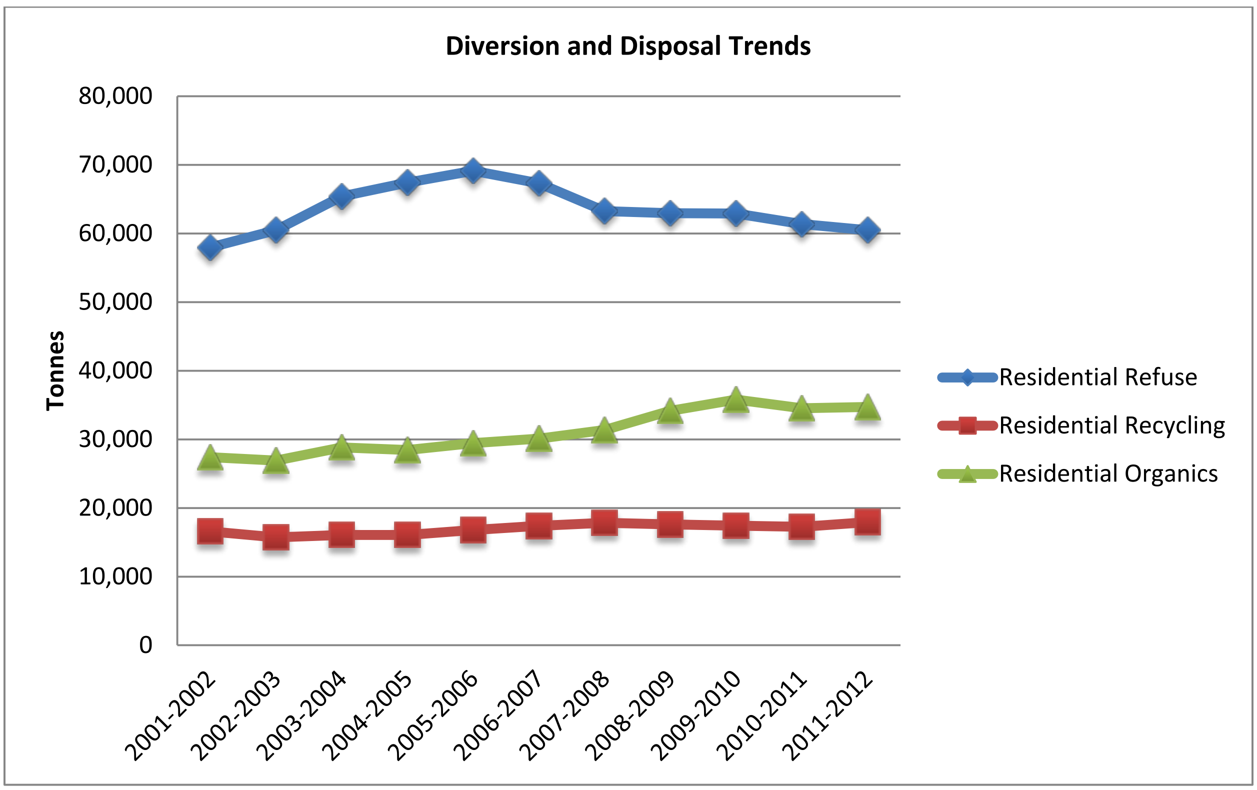
8.2.3 Garbage Collection

Bi-weekly curbside garbage collection (including bulky items) is provided to all eligible residential dwellings including single family households, multi-unit residences up to 6 units, and some condominium locations.

For single unit households, there is a bi-weekly six (6) bag limit for garbage, which was reduced in 2007 from the previous ten (10) bag limit in an effort to impact diversion. The amount of divertible materials in the residential residual wastestream decreased following implementation of this policy change.

Apartment buildings serviced through municipal collection are allowed up to 5 bags per unit. Commercial locations and large apartment buildings are required to arrange for collection through the private sector.

In 2011/2012, a total of 60,500 tonnes of residential garbage was collected in HRM compared to the 1995 Strategy's original projections for the mature system in the year 2000 of 57,100 tonnes. The tonnage of refuse generated by the residential sector has fluctuated over the past 10 years, peaking in 2005/06 at 69,100 tonnes. The figure below presents the tonnage of recycling and organics captured from the residential sector and the correlation to the amount of residential garbage generated between 2001 and 2012.



8.2.4 Source Separation

Green Cart Program

Organics are currently collected in green carts on a bi-weekly basis from eligible residences, including all single family residential dwellings and multi-unit dwellings less than 6 units in size.

In 1998, HRM launched the organics program and distributed 100,000 green carts to eligible properties. In the summer of 2003, HRM piloted a weekly organics collection program in selected areas in response to odour and nuisance concerns experienced in the warm weather. As a result of the pilot program findings, HRM now provides weekly organics collection in July and August to urban residents. This enhanced service is revisited and assessed annually by Council.

Since the implementation of the green cart program, there have been no changes to the materials accepted in the program. The following materials are currently divertible through the green cart program:

Food Waste
- Fruit and Vegetable Peelings
- Table Scraps
- Meat, Bones, Fish, Dairy
- Cooking Oil and Fat
- Bread, Rice, Pasta
- Coffee Grounds, Filters, Tea Bags
- Egg Shells

Yard Waste
- Excess leaves
- Brush
- Plants

Other
- Sawdust
- Wood Shavings

Boxboard & Soiled Paper
- Cereal Boxes
- Shoe, Cracker, Cookie Boxes
- Paper Towel Rolls
- Soiled Paper
- Food Napkins
- Kitchen Paper Towel
- Tissue Boxes

The introduction of the green carts and curbside source separated organics program has been successful. Since the launch of the program, a progressive annual increase in the amount of organics diverted from the wastestream has been realized. The mature system presented in the 1995 Strategy targeted a diversion rate of 33% of organic waste from the residential and commercial sectors combined. More specific to the residential sector, the 2004 HRM Solid Waste/ Resource Management System Review indicated that of the wastes collected at curbside, an estimated 21.9% of the residential wastestream was targeted to be diverted through the curbside organics program.[10] The performance of the system has exceeded the original strategy goal of 21.9% under the mature system, indicating that the organics program has exceeded expectations in performance. The table below presents the trends in residential organics diversion throughout the 'mature system' phase. Note that the diversion rate in the following table only accounts for residential curbside collection programs including refuse, recyclables and organics.

	Strategy Projected for 2000	2001-2002	2004-2005	2007-2008	2010-2011	2011-2012
Residential Curbside Organics (tonnes)	24,000	27,394	28,452	31,371	34,547	34,713
Residential Waste Diverted Through Organics Program	21.9%	26.9%	25.4%	27.9%	30.5%	30.7%

8.2.5 Recycling

HRM currently provides curbside collection service to eligible residences using a blue bag system. Residents are currently able to place unlimited quantities of recycling at the curb, however they are required to separate the material into three streams. Containers are to be collected in the blue bag, paper fibres are contained in a retail (grocery) bag, and cardboard is to be gathered in small bundles and placed beside other recyclable materials outside of the bags. HRM utilizes side-load, two compartment collection vehicles to collect the recyclable materials, where paper fibres and cardboard are separated from containers. Recycling is currently collected bi-weekly from residences in rural areas and is collected weekly in urban and suburban areas.

The following table presents the tonnage of recyclable materials collected through the curbside residential collection program, and the respective amount of waste diverted through the recycling program in comparison with the 1995 Strategy's recyclable diversion goal. Note that the diversion percentage presented in the table includes only the residential curbside refuse, organics, and recycling tonnages.

[10] O'Halloran Campbell Consultants Ltd. January 2004. HRM Solid Waste/Resource Management System Review.

	Strategy Projected for 2000	2001-2002	2004-2005	2007-2008	2010-2011	2011-2012
Residential Curbside Recycling (tonnes)	28,000	15,294	16,756	17,852	17,258	17,946
Residential Waste Diverted Through Recycling Program	25.7%	15.0%	15.0%	16.4%	15.1%	15.9%

The performance of the recycling program has not increased significantly over the past decade. Since the province's Beverage Container Deposit-Refund System came into effect in 1996, a portion of residential recyclable materials that previously would have been managed by the recyclable collection program are instead diverted through the deposit program, which could be a contributing factor to the low capture rates of the residential recycling program.

In 2011, mixed plastics (3, 4, 5, and 7) were added to the blue bag recycling program. These additions were made to support the overall vision of the 1995 Strategy and to increase the current recycling diversion rate.

As a result of these changes, the following items are currently accepted in the curbside recycling program:

Paper Fibre Recycling (Retail/Grocery Bag)

Dry and Clean Paper
Newspaper
Flyers
Glossy Magazines
Catalogues
Envelopes
Paper Egg Cartons
Paperbacks
Phonebooks
Shredded Paper

Container Recycling (Blue Bag)

All Deposit Bearing Containers
All Plastic Containers
Glass Bottles and Jars
Steel and Aluminum Cans
All Milk Containers
Mini Sips and Tetra Juice Packs
Plastic Bags

Bundled Cardboard

Corrugated Cardboard (2ftx3ftx8in)

8.2.6 Solid Waste Resource Collection and Disposal By-Law

In January 1999, By-Law S-600 came into effect to support in part, the goals of the 1995 Strategy. The by-law provides the guidelines for the preparation and collection of solid waste, as well as prohibitions, offences and penalties. The by-law further defines which premises' are eligible for collection, and the specific requirements for ICI locations including commercial bin and disposal requirements.

The bylaw also addresses waste disposal fee structure for the HRM waste management facilities, vehicle requirements, and fee payment methods. Since the inception of By-Law S-600, there have been 8 amendments, the last of which took effect in September of 2010.

8.2.7 Curbside Give Away Weekend

To support the 1995 Strategy's focus on reducing the amount of waste generated and promotion of reuse initiatives, Curbside Give Away events are held twice annually. During these events, residents can place re-usable household items at the curb, which can then be taken for free by other residents. Any leftover items are to be removed at the end of the event.

Curbside Give Away Events were first introduced to the public in June of 2010 with success and have since been held twice yearly in the spring and fall.

8.3 CURRENT PERFORMANCE COMPARED TO INDUSTRY BENCHMARKS

8.3.1 Single vs. Two Stream Recycling Collection

The current collection system for recyclables involves two stream sorting in the collection vehicles (paper and cardboard in one compartment, containers in the other). Requiring residents to sort recyclable material into multiple streams can sometime lead to discouragement and act as a disincentive towards participating in the recycling program. “Easy to use” programs such as single stream recycling can often address this issue and result in higher participation and capture rates. Single stream recycling is considered a best practice as it is generally a more efficient collection approach for collection from single family and multi-family households, and is often regarded as an improvement in the level of service by residents. The negative implications of single stream programs are higher processing costs and higher residue levels.

Many of the larger municipalities in Ontario (Toronto, Region of Peel, Region of York) and in the United States (over 40 new programs in 2008) have switched from dual stream systems to single stream systems over the past ten years, as they encourage residential participation and improve capture rates. This was discussed in much greater detail in Section 6.0.

In 2010, the rural Bluewater Recycling Association (BRA) in southwestern Ontario changed from a dual stream blue box system to a single stream automated cart system. With the change to a single-stream, cart based system, the BRA has cut their collection times from 31 hours per week to 14.5 hours per week, and has reported a 17% increase in materials collected. Although the cost to operate and maintain their automated vehicle including the cost of carts is 40.4% more per hour than the traditional manual top loader vehicles, due to the efficiencies saved with switching to a single stream, automated system, the net cost is 34.3% less than the traditional system. In addition to collection cost savings, the BRA has also experienced a 17% increase in capture rates for recyclable materials at the curb.

In August 2011, the City of Timmins moved from a dual stream to single stream automated cart recycling system. Since the move to the new collection system (including an expansion to the recyclable materials list), the City has experienced a 32% increase in recyclable material tonnage and approximately 15% decrease in refuse generation.

8.3.2 Recycling Collection Containers

The concept behind increasing recycling container volume is that increased container capacity provides more space for additional recyclables, therefore reducing the chances that recyclables will be placed in the garbage. HRM has a very mature recycling program in place utilizing a bag system in which blue bags, retail bags and bundles are used to separate materials for collection at the curbside. The performance of the system results in a 15.9% residential curbside diversion rate for recyclables which is low in comparison to other municipalities shown in the table below. However, HRM also does not include boxboard in the collected fibre stream and so the tonnage of boxboard and the impact of the Nova Scotia deposit return program would likely raise HRM's performance to be comparable to other municipalities. HRM also does not collect recyclables from most apartment buildings as this is managed by the ICI sector.

Municipality	Container Type	Residential Recyclables Diverted (2010)[11]
Halton Region	Blue Box Only	23.10%
York Region	Blue Box Only	23.74%
City of Hamilton	Blue/ Clear Bag, Blue Box or Both	20.56%
City of Toronto	Automated Cart Only	19.29%
Peel Region	Blue/ Clear Bag, Blue Box or Both	24.32%
City of London	Blue/ Clear Bag, Blue Box or Both	22.10%
County of Simcoe	Blue Box Only	33.39%
Durham Region	Blue Box Only	21.84%
Waterloo Region	Blue Box Only	20.22%
Niagara Region	Blue/ Clear Bag, Blue Box or Both	19.35%
City of Ottawa	Blue/ Clear Bag, Blue Box or Both	18.89%
Essex-Windsor Solid Waste Authority	Blue Box Only	16.89%
Municipal Average		**21.97%**

A variety of approaches are used to manage recyclable materials at the curb in communities across Canada (shown below).

Container Type	Municipal Program
Blue Bag Only	Edmonton, Charlottetown, HRM, Guelph
Blue/ Clear Bag, Blue Box or Both	Peel, Niagara, Muskoka, London, Hamilton, Ottawa
Blue Box Only	York, Durham, Waterloo, Windsor
Automated Cart Only	Calgary, Toronto, Kelowna

Many municipalities have found that moving to an automated cart recycling program is the most efficient and economical when operating a single stream collection system. There are several municipalities in Canada who operate single-stream cart-based recycling systems including the Cities of Gatineau (and in fact many Quebec jurisdictions), Calgary, and Kelowna. Cart based systems have become a best practice in waste collection as they protect recyclable material from the elements (less snow and water present in the materials sent to the MRF and to market), reduce scavenging of valuable recyclable materials, and increase collection efficiency resulting in long term cost savings.

[11] WDO Datacall. 2010. Residential GAP Diversion Rate by Municipal Groups. http://www.wdo.ca/content/?path=page82+item35931

An automated recycling cart system produces the greatest benefits to municipalities who combine the system with single stream collection. Generally, due to the large volume of materials that recycling carts are able to manage, recycling can be provided on a bi-weekly basis without compromising the diversion rate. Municipalities who operate single stream automated recycling cart collection are able to provide the service bi-weekly in combination with bi-weekly garbage collection and weekly organics collection to provide residents with convenient diversion opportunities and operate an efficient, cost-effective collection system. Guelph in Ontario is currently converting to this program. As a result, the municipalities operating single stream automated cart recycling programs typically have low overall collection costs with high diversion rates. It is generally advisable to allow one year to procure carts including fabrication and delivery, not including the formal tendering process.

8.3.3 Automated Garbage Collection

As discussed above, automated waste collection is considered to be an emerging best practice in waste management where efficiencies can be gained in collection of any wastestream. Automated collection provides better working conditions for vehicle operators and can also be more efficient than manual collection.

In October, 2012, the City of Winnipeg began phasing in the change to automated garbage and recycling cart collection from manual collection. The City offers 2 sizes of garbage carts to residents, 240L, which holds approximately 3 regular sized garbage bags and 360L which holds approximately 5 regular sized garbage bags. Winnipeg provides the carts as part of their waste collection program levy but charge for replacement or upgraded (larger or additional) carts. Although results of the program are yet to be tabulated, Winnipeg expects to improve the current diversion rate of 15% by reducing the amount of waste going to landfill by up to 50%[12].

In 2009 the City of Toronto reported that in one area of the City they will reduce from 22 recycle/organic trucks and 17 garbage trucks to a total of 18 trucks for all wastestreams. Automated collection facilitates the collection of a much larger route than manual collection in the same amount of time e.g. 1000 to 1200 stops compared to around 700 stops for manual collection. There are significant ergonomic and health and safety benefits associated with automated collection including injury prevention (slip and fall), and injury from lifting (e.g. back injury). This combined with the sheer efficiency of automated collection makes it an industry best practice.

The switch to automated collection is fairly new for most municipalities e.g. Toronto, 2009, Bluewater, 2010, Timmins, 2011, Winnipeg, 2012, Guelph 2012 and these programs should be monitored with respect to efficiencies gained, cost and ‘lessons learned’.

[12] Winnipeg News Release. April 2012. http://winnipeg.ca/cao/media/news/nr_2012/nr_20120426.stm#1

8.3.4 Co-Collection of Materials

Co-collection of waste in the same vehicle can offer savings in fleet size and fuel as well as reducing emissions and vehicular traffic (with the associated reduction in wear on roads). Many municipalities are utilizing a co-collection model to achieve efficiencies in collection. Material streams can be collected in a separate vehicle or co-collected, that is, two-streams collected at the same time in the same vehicle. Typically, in co-collection, a truck is divided into two or more compartments to keep the streams separate. This method of collection works best when there is transfer capacity (i.e. material is dumped at a transfer station and transferred to a processing facility when enough material is collected) or when processing/disposal facilities are geographically proximal (usually on the same site) physically located close to each other so trucks do not have to drive long distances half empty.

Some examples of municipalities in Ontario utilizing co-collection are as follows:

- The City of Toronto co-collects organics and either recyclables or garbage on alternate weeks. Toronto uses a cart-based system and single stream recyclables.
- The City of Hamilton co-collects garbage and organics weekly; two-stream recyclables is also collected weekly.
- The Region of Halton co-collects organics and single stream recyclables.
- The Region of York co-collects organics and single stream recyclables.
- The City of Ottawa recently (October 2012) moved to a system where organics and recyclables are co-collected (alternating weeks blue and black box).
- The City of Guelph currently co-collects organics with single stream recyclables and will co-collect both organics with single stream recyclables and garbage with organics (alternating weeks) when their cart system has been fully rolled out.

Each of these municipalities use either transfer stations to transfer various materials or their transfer station with some processing facilities (MRF, composter, landfill) are on the same site. HRM's processing facilities are not geographically located in such a way that co-collection would appear to be able to drive greater efficiencies in its current collection system. Co-collection however becomes a real opportunity for HRM in the context of a Waste Resource Campus with multiple processing facilities located on one site.

8.3.5 User Pay Programs and RFID Technology

HRM currently operates a tax-based system, in which a certain portion of residential and commercial taxes in combination with revenues from tipping fees at Otter Lake, Miller, and New Era are used to fund waste management programs and operations. An alternative regarded by some as a best practice are full user pay programs, in which residents are required to pay by the quantity of garbage they produce. Generally, the jurisdictions that have implemented full user pay programs are smaller urban or rural municipalities that have implemented the systems without a container limit.

The City of Toronto's program operates a user-pay system by choice of cart, that is, the fee is levied as a charge per household based on the size of the garbage cart (range of three cart sizes) chosen by the household rather than on a per bag basis. To improve efficiencies and address some of the challenges faced with user pay programs and/or cart based programs, numerous municipalities are utilizing Radio-frequency identification (RFID) technology to improve their collection systems:

- Positively identifying which residence generated the waste
- Keeping track of their valuable assets (the carts)

As well as other challenges commonly encountered by all waste collection programs:

- Proving that garbage was collected to avoid double collection
- Proving that the truck was on the route at the specified time to avoid sending a truck back for customers who forgot to put out their garbage
- Determining if customers are putting out more garbage than allowed[13]

RFID systems are generally implemented alongside cart-based full user pay programs, where the manufacturers of the carts embed an RFID tag to hold a unique identification number, which is then assigned to a specific household. Collection trucks are generally outfitted with an RFID reader, which reads the information off of each cart as it is emptied. The systems are advantageous in that they do not require a 'line of sight' as a barcode scanner does, and enable collection staff to efficiently record large amounts of information, which can be used to address common collection complaints such as missed collection or refused wastes. The City of Toronto, City of Timmins, City of Winnipeg and City of Guelph are currently using RFID technology to enhance their automated collection systems.

8.3.6 Level of Service

Residents are currently provided with varying levels of service (e.g. bi-weekly vs. weekly recycling) dependent on where they reside within the region. Urban areas are currently provided with a different level of service for recycling collection than rural areas. This is consistent with many municipalities where rural areas are sparsely populated and travel distances are great. During the summer months (July and August) there are currently varying levels of organics service provided, as residents in urban/suburban areas are typically provided with weekly service during these months, while rural residences continue to receive bi-weekly collection, however this service is subject to change every year, as Council chooses which level of service to provide each year.

[13] Impinj Asset Management. Monroe County Cleans Up with RFID: Impinj RFID Technology Enables Automated Waste Recovery.

Some municipalities in Canada have recently began switching their collection systems to provide a uniform level of service to eligible residences in efforts to impact diversion rates through increasing the convenience and accessibility of diversion programs. Particularly where organics programs are in place, weekly collection throughout the year to all residents is the norm for most communities as this allows for maximum diversion of organic material and is generally the most accepted practice by the public as it ensures that potentially odorous material is collected frequently.

For example, in 2008, the Regional Municipality of Halton switched to a uniform level of service for the 4 member municipalities alongside the launch of their green cart program and a move to bi-weekly garbage service. Previously, Halton provided varying levels of service, in which urban areas were provided with weekly garbage collection service, while some rural areas were provided with bi-weekly service. Since Halton has moved to a uniform level of collection service and launched the green cart program alongside a move to bi-weekly garbage collection, the residential diversion rate has increased from 41% in 2006[14] to 60% in 2011[15]. In 2011, Halton reported a 93% overall participation rate in the blue box program and an 80% urban household participation in the organics program and 60% rural participation[16].

In 2012, The County of Simcoe moved to a uniform level of special collections where all residents are now provided with leaf and yard waste collection, Christmas tree collection and a call-in, user pay bulky service. Although the contract term has not yet begun, the County is expected to experience considerable savings in comparison to the previous system where varying levels of service were provided depending on the sub-municipality residents live in, and bulky drop-off vouchers were provided free of charge.

8.3.7 Bag Limits

Bag limits have been found to be an effective tool to increase waste diversion (as long as diversion programs are adequate to support the established bag limits). As the bag limit decreases, it forces residents to either increase their participation in diversion programs or find an alternative means of disposal (i.e. take the material to a drop-of themselves). Implementing a bag limit of less than 3 weekly (or 6 bi-weekly) has become a best practice, and many municipalities have benefitted from such initiatives as waste generation typically decreases and residential diversion increases from this low cost initiative.

HRM currently has a 6 bag limit (5/unit for multi-unit locations), which was reduced from the previous limit of 10 in efforts to increase participation in the curbside diversion program. The current HRM bag limit is higher than other Nova Scotia municipalities. HRM could consider gradually reducing their residential bag limit to a prescribed number of bags per week which could be established using available waste audit data/waste quantities, known current curbside

[14] WDO 2006/2010 GAP by Municipal Grouping. http://www.wdo.ca/content/?path=page82+item35931

[15] Halton Region Spring 2011. WasteLess News.

[16] Halton Region Spring 2011. WasteLess News.

set-out behaviours, and known residential support for varying levels of bag limits (e.g. annual CRA waste surveys). A recent curbside survey undertaken by HRM indicates that over 75% of households put out less than 4 bags of garbage every two weeks.

There are many different approaches that are successfully used by other municipalities including bag limits, bag tags or a combination of both. Many other municipalities have moved to a lower limit, especially with the implementation of organics programs. The City of Hamilton gradually reduced its two-bag limit over a 3 year period to a voluntary one-bag limit to a mandatory one-bag limit in 2010. While the exact effect on diversion for Hamilton has yet to be measured (the next curbside audit has not yet be undertaken), generally, experience indicates that diversion can be increased by an additional 1 to 5% with such initiatives. Most municipalities have implemented a gradual decrease over time. It should be noted that there is a risk of greater contamination in both recycling and organics streams as some residents may overflow garbage (above the bag limit) to those streams and these programs need to be carefully monitored and enforced.

The County of Simcoe implemented a one bag limit and has demonstrated great success in achieving almost 60% residential diversion[1] when residents have access to both an organics and recycling program. Municipalities that have focused on a one-bag (or container) limit may have partial user pay programs in effect (e.g. pay for additional bags) such as Simcoe, or may not have that option, such as Hamilton.

The City of Peterborough, ON has also demonstrated great success in reducing the residential bag limit. The bag limit policy for the City was phased in since 1990. In 1990, residents were limited to six bags of garbage, then four bags in 1991, three bags in 1994 and finally two bags of garbage in 1995, which remains the limit to date. There is no option to place out more bags however residents can take additional garbage to the landfill, where they are charged $5.00 to dispose of waste. Over the period since 1990, the City has steadily lowered its waste generation rate and more than doubled the diversion of waste to 50%.[17]

8.3.8 Leaf and Yard Waste Management

Currently, residential leaf and yard waste (LYW) is collected as part of the Green Cart program with LYW either in or beside the cart where they must be contained in clear/orange plastic bags or kraft paper bags, up to a maximum of 20 bags weighing no more than 55lb each. Residents are directed to arrange branches into armload-sized bundles, and are allowed to dispose of a maximum of 5 bundles bi-weekly. Bundles must not exceed 75lb and can be no larger than 1.2 m long or .2m in diameter.

The current LYW generation rate is in the order of 9,500 TPY for the residential sector. Material is received mixed with organics at either Miller or New Era. In the fall and spring during peak season HRM engages contractors to send out separate additional collection vehicles to manage

[1] 2010 GAP Diversion Summary. Waste Diversion Ontario.

[17] June 2004. Ontario Centre for Municipal Best Practices. Best Practices Summary Report.

increased volumes. This LYW material is delivered to an outdoor windrow composting facility (currently Kel-Ann). As discussed at length in Section 7.0 there is also occasion where the weekly tonnage of organic and LYW material combined exceeds composting facility weekly capacity and in that case those materials are shipped to another separate composting facility (currently Fundy Compost).

Also as discussed in Section 7.0 there are no prescribed ‘best practices’ with respect to the management of LYW in concert with a household organics collection program but typically LYW is collected separately from organics in the larger municipalities because the sheer volume of material warrants separate collection and processing. Some allow ‘top up’ of LYW in Green Bins/Carts and others do not. Hamilton is now endeavoring to remove LYW for separate collection from its Green Bin program and while Ottawa allows the blend of materials they have a put-or-pay contract for minimum tonnage to their facility and current organics tonnage does not meet that minimum without LYW. HRM also has “put or pay” contracts for minimum annual tonnages at Miller and New Era, so would have to review implications of further diversion of separately collected LYW and movement of boxboard to recycling. Guelph is going to allow ‘top up’ of LYW in its new automated cart based system. Again, there are no prescribed ‘best practices’ in this regard with LYW managed on a ‘case by case’ municipal basis.

Some examples of how larger municipalities are dealing with collecting LYW are provided below. Collection costs have been provided where possible.

- The City of Hamilton had been operating a dedicated seasonal bi-weekly LYW collection program from mid-April to the end of July and from the beginning of September to the end of November (providing each household with 13 weeks of collection). Collection costs per tonne range between $133 and $221 depending on the collection zone and service provider.

  The City recently negotiated a new collection contract; effective April 2013, unlimited year round LYW collection will be provided. Part of the rationale for offering this enhanced level of service was to maintain the merchant capacity at the composting facility; allowing separately collected LYW to be processed at the City’s LYW composting facility at a lower cost.

- The City of Ottawa allows LYW in their Green Bin program, however also provides separate LYW collection to residents weekly during peak seasons and bi-weekly for the remainder of the year. In 2009, collection costs for this service ranged from $117 to $184/tonne depending on the collection zone and service provider.

- The City of Toronto collects LYW bi-weekly (on the same week as garbage collection) from mid-March into December.

- The Region of Durham provides seasonal LYW collection, bi-weekly in April, June, July, August and September, and weekly in May, October, November. No collection is provided in January, February or March.

- The Region of York collects yard waste with recycling biweekly from April to November.
- The Region of Peel provides bi-weekly yard waste collection from July to September, weekly collection is provided from April to June and in October and November.

As can be seen from the examples above, there is no standard for collection of LYW; municipalities have developed different schedules to accommodate the volume of LYW generated, the capacity of Green Bins and the capacity of the processing facility. In general, LYW is collected separately as the processing fees are lower than those for SSO.

A benefit of separate leaf and yard waste collection may also be the ability to switch from the larger carts to a smaller Green Bin (e.g. with new residents and container replacements) which could result in cost-savings for HRM. This could also occur in concert with year-round weekly collection of organics.

One best practice in LYW collection that is almost universal among municipalities across Canada is the exclusive use of kraft paper bags for collection. This decreases processing costs associated with the handling of plastics in the composting process. Residents in HRM are permitted to use kraft paper bags but the elimination of the plastics should be considered further.

8.3.9 Expanded Multi-Residential Sector Collection

Increasingly, municipalities have identified that the next frontier in waste diversion is providing the multi-family sector with access to the same waste management and diversion programs as the single family sector. Many municipalities across the country are making efforts to identify innovative methods to increase the convenience of waste diversion programs for this sector. Currently, HRM provides collection service to approximately 8,300 multi-family condominium units within the Region, however a large portion of the multi-family sector (primarily high rise apartment buildings) are required to make arrangement for separate collection through the private sector. As per by-law S-600, all locations, regardless of whether they are serviced municipally or privately are required to place source separation bins at their sites, however since there are no reporting requirements stipulated in the by-law, it is difficult for HRM to track the diversion rates of multi-family homes separately from ICI locations.

If HRM were to increase the current level of collection service to include all multi-family locations, there would be greater opportunity to monitor and control the performance of the diversion programs in this sector. Other municipalities including the City of Vancouver, the City of Toronto, Port Coquitlam, B.C, and York Region have successfully implemented multi-family collection programs and have found that they are able to increase the performance of the diversion programs in this sector through various initiatives such as the provision of containers to each household, increasing ownership of waste (e.g. discontinuing use of garbage chutes), and through on-going promotion and educational materials/activities. Typically, the diversion rate in this sector is 20%, however that would be expected to increase with the implementation of various initiatives mentioned above, and with program maturation (as has been the case with

HRM). This can be achieved through regulatory and reporting requirements, but is more typically associated with financial incentives or disincentives to drive programs.

Best practices[18] for multi-family sector waste collection stipulate that successful programs should consist of the following:

- Create and maintained a database of multi-family properties.
- Establish benchmark performance measures and methods for monitoring of the program on a regular basis.
- Provide adequate collection capacity for all wastestreams, specifically divertible materials.
- Provide P&E materials, tools and program support – engage in out-reach activities including training for stakeholders.

HRM already employs these best practices with existing multi-family curbside collection and condominium property collection programming and would simply extend these practices to the balance of the multi-family sector. Most municipalities focus on the collection of recyclables and organics from this sector and not so much on front-end garbage collection for larger buildings that is left to the private sector.

8.4 OPPORTUNITIES FOR IMPROVEMENT

8.4.1 Impact of Decisions Regarding Campus Concept and Recyclables Processing

Clear direction as to whether HRM will maintain a de-centralized infrastructure model, or transition to a campus concept is required before collection contracts can be re-organized. The following sections describe several potential contract changes including modifications to collection zones and collection frequency. Other initiatives such as partnering with neighbouring waste regions also have the potential to impact collection contracts especially in the rural areas.

It may be many years before all program and infrastructure issues are resolved and a completely revised and optimized collection program can be implemented. It is not unusual that a period of 5-10 years is required to fully implement a revised collection strategy.

Another factor which will impact the collection program is the decision to either maintain a two stream recyclables program, or convert to single stream processing and collection. There is no urgency to reach a quick decision as the existing two stream MRF will remain operational until 2019. However, a decision by 2015 is required to appropriately plan for the new facility.

8.4.2 Contract Timing and Duration

Stantec understands that HRM has successfully extended the eight collection contracts until 2014. This will enable some minor modifications to be made prior to retendering. Ideally,

[18] Continuous Improvement Fund. Guidelines for Implementing Best Practices in Municipal Multi-residential Recycling Programs. November 2009.

collection tenders are advertised at least one year prior to contract commencement date. This is intended to provide sufficient time for bid evaluation and award, and lead time for new truck delivery. Depending on economic conditions, six months is not an unusual delivery schedule.

An ideal scenario would include resolution of all infrastructure and program issues, in all zones, all at a particular time. That is unlikely. The reality is that certain infrastructure elements will come on line earlier than others. HRM should not attempt to force contract alignment earlier than a reasonable infrastructure plan permits. Re-zoning collection to 4-6 areas from the current 8 areas is also likely advantageous, but again re-zoning will be contingent on other decisions. Finally, the optimum term for a collection contract is often considered to be the expected life of the collection vehicles. Modern vehicles operate with low maintenance for at least 7 years. Therefore, a longer contract term requiring all bidders to purchase new vehicles will better utilize the purchased fleet.

All 8 collection zones are now bid at the same time. It is completely acceptable to bid individual zones if certain unknowns are resolved. The long term goal would be to re-align the tender dates, but this can be done as part of a long term strategy.

8.4.3 Short Term Collection Program Changes

Stantec recommends the following three collection program changes in the short term:

- Remove white goods from garbage collection and implement segregated collection
- Ban all plastic bags from the yard waste and organics collection program
- Remove clean boxboard from organics wastestream and add to recyclables.

Detailed reasons for these changes are provided in previous sections. Briefly, these changes are proposed to provide a cleaner feedstock (ban plastics bags), recognize product value (boxboard), and avoid double handling of appliances. Stantec does not recommend a particular date for these changes except that all should be implemented by June 30, 2014 when the next set of collection contracts become effective.

8.4.4 Collection Zones

Stantec recommends that HRM consider reducing the number of collection zones, but only after outstanding program and infrastructure decisions are resolved. Determining appropriate bidding zones is based on several factors including maintaining competition in the marketplace and geographic constraints. Stantec suggests that a total of 4-6 zones would be satisfactory with 2-3 zones in urban areas and 2-3 zones in rural areas. This still maintains a healthy industry (more than one potential winning bidder) while reducing the administrative burden on HRM staff.

A subsequent section of this report describing partnership opportunities in Nova Scotia highlights the potential for drop-off arrangements with neighbouring waste regions. For example, if an outlying area of HRM can have materials collected delivered to an adjacent region, greatly reducing travel distances, then considerable savings should follow and such opportunities should be explored in areas most remote from the Dartmouth/Halifax drop-off locations.

8.4.5 Frequency of Collection

The current collection program strategy of more frequent collection in urban areas is consistent with similar regions with an urban/rural mix. Stantec suggests that this cost containment strategy remain in effect for future contracts.

Stantec does however recommend that urban areas receive weekly organics and recyclables collection throughout the year with a maintained bi- weekly garbage collection cycle. Best practice in this regard is to have recyclables and organics collection at least as frequently as the garbage stream. While HRM collects organics and recycling on an ‘as frequent’ basis as garbage, the requirement to store divertable materials (especially organics) for more than one week is still a disincentive to participation, and affects recovery. Space constraints often drive resident behavior with respect to which container to place an object. The tendency is to disposal of materials in the stream that will get collected sooner which for HRM means that some organics and recyclables (based on capture rates previously discussed) are likely included in the garbage stream the week the garbage stream is collected.

While weekly collection of all wastestreams is very convenient the reality is that once organics and recyclables are properly diverted the amount of waste requiring collection is greatly diminished. Weekly collection of garbage at that point can be thought of as a high level of service. Numerous jurisdictions, with the implementation of their organics collection programs have shifted to bi-weekly collection of garbage as an appropriate level of service, as a means to drive diversion and to provide cost-effective curbside collection. While best practice for organics collection is weekly, recyclable materials can still be collected on a bi-weekly basis e.g. alternating with bi-weekly garbage because in this scenario collection of recyclables and garbage is on an as-frequent basis. This is particularly easy to accommodate with single-stream recyclables collection.

8.5 CONCLUSIONS AND RECOMMENDATIONS

8.5.1 Conclusions

Based on the review of HRM collections programming the following broad conclusions can be made:

- That there are opportunities to realize further efficiencies in HRM’s collection system through various mechanisms including but not limited to collection re-zoning, automated collection and single-stream recycling.

- There are potential opportunities for even further efficiencies e.g. co-collection with a new campus with centralized waste processing infrastructure.

- There are opportunities to drive greater diversion through more frequent collection of organics, decreased bag limits or clear garbage bags, and expanded multi-family sector collection.

8.5.2 Recommendations

- The next collection RFP should request pricing for separate LYW collection (either materials set beside the Green Cart and seasonal peak material or all LYW). An audit of these materials to determine quantities should be undertaken – 2013.
- Plastic bags should be eliminated from the LYW collection and processing system.
- Separate white goods collection pricing should be sought and collection program implemented.
- More detailed collection modeling could be undertaken to assess the benefits of automated versus manual collection, separate collection of LYW, single stream versus dual stream collection.
- Modeling should also be undertaken to determine collection area re-zoning once long term processing facility location(s) are determined.
- The next collection RFP should reflect the collection of boxboard in the recyclables stream not the organics stream as discussed in both Section 6.0 and 7.0.
- Future collection contracts should be seven (7) years in length – considered to be a typical life for a curbside collection vehicle and optimum contract term.

9.0 Review of Energy From Waste Opportunities

9.1 BACKGROUND

Currently, HRM has no Energy from Waste (EFW) system in place. The 1995 Strategy did not include EFW as a component of the overall plan. Many EFW technologies, including gasification and pyrolysis, were in the early stages of development when the 1995 Strategy was developed and therefore, were not considered in the analysis. With EFW technologies becoming more widespread, it would be reasonable to reconsider whether EFW technology is a viable alternative for HRM in the future.

EFW technology can be categorized into combustion (incineration), gasification, pyrolysis and plasma arc gasification. Within each category there are many different subtypes, each at varying levels of development. Industry analyses will focus on Canada-based facilities whenever possible though some commercialized technologies can only be found elsewhere.

It should be cautioned that this review was not exhaustive, and that some subtle changes may have occurred since this information was gathered. This review is not intended to be a definitive opinion and analysis, but rather an overview on which a recommendation can be made as to whether Energy-from-Waste should be made a strategic short term priority for HRM.

9.2 COMBUSTION

9.2.1 Background

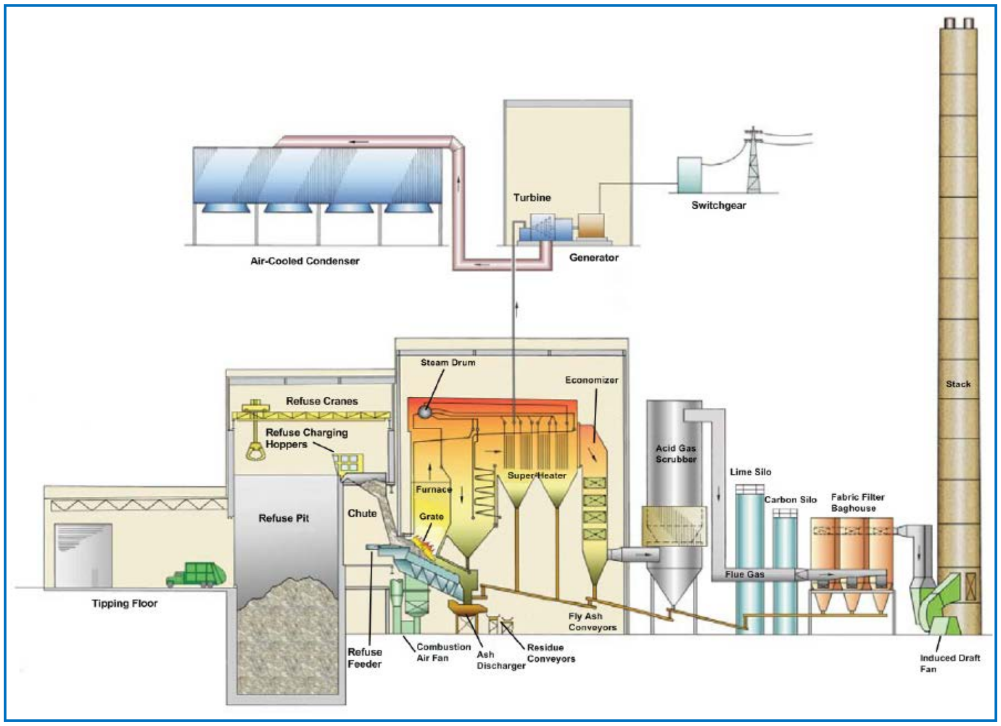
Conventional combustion is a well-established technology developed over 100 years ago for energy generation from municipal solid waste (MSW). The first attempts to dispose of solid waste using a furnace are thought to have taken place in England in the 1870s. Since that time, vast technological improvements have been made making conventional combustion the most common Energy from Waste technology currently being used to treat MSW.

The most conventional combustion approach is called single-stage combustion or mass burn incineration (sometimes referred to as grate-fired technology). Over 90% of EFW facilities in Europe utilize mass burn incineration technology with the largest facility treating approximately 750,000 TPY[19].

The following paragraphs discuss the mass burn combustion process. The following figure provides a conceptual overview of a modern single-stage EFW facility[20].

19 Malkow, T. (2004). Novel and innovative pyrolysis and gasification technologies for energy efficient and environmentally sound MSW disposal. Waste Management, 53-79.

20 Stantec Consulting Limited. (2009). Durham/York Residual Waste Study Environmental Assessment. Edmonton: Stantec.

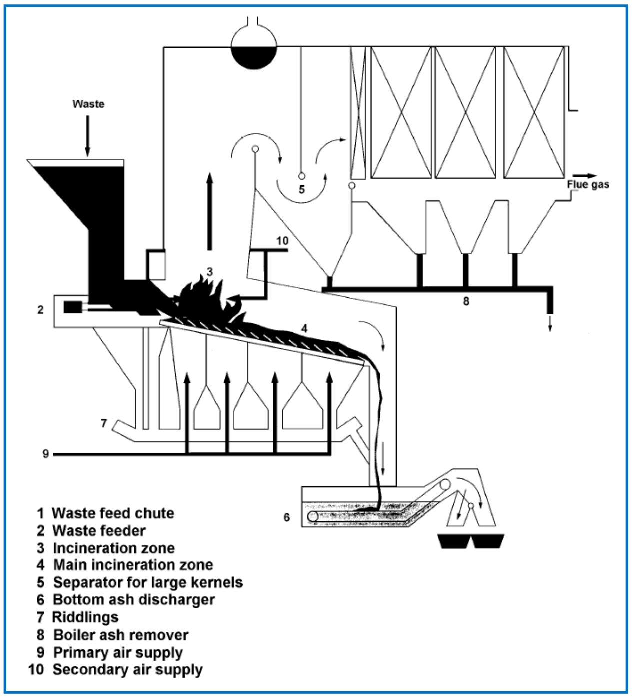


At a mass burn facility, minimal pre-processing of MSW is required. Normally, trucks carrying refuse enter a building where they discharge their waste into a pit or bunker. From the pit, the waste is transferred into a hopper by an overhead crane. The crane is also used to remove large and non-combustible materials from the wastestream. The crane transfers the waste into a waste feed hopper which feeds the waste onto a moving grate where combustion begins.

Several stages of combustion occur in mass burn incinerators. The first step reduces the water content of the waste in preparation for burning (drying and degassing). The next step involves primary burning which oxidizes the more readily combustible material while the subsequent burning step oxidizes the fixed carbon. In single-stage combustion, waste is burned in substoichiometric conditions, where sufficient oxygen is not available for complete combustion.

The oxygen available is approximately 30 to 80% of the required amount for complete combustion which results in the formation of pyrolysis gases. These gases are combined with excess air and combusted in the upper portions of the combustion chamber which allows complete oxidation to occur. The following diagram shows an example of an inclined grate incinerator with a heat recovery boiler[21].

21 German Federal Environment Agency. (2001). Draft of a German Report for the creation of a BREF-document "waste incineration". Umweltbundesamt.



Mass burn technology applications provide long residence times on the grate(s) which in turn results in good ash quality (i.e., less non-combusted carbon). Newer facilities have greatly improved energy efficiency and usually recover and export energy as steam and/or electricity. Typical mass burn facilities have energy recovery efficiencies of 14% to 27% (assuming that the energy from combustion is being converted into electricity)[22]. Higher energy recovery efficiencies are achieved through the recovery of heat either in conjunction with or in lieu of electricity.

Mass burn facilities can be scaled in capacity anywhere from approximately 36,500 to 365,000 TPY per operating unit[23]. These facilities generally consist of multiple modules of furnaces and can be expanded through addition of more units and supporting ancillary infrastructure as required. Generally it is preferred to design such facilities with multiple units allowing for individual modules to be shut down for maintenance or if there is inadequate feedstock[24]. Multiple modules can often be accommodated on a single site with some sharing of infrastructure (e.g., share tip floor, ash management areas, stack).

The capacity of a mass burn incinerator is dependent upon the calorific value of the waste being treated. In Europe, the normal maximum size of a facility is 280,000 TPY, assuming that the waste has a calorific value of 11 MJ/kg. That said, over recent years, the trend in Europe has

22 AECOM Canada Ltd. (2009). Management of Municipal Solid Waste in Metro Vancouver - A Comparative Analysis of Options for Management of Waste After Recycling. Burnaby.

23 GENIVAR Ontario Inc. in association with Ramboll Danmark A/S. (2007). Municipal Solid Waste Treatment in Canada.

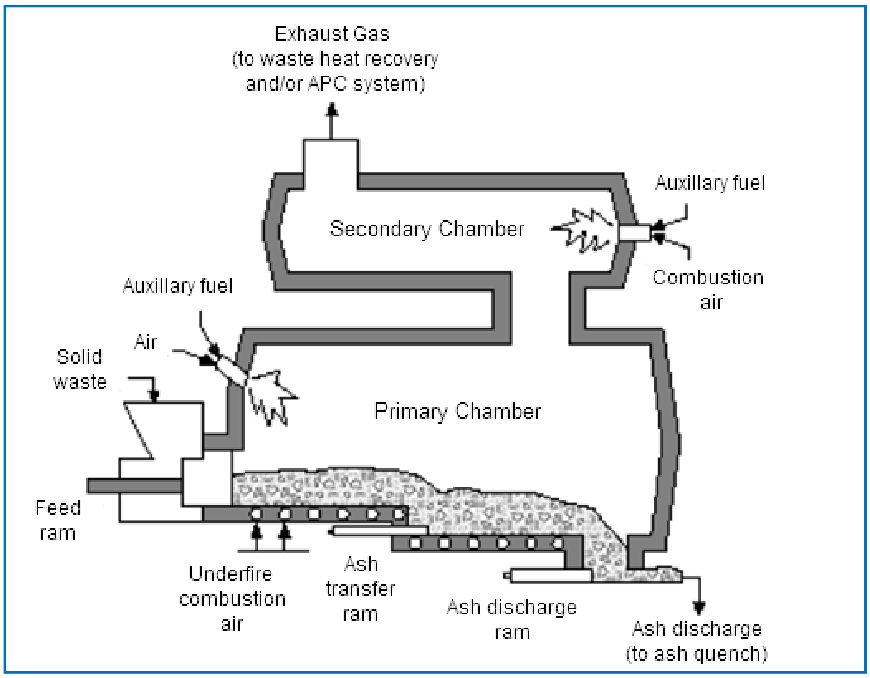
24 AECOM Canada Ltd. (2009). Management of Municipal Solid Waste in Metro Vancouver - A Comparative Analysis of Options for Management of Waste After Recycling. Burnaby.

been to build slightly larger facilities. Two other conventional combustion approaches are used to manage MSW, but are less common. These two other conventional approaches are modular, two stage combustion and fluidized bed combustion.

Modular, Two Stage Combustion

In modular, two-stage combustion, waste fuel is combusted in a controlled starved air environment in the first chamber. Off-gases are moved into a second chamber where they are combusted in an oxygen rich environment. The heat generated in the second stage is fed into a heat recovery boiler. Ash is generated in the first stage and is managed in a similar manner as that from moving-grate systems (mass burn incineration).

The following figure provides a schematic overview of a two-stage incinerator[25]. It should be noted that two-stage incinerators are sometimes referred to as a type of gasification technology. However, they are not true gasifiers and are therefore normally classified as a conventional combustion technology.

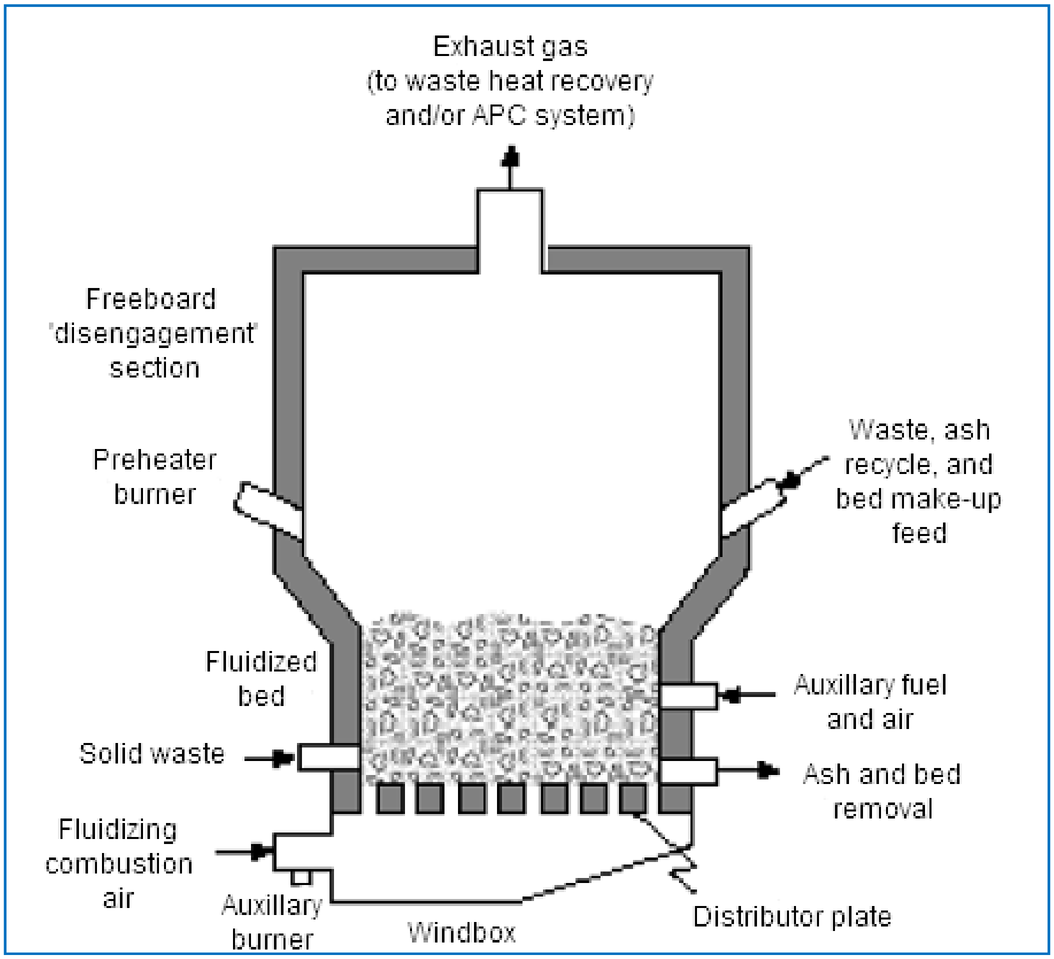


[25] A.J. Chandler and Associates Ltd. (2007). Review of Dioxins and Furans from Incineration in Support of a Canada-wide Standard Review. Ottawa.

Fluidized Bed Combustion

In fluidized bed combustion waste fuel is shredded, sorted and metals are separated in order to generate a more homogenous solid fuel. This fuel is then fed into a combustion chamber, in which there is a bed of inert material (usually sand) on a grate or distribution plate. The inert material is maintained in a fluid condition by air blowing upwards through it. Waste fuel is fed into or above the bed through ports located on the combustion chamber wall.

Drying and combustion of the fuel takes place within the fluidized bed, while combustion gases are retained in a combustion zone above the bed (the freeboard). The heat from combustion is recovered by devices located either in the bed or at the point at which combustion gases exit the chamber (or a combination of both). Surplus ash is removed at the bottom of the chamber and is generally managed in a similar fashion as bottom ash from a moving grate system (mass burn incineration). The following provides a schematic overview of a fluidized bed incinerator[26].



[26] A.J. Chandler and Associates Ltd. (2007). Review of Dioxins and Furans from Incineration in Support of a Canada-wide Standard Review. Ottawa.

Both two-stage combustion and fluidized bed combustion approaches can be used to manage MSW, however, for fluidized bed applications the waste must be processed into a more homogenous feed. Both processes generally are more complex than single-stage mass burn incineration. For that reason, generally when considering conventional combustion systems in planning processes, single stage combustion systems are usually assumed.

Of the approximately 450 EFW facilities in Europe, 30 of them utilize fluidized bed technology. Most of these use a feed stock mixture of MSW, sewage sludge, industrial waste, pre-sorted organic waste, Refuse Derived Fuel (RDF) or woodchips. Very few facilities are using only MSW as feed stock because of the availability of supplemental fuels. One of the disadvantages of the fluidized bed systems is that a larger portion of fly ash is generated by the fluidized bed process (6% compared to 2% for mass burn systems) due to the particulate present in the fluidized bed itself[27].

Batch Combustion

In addition to mass burn, two stage and fluidized bed incineration, there are other incinerators referred to as batch waste incinerators that are capable of treating a variety of wastes including MSW. Batch waste incinerators are those that operate in a non-continuous manner (i.e., they are charged with waste prior to the initiation of the burn cycle, and the door remains closed until the ash has cooled inside the primary chamber). Batch waste incinerators tend to treat smaller amounts of waste than other conventional approaches (they are usually sized between 50 and 3,000 kg per batch) and are typically utilized in remote locations where landfill alternatives and/or wildlife concerns associated with landfills are present.

Batch waste incinerators normally utilize dual chamber controlled air technology (comparable to two stage combustion but more simple). In batch incinerators, waste (which is normally pre-mixed) is charged into the primary chamber by the operator. The initial heat required to ignite the waste is supplied by a burner which shuts off once combustion becomes self-sustaining. Controlled amounts of underfire air are introduced through holes in the primary chamber and as combustion gases are created they move to the secondary chamber where combustion is completed with the air of additional over-fire air or a secondary burner.

Batch waste incinerators do not typically utilize heat recovery or air pollution control equipment but are still capable of meeting stringent emissions limits (e.g., Ontario Guideline A-7) if they are designed and operated in a proper manner[28].

The table below provides a summary of conventional combustion processes, costs, scalability and reliability.

[27] Stantec. (2010). Region of Bonnyville - Service Level Review Technical Memo - Thermal Treatment Technolgies Review. Burlington: Stantec Consulting.

[28] Environment Canada. (2010). Technical Document for Batch Waste Incineration.

Conventional Combustion Summary	
Traditional mass burn incineration is a well-established technology developed over 100 years ago for energy generation from municipal solid waste.	
There are hundreds of plants in operation, including approximately 450 in Europe (420 mass burn, 30 fluidized bed), 87 in the United States and over 400 in Asia. There are seven conventional combustion facilities in Canada.	
Conventional combustion facilities have reasonably good energy efficiency (up to 30% for electricity only and 60% or more for combined heat and power or just heat recovery systems) and usually export their energy as either steam and/or electricity.	
The largest facility in Canada is a mass burn facility, processing approximately 300,000 TPY of waste. (Quebec City). There are several mass burn facilities in Europe that treat over 300,000 TPY.	
At least 20 companies offer mass burn incineration technology or components of this technology, or services to develop such facilities in North America and elsewhere. There are four primary suppliers of the combustion (grate) systems active in the EU and North America.	
Other Summary Points	
Median Reported Capital Cost	▪ $775/annual design tonne +/- 50% (2009$ CDN)
Median Reported Operating Cost	▪ $65/tonne +/- 30% (2009$ CDN)
Feedstock	▪ MSW, biomass ▪ Minimal waste preparation/pre-processing required by technology ▪ Designed to process variable wastestreams
Residual to Disposal	▪ 5% (by weight) if the majority of bottom ash can be marketed for other applications ▪ Up to 20 to 25% by weight if there is no market for recovered materials from the ash (0.2 to 0.25 tonnes per input tonne) ▪ Landfill capacity consumption reduced by 90 to 95%
Potential Energy and Revenue Streams	▪ Revenue potential for: electricity, heat (steam and/or hot water), recovered recyclable metals, construction aggregate ▪ Electricity production, 0.5 to 0.6 MWh/annual tonne of MSW for older facilities ▪ Electricity production rates of between 0.75 to 0.85 MWh/annual tonne for newer facilities

Conventional Combustion Summary	
Scalability	▪ Various sizes of mass burn units; use of multiple units also possible
Reliability	▪ Numerous facilities operating worldwide with proven operational success. ▪ Less complex than other WTE approaches ▪ Scheduled and unscheduled downtime reported as <10%.

9.2.2 Benchmark Analysis

In Canada there are currently seven operational conventional combustion incinerators that treat MSW at capacities greater than 25 tpd. These seven facilities are located in British Columbia (1), Alberta (1), Ontario (1), Quebec, (3), and PEI (1). Of these seven facilities, two are larger mass burn incinerators (L'incinérateur de la Ville de Québec, Quebec and Greater Vancouver Regional District Waste to Energy Facility, British Columbia), one is a smaller mass burn incinerator (MRC des Iles de la Madelaine, Quebec), two are defined as two-stage starved air modular incinerators (PEI Energy Systems EFW Facility, PEI and Algonquin Power Peel Energy-From–Waste Facility, Ontario), and one is defined as a three-stage incinerator (Wainwright Energy from Waste Facility, Alberta). Neither L'incinérateur de la Ville de Québec nor MRC des Iles de la Madelaine have any sort of energy recovery from their combustion processes and therefore will not be discussed.

Metro Vancouver Waste to Energy Facility

The Waste-to-Energy Facility is located in south Burnaby, British Columbia and was opened in 1988. Waste is received from Burnaby, New Westminster, and the North Shore and processed at the facility, which is accountable for safely disposing of >25% of the Region's waste through incineration. On an annual basis, the Waste-to-Energy Facility converts 285,000 tonnes of garbage into steam and electricity. The steam produced is sold to a paper recycling facility, while the power is sold to BC Hydro. In a typical day the facility is capable of producing 2,740 tonnes of steam to supply a turbo generator, where 600 tonnes is extracted and sold to the paper recycling facility; 400 megawatt-hours of electricity used to power 15,000 homes; 130 tonnes of bottom ash used in road building and landfill cover; 25 tonnes of metal, which is recycled into reinforcing steel; and 30 tonnes of fly ash that must be landfilled[29].

L'incinérateur de la Ville de Québec

Located in Limoilou, Quebec, this incineration facility has been in operation since 1974. The incinerator receives garbage from residential, institutional, commercial and industrial areas of Quebec City and its surrounding municipalities. Annually, the facility can process up to 312,000

[29] Metro Vancouver. (2011, August 1). *Waste-to-Energy Facility.* Retrieved October 9, 2012, from Metro Vancouver: http://www.metrovancouver.org/about/publications/Publications/WasteEnergyFactsheet.pdf

tonnes of waste. Heat produced from the incineration is partially used for drying sludge, which is also processed by the incinerator. The remaining heat is converted into steam and is then sold. Approximately 810,000 tonnes of steam are produced annually. Treatment of the smoke produced results in 11,000 tonnes of solid waste per year while the sludge incineration results in 3,000 tonnes of ash annually that is landfilled[30].

Algonquin Power Peel Energy-From-Waste Facility

Operating since 1992, the Algonquin Power Peel EFW Facility in Brampton, Ontario processes approximately 174,000 tonnes of solid waste annually. 160,000 tonnes is residential waste while the remainder is made up of international airport waste and industrial, commercial and institutional waste. Up to 9 MW of electricity can be produced using a steam turbine[31]. Annually, approximately 40,000 tonnes of bottom ash is produced while fly ash and Air Pollution Control (APC) residue can account for roughly 6,000 tonnes[32].

PEI Energy Systems EFW Facility

Charlottetown's energy-from-waste facility processes approximately 26,000 tonnes of waste each year to produce 58,000 tonnes of steam. The steam that is generated is used in Charlottetown's district heating system. Roughly 12,000 tonnes of bottom ash is produced annually is landfilled. 680 tonnes of fly ash and APC residue is also produced and disposed as hazardous waste. Heat is recovered in the facility using an ABCO heat recovery steam generator, producing 400psig saturated steam and hot water. Air pollution is controlled by employing a spray humidifier, dry lime injection, powdered activated carbon addition and a fabric filter.

Wainwright EFW Facility

Located in Wainwright, Alberta and operated by GM Pearson Biomedical Waste, the Wainwright EFW facility has been operating since 1994. It processes about 4,500 tonnes annually, 72% of which is medical waste. This waste is converted into roughly 49,000 tonnes of steam and is sold to Bunge Canada. The Wainwright EFW facility employs a basic model 1500 pulse hearth for heat recovery and uses a 3-stage starved air modular system for thermal treatment. Air pollution control is performed using dry lime injection, powdered activated carbon addition and fabric filtration.

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[30] Ville de Quebec. (2012). *Ordures ménagères - Incinérateur.* Retrieved October 9, 2012, from Ville de Quebec: http://www.ville.quebec.qc.ca/environnement/matieres_residuelles/ordures_menageres/incinerateur.aspx

[31] Dodds, B. (2005, June 8). *Energy from Waste Facility.* Retrieved October 9, 2012, from County of Simcoe: http://gilford.county.simcoe.on.ca/ClearFrame/Production/eGenda/eGenda.nsf/0/cb954d8a3061e417852570110066f46a/$FILE/Algonquin%20EFW%20presentation.pdf

[32] Environment Canada. (2010, April 6). *MSW Thermal Treatment in Canada 2006*. Retrieved October 9, 2012, from Environment Canada: http://www.ec.gc.ca/gdd-mw/default.asp?lang=En&n=D54033E4-1&offset=5&toc=show

There are also several mass burn incineration facilities currently in the planning or development stages, one by the Region of Durham in Ontario. Recently, ground has been broken for the Durham York Energy Centre (DYEC) and the facility is now in the development stages. The mass burn incineration facility will be sized initially to treat 140,000 TPY (436 tpd), however the facility design will allow for future expansion up to 400,000 TPY (1290 tpd). The vendor supplying the technology for this facility is Covanta. While at operating capacity, it is expected that the electricity sold to the grid will be sufficient enough to power 10,000 homes.

Energy production via combustion or incineration is much more widespread in Europe. A recent projection developed by the European Confederation of Waste to Energy Plants estimates that over 550 plants with a combined capacity of 80 million TPY will be in operation by 2016.

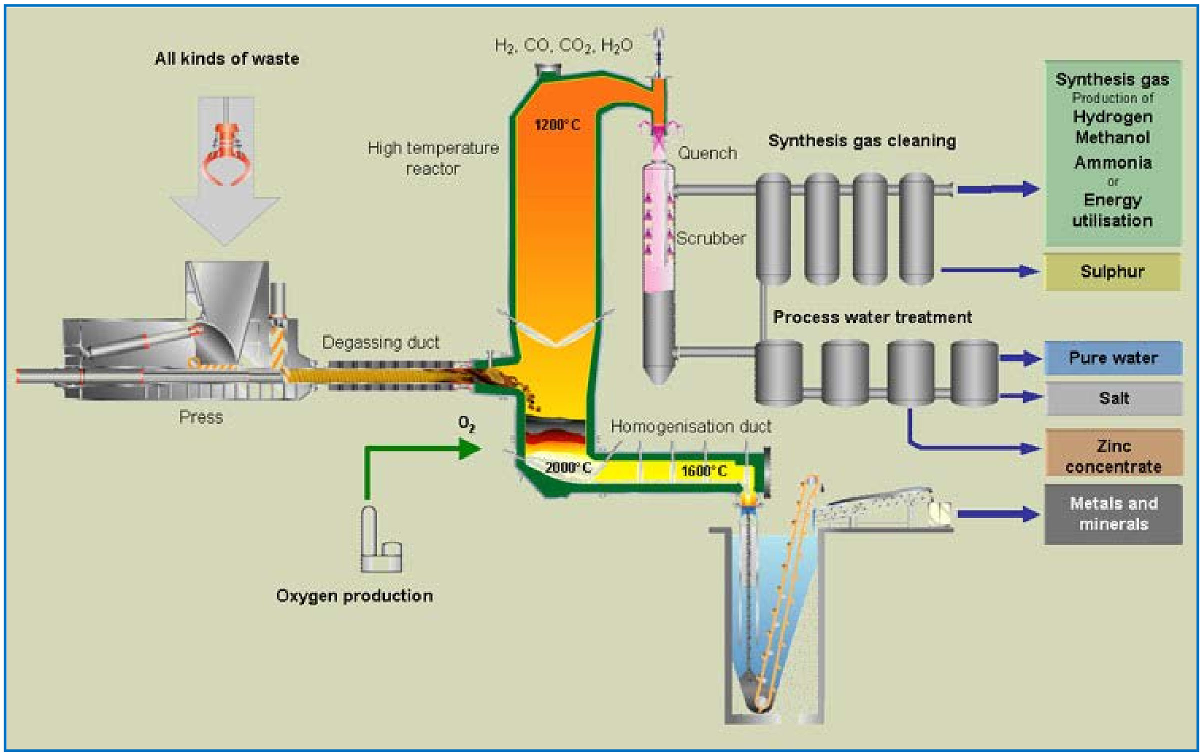
9.3 GASIFICATION

9.3.1 Background

Gasification is the heating of organic waste (MSW) to produce a burnable gas (syngas) which is composed of a mix of primarily H_2 and CO along with smaller amounts of CH_4, N_2, H_2O and CO_2. The syngas produced can then be used off-site or on-site in a second thermal combustion stage to generate heat and/or electricity. Gasifiers are primarily designed to produce usable syngas.

There are three primary types of gasification technologies that can be used to treat waste materials, namely fixed bed, fluidized bed and high temperature gasification. Of the three types of gasification technologies, the high temperature method is the most widely employed on a commercial scale. The waste passes through a degassing duct in which the waste is heated to reduce the water content of the waste (drying and degassing) and is then fed into a gasification chamber/reactor where it is heated under suitable conditions to convert the solid fuel to syngas. Oxygen is injected into the reactor so that temperatures of over 2,000°C are reached. The amount of oxygen required is just enough to maintain the heat that is necessary for the process to proceed. The high temperature causes organic material in the MSW to dissociate into syngas. The syngas is processed to remove water vapour and other trace contaminants, so that it can be used for power generation, heating or as a chemical feedstock.

The Thermoselect technology (which is licensed to JFE Environmental Solutions Corp. of Japan and Interstate Waste Solutions in the United States) is one gasification technology used to treat MSW. As of 2009, there were six plants operating in Japan which utilize the Thermoselect technology to treat MSW[33]. The following figure provides a conceptual overview of a high temperature waste gasification process used to treat MSW, based on the Thermoselect process[34].

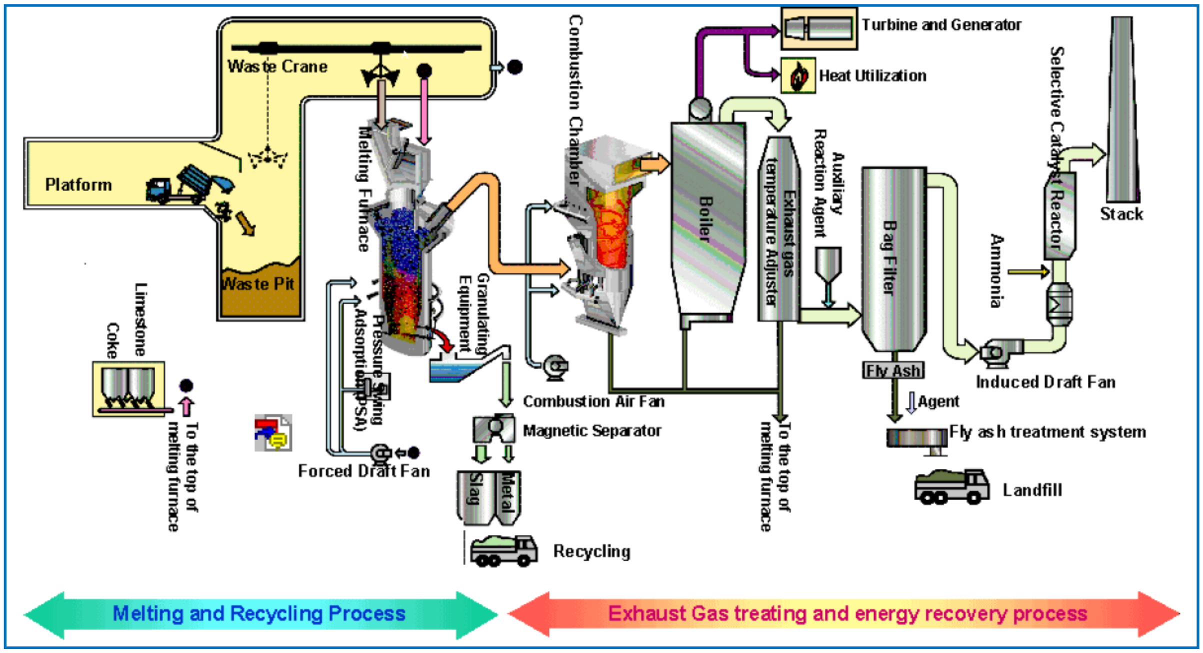


Nippon Steel employs a high temperature gasification, which they call a “Direct Melting System” (DMS). The process produces a syngas that is combusted in a steam boiler, driving a steam turbine to produce electricity. The heating process begins by feeding waste into a gasification chamber/reactor. The high temperature causes organic material in the MSW to dissociate into syngas. The syngas is transferred to a combustion chamber which heats a boiler that in turn powers a turbine and produces electricity. The flue gas produced via combustion is then cleaned using a bag filter and an SCR (to reduce NOx) before it is released into the atmosphere. The Air Pollution Control system is similar to that used for conventional combustion with the exception that no provisions for the control of acid gases have been identified in the information that is available. The ash management system is also similar to that

[33] University of California. (2009). Evaluation of Emissions from Thermal Conversion Technologies Processing Municipal Solid Waste and Biomass. Riverside: University of California.

[34] Thermoselect. (2003). Thermoselect - High Temperature Recycling. Retrieved February 3, 2010, from Thermoselect: http://www.thermoselect.com/index.cfm?fuseaction=Verfahrensuebersicht&m=2

required for conventional combustion. This system does have similarities to modular, two-stage combustion. The diagram below provides a conceptual overview of the high temperature waste gasification process employed by Nippon Steel[35].



Ramboll recently visited a gasification facility in China supplied by Kawasaki Steel Thermoselect System (now JFE Engineering after the fusion of Kawasaki, Nippon Steel and JFE). The plant has been in operation since 2000 and was designed with two lines, 2x15 t/h (actual capacity 250-260 tpd or between 159,000 TPY and 171,000 TPY based on actual plant availability). The APC system includes the cleaning of syngas by water and catalyst before usage at the steel work. Waste received is made up of 50% industrial waste and 50% pre-sorted plastic. The facility used MSW feedstock for the first six months, and now uses only more homogenous separated industrial waste and plastic as noted earlier. The facility appears to consume more energy than it produces, with a net energy output of approximately -3%. JFE indicated in the site tour that they did not intend to build any further gasifiers with the Thermoselect technology in Japan.

Outside of Japan, gasification is only used at a few facilities to treat MSW. This is primarily due to operational issues that arise due to the heterogeneous nature of MSW as the gasification process generally requires a fairly homogenous feedstock. In addition, gasification tends to have a much higher range of operating and capital costs in comparison with conventional combustion facilities, given the requirement for waste pre-processing and the added complexity

[35] Dvirka and Bartilucci Consulting Engineers. (2007). Waste Conversion Technolgies: Emergence of a New Option or the Same Old Story? *Federation of New York Solid Waste Associations Solid Waste and Recycling Conference.*

of the technology. Gasification also tends to have higher net costs, given that generally less energy (and thus less revenue) is recovered from the wastestream[36].

Gasification facilities require APC systems to reduce unwanted emissions to air, although the APC approach will vary based on how the syngas is processed as discussed below. Gasification systems and mass burn systems are not directly comparable as the point in the process where combustion takes place differs, as does the APC approach. Although, gasification systems generally appear to have (or report to have) somewhat lower stack emissions than mass burn EFW plants, these results are based testing from pilot-scale facilities, not actual commercial-scale operations[37].

There are two key differences between APC systems for gasification systems and conventional mass burn combustion: first, some gasification approaches focus on cleaning of the syngas prior to combustion, so that emissions control is based on the control of syngas quality; second, based on the composition of the syngas, it may be directly combusted and have some form of more conventional APC system, however these systems may be sized smaller and/or may not require certain APC components that would normally be necessary for a conventional approach.

The table below provides a summary of gasification processes, costs, scalability and reliability. It should be noted that the available costing information for gasification technologies is generally provided through informal processes and not on the basis of any contractual commitments to the parties involved. Therefore, it is not clear that reported capital costs address all capital and construction cost elements, nor is it clear that reported operating costs address all real costs associated with such facilities. The cost for each facility will vary on a site-by-site basis.

Gasification Summary	
Gasification combusts fuel to create syngas.	
The technology has been in use for over a century, but only recently has MSW been used as a feedstock.	
At least 42 companies offer gasification technologies or components of this technology that are capable (or claim to be capable) of treating mixed MSW in North America and elsewhere.	
The earliest example of this technology being used for MSW was in 1991 in Taiwan.	
Other Summary Points	
Median Reported Capital Cost	▪ $850/annual design tonne +/- 40% (2009$ CDN)

[36] Fichtner Consulting Engineers. (2004). The Viability of Advanced Thermal Treatment of MSW in the UK. London: ESTET.

[37] RPS-MCOS Ltd. (2005). *Feasibility Study of Thermal Waste Treatment/Recovery Options in the Limerick/Clare/Kerry Region.*

Gasification Summary	
Median Reported Operating Cost	▪ $65/tonne +/- 45% (2009$ CDN) (this reported cost by vendors seems well below the range of expected operating costs based on performance of gasification in the EU and Japan)
Feedstock	▪ Automobile shredder residue (ASR), biomass, black liquor, coal, hospital waste, MSW, organic wastestreams, plastics, PVC, refinery residues, sludge, tires ▪ Waste preparation/pre-processing required by technology ▪ Difficulties in accepting variable (heterogeneous) wastestreams
Residual to Disposal	▪ <1 % if bottom ash can be marketed for other applications ▪ 10 to 20% if it is not marketable (0.1 to 0.2 tonnes of residue per 1 tonne of input waste) ▪ Landfill capacity consumption reduced by 90 to 95%
Potential Energy and Revenue Streams	▪ Revenue potential for: electricity, syngas, aggregate recovered from ash ▪ Electricity production, 0.4 to 0.8 MWh/annual tonne of MSW
Scalability	▪ Usually built with a fixed capacity; modular ▪ Individual modules range in size from approximately 40,000 to 100,000 TPY
Reliability	▪ At least seven plants in operation in Japan at a large scale with over two years of operating experience ▪ Limited data available in other jurisdictions to assess operational success with MSW feedstock in regards to technical reliability ▪ Complex operation ▪ Scheduled and unscheduled downtime reported as approximately 20%, However other reports indicate potential for up to 45% downtime.

9.3.2 Benchmark Analysis

Over 42 companies currently offer gasification technologies or technology components that are capable of treating mixed MSW in North America and elsewhere. The earliest example of this technology was in 1991 in Taiwan.

Japan

There are several (6-7) new gasification facilities operating at a commercial scale in Japan which have been constructed within the past 10 years. The use of gasification in Japan is partially driven by the regulatory environment which favours high temperature treatment (slagging) of the bottom ash/char due to the presence of low levels of dioxins. The Japanese regulatory approach is somewhat different from other jurisdictions as it regulates net dioxin emissions to the environment from all sources (air, waste water, ash). Such an approach has not been applied in other jurisdictions for EFW (e.g., the EU) as other regulatory approaches related to ash and effluent management have been used to minimize health and environmental impacts as discussed in later sections of this report.

Several facilities are currently being operated in Japan on MSW or blends of MSW and other feed stocks. These facilities utilize Interstate Waste Technologies high-temperature gasifiers. Each facility is capable of processing up to 170,000 TPY and produces approximately 900kWh/tonne. By-products of these technologies include slag, sulfur, metal hydroxides, mineral salts, and metal aggregate[38].

According to Juniper Consultancy Services, the technology utilized by Nippon Steel in Japan is the most proven waste gasification technology even though it is not well known outside of the country[39]. As of 2009, Nippon Steel was operating 28 facilities that utilize MSW as a feed stock[40].

Asia

Over twenty EFW facilities have been developed throughout Asia using MSW feedstock and technology provided by Entech Renewable Energy Systems. Plants are designed to process 42,000 TPY of MSW and generate approximately 750 kWh/tonne. Associated byproducts are slag, and emission control wastes.

Edmonton Waste Management Centre

The City of Edmonton is currently working with Enerkem Inc. of Montreal, Quebec to produce an EFW facility. Original plans involved the use of syngas for power generation, but later were changed to use syngas to produce methanol. The future plant is estimated to use 100,000 TPY of feed stock and produce approximately 30 million litres of methanol per year. The methanol can then be converted to ethanol to be used as a fuel additive[41].

Europe

In Europe, there are currently no commercially operating gasification facilities that treat MSW as the technology is considered too expensive and unproven. The only larger scale commercial gasifier using MSW as feedstock was a Thermoselect gasification plant that was operated in

[38] CH2M Hill. (2009, May). *Waste-to-Energy Review of Alternatives.* Retrieved October 9, 2012, from Durham Environment Watch: http://www.durhamenvironmentwatch.org/Incinerator%20Solutions/WastetoEnergyReviewofAlternativesBC.pdf

[39] Juniper Consultancy Services Inc. (2007). *Nippon Steel Gasification Process Review.* Retrieved February 3, 2010, from Juniper Consultancy Services Inc.: http://www.juniper.co.uk/Publications/Nippon_steel.html

[40] University of California. (2009). *Evaluation of Emissions from Thermal Conversion Technologies Processing Municipal Solid Waste and Biomass.* Riverside: University of California.

[41] CH2M Hill. (2009, May). *Waste-to-Energy Review of Alternatives.* Retrieved October 9, 2012, from Durham Environment Watch: http://www.durhamenvironmentwatch.org/Incinerator%20Solutions/WastetoEnergyReviewofAlternativesBC.pdf

Karlsruhe, Germany for a few years, but it was shut down in 2004 due to technical and financial difficulties[42].

9.4 PYROLYSIS

9.4.1 Background

Pyrolysis is the thermal decomposition of feedstock at a range of temperatures in the absence of oxygen. The end product is a mixture of solids (char), liquids (oxygenated oils), and syngas (consisting of CO_2, CO, CH_4, H_2). The pyrolytic oils and syngas can be used directly as boiler fuel or refined for higher quality uses such as engine fuels, chemicals, adhesives, and other products. The solid residue is a combination of non-combustible inorganic materials and carbon.

Pyrolysis requires thermal energy that is usually applied indirectly by thermal conduction through the walls of a containment reactor since air or oxygen is not intentionally introduced or used in the reaction. The transfer of heat from the reactor walls occurs by filling the reactor with inert gas which also provides a transport medium for the removal of gaseous products.

The composition of the pyrolytic product can be modified by the temperature, speed of process, and rate of heat transfer. Liquid products (pyrolytic oils) are produced by lower pyrolysis temperatures while syngas is produced by higher pyrolysis temperatures. The syngas produced can be combusted in a separate reaction chamber to produce thermal energy which can then be used to produce steam for electricity production.

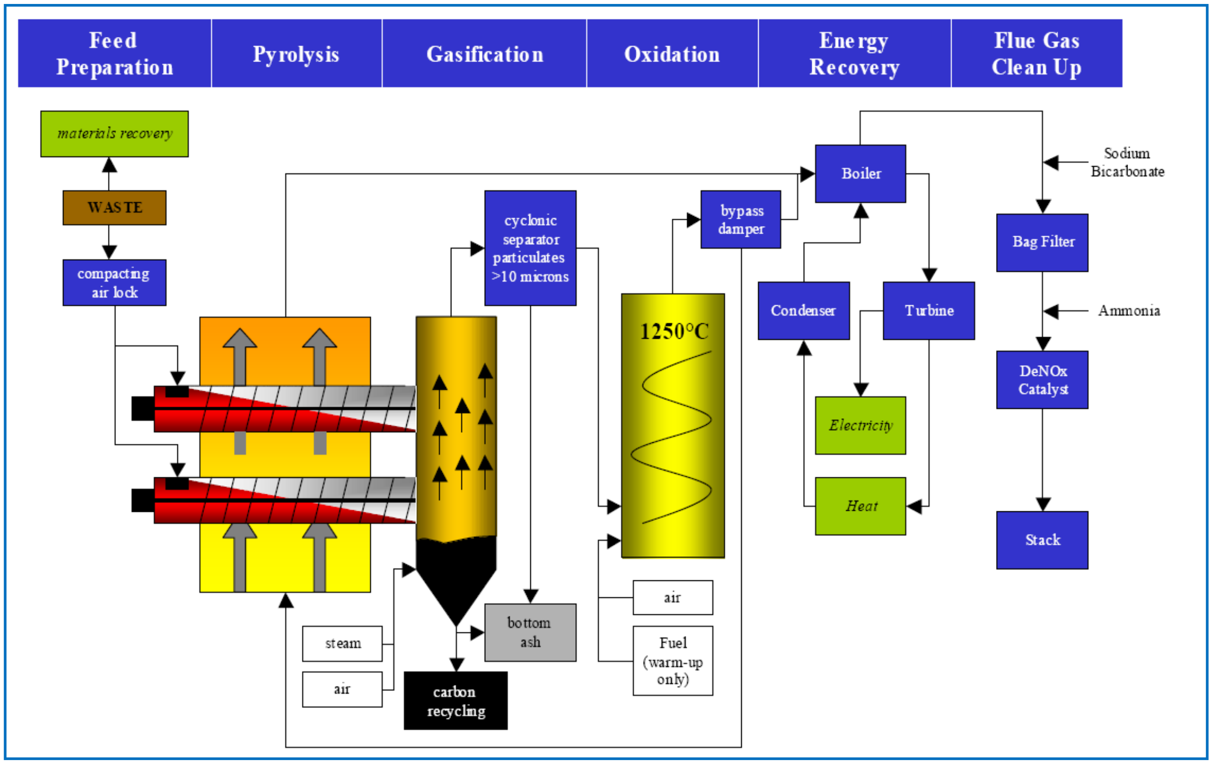
Overall, the operators find the grate fired plant more reliable and flexible with higher availability in comparison with the pyrolysis plant. Due to the pre-treatment of waste and the fuel burned in the high temperature chamber, the electrical output from the pyrolysis process is almost balanced with the internal energy consumption.

Pyrolysis generally takes place at lower temperatures than used for gasification which results in less volatization of carbon and certain other pollutants, such as heavy metals and dioxin precursors. The relatively low temperatures allow for better metal recovery before the residual pyrolysis products enter the high temperature chamber where they are vitrified.

Issues identified in relation to the pyrolysis process include: low energy outputs; the requirement for a properly sealed reaction chamber for safe operation, (the pyrolysis process is highly sensitive to the presence of air and accidental incursions of air can result in process upsets and increase the risk of explosive reactions); the requirement for pre-treatment of the MSW. The following figure, presents a schematic overview of the Compact Power pyrolysis technology as developed by Compact Power Ltd. In the Compact Power process, sorted MSW is conveyed by

[42] AECOM Canada Ltd. (2009). *Management of Municipal Solid Waste in Metro Vancouver - A Comparative Analysis of Options for Management of Waste After Recycling.* Burnaby.

a screw through the heated tubes for pyrolysis, followed by gas combustion in a cyclone where energy is captured to produce steam and then electricity. It should be noted that the Compact Power technology utilizes a gasification step following pyrolysis – this does not necessarily occur in all pyrolysis based EFW facilities[43].



The following table provides a summary of the pyrolysis process. Cost data obtained was less reliable than the costs presented in this report for other technologies. It is unclear if the reported capital costs address all capital and construction cost elements.

43 Malkow, T. (2004). Novel and innovative pyrolysis and gasification technologies for energy efficient and environmentally sound MSW disposal. *Waste Management*, 53-79.

Pyrolysis Summary	
Pyrolysis is the thermal decomposition of feedstock at high temperatures in the absence of oxygen.	
The longest operating pyrolysis facility is located in Burgau, Germany and has been operating since 1987.	
The largest facility (located in Japan) processes approximately 150,000 TPY of SRF.	
Over 20 companies market pyrolysis technologies or approaches for treating MSW.	
Other Summary Points	
Median Reported Capital Cost	▪ No reliable data
Median Reported Operating Cost	▪ No reliable data
Feedstock	▪ Biomass, automotive shredder residue, coal, hospital waste, MSW, plastics, polyvinyl chloride, sludge, tires, wastewater ▪ Waste preparation/pre-processing required by technology ▪ Difficulties in accepting variable wastestreams
Residual to Disposal	▪ If treated, residues reduced to 0.1 to 0.3 tonnes per input tonne ▪ >30%, if residue not treated ▪ Landfill capacity consumption reduced by up to 90%
Potential Energy and Revenue Streams	▪ Revenue potential for: electricity, syngas, pyrolysis oil ▪ Electricity production, 0.5 to 0.8 MWh/annual tonne of MSW

9.4.2 Benchmark Analysis

The concept of pyrolysis of MSW gained much popularity in the 1960s due to its organic composition being assumed to be well suited for pyrolytic treatment. However, by the late 1970s, technical and economic difficulties surrounding the pyrolysis of MSW arose, which resulted in a decreased interest and expectations for the technology. Since that time, pyrolysis has been further investigated, although it still faces some technical limitations.

Intrinergy Coshocton, LLC

Located in Coshocton, Ohio, Intrinergy uses GEM Thermal Cracking Technology to process an undisclosed amount of blends of crumb rubber, shredded carpet fluff, wood chips and biomass to produce approximately 4MW of energy via GE-Jenbacher reciprocating engines and one boiler. Associated by-products include char and ash.

Scarborough Power

Scarborough Power's pyrolysis facility in Seamer Carr, United Kingdom, was first opened in 2008. This facility also uses GEM Thermal Cracking Technology and processes 18,000 TPY of MSW and produces 1.8 MW using a Deutz reciprocating engine. Associated by-products include char and ash.

Japan

Between 2000 and 2003, six commercial pyrolysis facilities were opened in Japan using Mitsui R21 Pyrolysis Rotating Drum technology. These plants process between 50,000 and 120,000 (raw, unprocessed) TPY of MSW to produce between 1.5 and 8.7 MW at approximately 300 kWh per tonne. Associated by-products include char and ash.

9.5 PLASMA ARC GASIFICATION

9.5.1 Background

Plasma arc gasification uses an electric current that passes through a gas (air) to create plasma which gasifies waste into simple molecules. Plasma is a collection of free-moving electrons and ions that is formed by applying a large voltage across a gas volume at reduced or atmospheric pressure. The high voltage and a low gas pressure, causes electrons in the gas molecules to break away and flow towards the positive side of the applied voltage. When losing one or more electrons, the gas molecules become positively charged ions that transport an electric current and generate heat.

When plasma gas passes over waste, it causes rapid decomposition of the waste into syngas. The extreme heat causes the inorganic portion of the waste to become a liquefied slag. The slag is cooled and forms a vitrified solid upon exiting the reaction chamber. This substance is a potentially inert glassy solid. The syngas is generally combusted in a second stage in order to produce heat and electricity for use by local markets. In some cases, alternative use of the syngas as an input to industrial processes has been proposed.

Currently, plasma arc gasification is not commercially proven to treat MSW. The primary reason appears to be the high capital and operational costs for such facilities. The wear on the plasma chamber is very high and to keep the process operating redundant plasma chambers are needed.

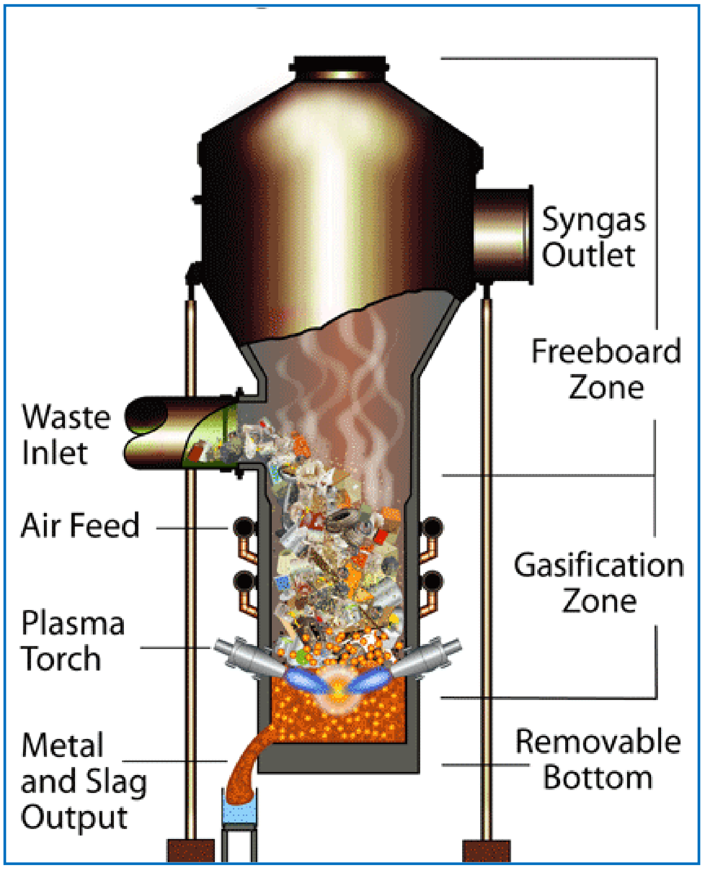
Plasma technology for MSW management has been discussed in Europe since the late 1980s but full scale facilities for MSW have not yet been implemented. At some Japanese facilities, a back-end plasma component has been added to vitrify the bottom ash produced from conventional mass burn combustion facilities. Ramboll recently visited the plant in Shinminto, Japan, where MSW combustion is undertaken by a traditional grate fired EFW facility with a back-end ash melter. The downstream ash melter is operated by JFE and consists of two, 36 tonnes per day units. Melting of the ash is undertaken by a plasma arc, operating at approximately 2,000°C. The melted ash is water quenched. The total amount of vitrified residues represents 50% by weight of the incoming ash. Approximately 1/3 of the material is used for construction purposes and the other 2/3 is used as landfill cover. The process consumes significant energy, generally producing net energy of only 100 kW per tonne of incoming ash, due to the limited fraction of remaining carbon left in the ash which limits the production of any syngas and thus limits energy production. Note that most ash management processes are net consumers of energy. Plasma chambers in operation in Japan experience a three-month cycle where the chamber has to be taken out of operation for repair every three months mainly to change the refractory lining.

There are no large scale commercial plants in operation in North America or Europe but there are number of plasma arc systems that are being tested or proposed to treat MSW. Two technologies which are currently being tested in Canada are the Alter NRG process and the Plasco process.

In the Alter NRG process, a plasma torch heats the feedstock to high temperatures in the presence of controlled amounts of steam, air and oxygen. The waste reacts with these constituents to produce syngas and slag[44]. The figure below provides a conceptual overview of the Alter NRG plasma gasification process[45].

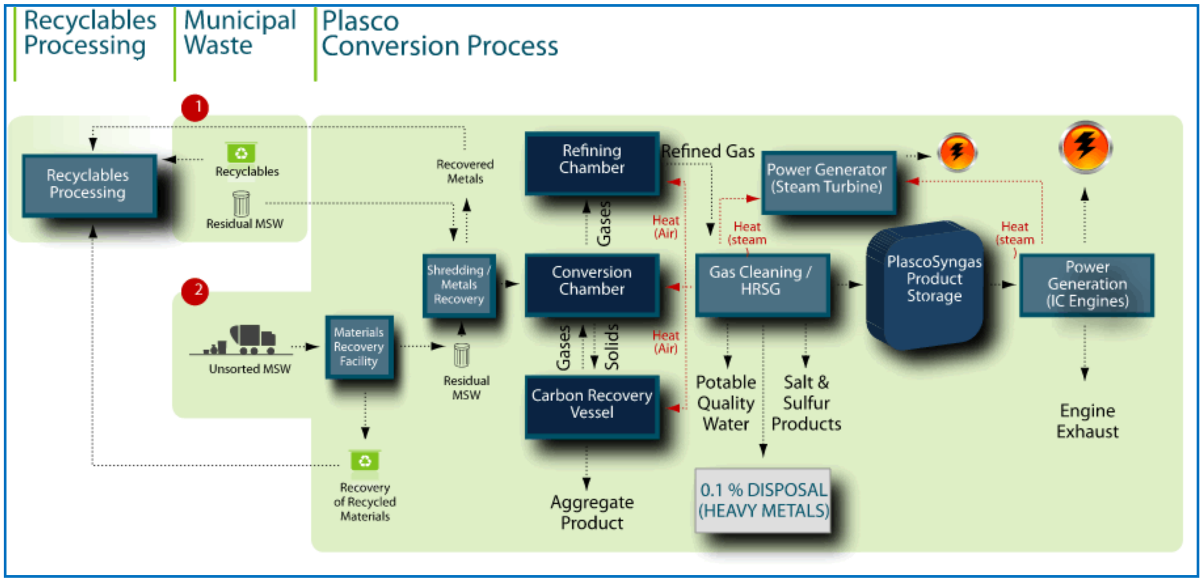
[44] Stantec. (2010). Region of Bonnyville - Service Level Review Technical Memo - Thermal Treatment Technolgies Review. Burlington: Stantec Consulting.

[45] Westinghouse Plasma Corporation. (2007). Westinghouse Plasma Corp. - Technology and Solutions - PGVR. Retrieved February 3, 2010, from Westinghouse Plasma Corporation: http://www.westinghouse-plasma.com/technology_solutions/pgvr.php



Plasco Energy Corp. (Plasco) has also developed a plasma arc gasification technology capable of treating MSW. The following figure presents a conceptual overview of the Plasco process[46].

[46] Plasco Energy Group. (2010). Environmental Performance. Retrieved February 22, 2010, from Plasco Energy Group: http://www.plascoenergygroup.com/images/Plasco_conversion_process_big.gif



The table below provides a summary of the plasma arc gasification process, costs, scalability and reliability.

Plasma Arc Gasification Summary	
Plasma gasification uses an electric current that passes through a gas to create plasma.	
Plasma arc is not a new technology; it has industrial applications and has been used for treating hazardous waste.	
The earliest facility found to use plasma arc gasification was a test facility which operated from 1987 – 1988.	
The largest facility currently operating in the world is located in Japan (Eco-Valley Utashinai Plant) and processes over 90,000 TPY of MSW and automobile shredder residue (ASR).	
24 companies supplying Plasma Arc gasification technologies and/or services have been identified that indicate use of MSW as a portion of their feedstock.	
Other Summary Points	
Median Reported Capital Cost	▪ $1,300/annual design tonne +/- 40% (2009$ CDN)
Median Reported Operating Cost	▪ $120/tonne +/- 50% (2009$ CDN)
Feedstock	▪ MSW, ASR, hazardous waste, hospital waste, organic wastestreams, shipboard waste, tires ▪ Waste preparation/pre-processing required by technology ▪ Difficulties in accepting variable wastestreams

Plasma Arc Gasification Summary	
Residual to Disposal	▪ Estimated at >1 to 10% (0.1 tonne of residue per 1 tonne of input waste), varying due to the nature of the waste and efficiency of the conversion process. ▪ Inert Slag, APC residue ▪ Landfill capacity consumption reduced by up to 99%
Potential Energy and Revenue Streams	▪ Revenue potential for: electricity, syngas, aggregate substitute ▪ Electricity production, 0.3 to 0.6 MWh/annual tonne of MSW ▪ **NOTE:** Plasma arc facilities tend to consume more energy to operate than other types of facilities
Scalability	▪ Modular facilities; multiple modules can be accommodated on a single site with some sharing of infrastructure.
Reliability	▪ Limited data available to assess operational success with MSW feedstock in regards to technical reliability ▪ Eco-Valley Utashinai Plant, Japan processes over 90,000 TPY of material but feedstock is not 100% MSW ▪ Only two plants (Japan) with 2 or more years of operations ▪ Canadian facility (Plasco in Ottawa) has not been in regular (24/7) operation as of early 2010 ▪ Complex Operation, scheduled and unscheduled downtime, unknown.

9.5.2 Benchmark Analysis

Ontario

In April 2006, Plasco Energy Corp. entered into an agreement with the City of Ottawa to develop a demonstration facility next to the City's Trail Road Landfill. Construction began in June 2007, and the first waste was received at the facility in January 2008. The plant is permitted to process 75 tonnes per day of solid waste provided by the City using Plasco's conversion technology. Plasco claims that the process would produce 1,150 kWh of power per tonne of waste when fully operational.

In the first year of operations (2008), the plant processed approximately 2,000 tonnes of MSW (6% of the permitted annual quantity of MSW), operating for 890 hours[47] or approximately 37 days (10% plant availability). In the Plasco process, the syngas produced in the primary conversion chamber is refined and cleaned. No emissions to air from the process are from the combustion of the syngas from MSW. The emissions to air from the process are associated with the combustion of the syngas in gas engines to produce electricity. These emissions must

[47] Plasco Energy Group. (2010). Environmental Performance. Retrieved February 22, 2010, from Plasco Energy Group: http://www.plascoenergygroup.com/images/Plasco_conversion_process_big.gif

meet requirements in the operating permit that are more stringent than those set out in Ontario guidelines for PM, organic matter, HCl, NO_x, mercury, cadmium, lead and dioxins/furans.

In 2011, the City of Ottawa negotiated a 20-year garbage processing deal with Plasco wherein the City will supply 300 tonnes per day of residential waste to Plasco. The deal is contingent on Plasco securing financing by 2013 and completing the construction of their facility by 2016.

Spain

In addition to the Ottawa plant, Plasco owns and operates one other facility in Castellgali, Spain. The Spain facility is a research and development scale model of the full system developed in Ottawa. The facility has been operating since 2003 and has a capacity of 5 tonnes per day. Between 2004 and 2007, the pilot plant was used almost solely to refine the design and operations for the commercial scale facility in Ottawa, Ontario.

In January, 2011, the Salinas Valley Solid Waste Authority selected Plasco's waste conversion technology to be the focus of an Environmental Review. Plasco has proposed to finance, build and operate a waste conversion facility that will convert approximately 100,000 TPY into green energy[48].

9.6 LEGISLATIVE REVIEW

To construct an Energy from Waste facility, one must seek "Municipal Waste Approval: Solid Waste". This Approval is issued by the Nova Scotia Department of Environment. When an application is accepted as complete by the Department, the form and supporting information are then subjected to a technical review and evaluation in order to decide if the proposed activity meets all minimum standards, policies, guidelines, procedures and regulations that are administered by the Department. If an applicant does not meet the suitable criteria, they will be informed by the staff as to which specific criteria have not been met to the satisfaction of the Department. If an applicant does meet the suitable criteria, the Department will issue an Approval, which will list any terms and conditions that the applicant must satisfy.

There is a possibility that the construction of an EFW plant may be able to receive grants, loans or financing from the government. Two different programs appear to be applicable to the project. The first of these is referred to as "Value-Added Manufacturing". The purpose of the Value-Added Manufacturing program is to provide financial assistance to Nova Scotia-based businesses to support the development of value-added products from materials recovered the wastestream to capitalize on business development opportunities created from the Nova Scotia Solid Waste-Resource Management Strategy. Eligible projects include:

a) "Prototype, pilot or demonstration of new technology for the collection, diversion, processing, manufacturing and distribution of materials diverted from the

[48] Stantec. (2010). Region of Bonnyville - Service Level Review Technical Memo - Thermal Treatment Technolgies Review. Burlington: Stantec Consulting

wastestream. Pilot or demonstration refers to the technical and commercial validation of a technology, process or service not previously available in Nova Scotia."

b) "Commercialization of new technology, products or services for materials diverted from the Nova Scotia wastestream, preferably with export potential. Favourable projects include those that possess market development potential and are designed to commercialize new technology, products or services in the following areas:
   i. Value-added manufactured products from solid waste;
   ii. Development of new solid waste processing and handling technologies; and,
   iii. Development of new or enhanced markets for waste materials."

Eligible applicants include individual businesses, business associations or industry groups, and industry-led collaborative partnerships between the private and public sectors and two or more businesses or consortia. Costs that are eligible are those that are considered to be essential to the startup and success of the project. These costs must be incremental, arms' length, represent fair market value and not qualified for sufficient assistance through other programs. Up to $300,000 in funding can be obtained by qualified projects through this program[49].

The second opportunity is a Research & Development Program. The purpose of this program is "to assist research and development initiatives that support the Province's Solid Waste-Resource Management Strategy and the mandates of Resource Recovery Fund Board Incorporated (RRFB Nova Scotia)". This program provides research funding to investigate, design and develop:

i. Materials or products that incorporate solid waste resources;
ii. Technologies that will facilitate the separation and recovery of solid waste resources; and,
iii. Enhanced market opportunities for solid waste resources and/or recycled materials.

Eligible projects under this program include:

- Projects that are comprised primarily of original work undertaken to acquire new knowledge with a specific practical application in view; or
- Projects involving systematic work, using existing knowledge gained from research and/or practical experience that is directed to producing new materials, products or devices; or
- Projects that install new processes, systems and services or improve substantially those already produced or installed.

Applicants that are eligible for this program include businesses, business associations, private and/or public partnerships, organizations, agencies, municipalities, universities and individuals.

[49] RRFB Nova Scotia. (2010, July 21). *Value-Added Manufacturing Program Guidelines*. Retrieved October 8, 2012, from RRFB Nova Scotia: http://www.rrfb.com/uploads/file/funding/RRFB_Funding_VAM.pdf

Applicants or project activities must be based in Nova Scotia unless otherwise approved by RRFB Nova Scotia. Up to 50% of approved eligible costs to a maximum of $50,000 can be provided. Where in the opinion of the Committee the project is of particular strategic value, a higher level of assistance may be offered[50].

9.7 RECOMMENDED FUTURE DIRECTION

EFW is considered as a mid to long-term waste management alternative for HRM to be considered in more detail in the 5-10 year range after local efforts to improve current facilities and operations are well under way. Aside from mass burn incineration, few EFW facilities are fully operational on a commercial scale in North America. Gasification of waste and several other technologies hold promise, but in the context of priority setting at HRM, Stantec recommends that HRM address clearly identified opportunities for improvement first, before staff and financial resources are expended on what is considered a mid to long term alternative.

The next five year period will be very challenging for HRM as a major infrastructure renewal program will be underway for waste management facilities. Operational changes will also consume resources. As previously discussed EFW does hold some promise, but with considerable landfill capacity available, HRM has no immediate need to pursue implementation of EFW technologies.

[50] RRFB Nova Scotia. (2010, July 21). *Research & Development Program Guidelines*. Retrieved October 8, 2012, from RRFB Nova Scotia: http://www.rrfb.com/uploads/file/funding/RRFB_Funding_RnD.pdf

10.0 Local Industrial/Commercial Waste Needs and Opportunities

10.1 EXISTING OPERATIONS

The ICI sector for the HRM includes the private collection and hauling of waste from local industrial, commercial, institutional businesses, and large apartment buildings. ICI waste is source-separated by commercial bins under the municipal by-law No. S-600 which provides HRM control over all waste generated within the municipality.

The 2008-2009 Solid Waste Characterization Study by SNC Lavalin revealed that 50% of ICI materials sent to landfill could be recovered as recyclables or compostable organics. With 60% of the total HRM wastestream originating from the ICI sector; this represents a significant opportunity to increase diversion in the HRM.

To support and further enhance diversion to reach the Provincial goal of achieving more than 60% diversion as outlined in the 1995 Solid Waste-Resource Strategy, HRM's solid waste program should provide for the delivery of education and communications programming through the conduct of curbside monitoring, ICI property education, inspection and use of policy tools to support diversion success.

10.2 COMPARISON OF CURRENT OPERATIONS TO 1995 STRATEGY

10.2.1 By-Law S-600:

HRM currently operates a four-stream ICI waste system consisting of recyclables, compostable organics, residual waste, and special wastes. This management model has not significantly changed since the1995 strategy which initiated the separation of ICI waste into recyclables, compostable organics, remaining mixed waste, and construction and demolition debris. The 1995 strategy also indicated that waste could be processed at municipal facilities or approved private sector facilities. The following statement summarizes the ICI objective from the 1995 strategy:

> *The Industrial, Commercial and Institutional (ICI) sector can use the municipally-sponsored recycling, composting and screening facilities or they can provide their own equivalent. User fees will encourage source-separation. Existing ICI collection systems should suffice with only slight modifications. Non-residential ICI hazardous waste will continue to be managed separately from the municipal system.*

The current HRM by-law No. S-600 discourages and prohibits in some ways the ICI sector from developing their own parallel system as encouraged in the 1995 strategy. By-law S-600 states that:

> *No person shall export or remove solid waste material generated within the Municipality outside the boundaries of the Municipality and all such solid waste shall be disposed of within the boundaries of the Municipality and in accordance with this By-law.*

The by-law prohibits the ICI sector from developing a parallel system outside of the HRM for waste management. A parallel system may be more practical if haulers were able to ship certain wastestreams to existing facilities outside of HRM boundaries for final disposal or processing.

Although the current ICI sector uses the HRM-sponsored disposal and processing facilities as encouraged by the 1995 Strategy, this waste accounts for significant operational challenges for HRM facilities due to the improper sorting of waste at the source. It is difficult however for the HRM to enforce and ensure source separation of materials at collection points for the ICI sector.

Despite these challenges, it is not recommended that HRM eliminate ICI processing altogether. The current revenue from ICI tipping fees is approximately $11million annually. Eliminating this revenue stream would be a significant loss to HRM. Potential operational savings and spared landfill space from not having to process ICI waste would not compensate this loss of revenue.

10.2.2 Waste Characterization Studies

Several Waste Characterization Studies have been conducted since 1995 and results are summarized in the table below.

Year	% of Total Sample Acceptable for Disposal	% Either Unacceptable for Disposal or Targeted for Diversion	Largest Component of ICI Sample
2003	31.2	68.8	14.6% Food
2003	39.4	60.6	17.9% Food
2004	41.5	58.5	-
2008	53.3	46.7	12.7% Food

As shown in the table above, the percentage of acceptable material for disposal at HRM facilities has increased steadily since 2003. However, despite this increase, there is still contamination of ICI loads.

10.2.3 Tipping Fees

The 1995 Strategy also encouraged the (tipping) fees to reflect the level of source separation. Based on observations of the current program, the ICI tipping fee structure has not been encouraging further source separation. By applying a higher fee for mixed loads, there would a great incentive for source separation. Similarly, by not accepting any mixed loads at the FEP facility, it would enforce and ensure source separation. Implementing such a fee structure would have to be phased in to give waste haulers and ICI waste generators time to adjust.

Similarly for organics, to encourage source separation, higher fees for mixed loads could be charged, as well as not accepting mixed loads altogether, or a separate composting process could be warranted based on the varying nature (wetter) of ICI organics. With respect to compostable material handled at the FEP, ICI waste represents a large portion of the organics processed that are eventually landfilled due to contamination.

10.2.4 Diversion Targets

The 1995 Strategy set forth specific diversion targets for the ICI sector to reach by the year 2000. To support increased diversion, in coordination with the implementation plan set forth in the Strategy, tipping fees for commercial waste and organics were adjusted. Since 1990, tipping fees for waste have increased from $27.50/tonne to $125/tonne. Since the introduction of the source separated organics program in 1999, tipping fees for organics have only increased by 10.5% from $68/tonne to $75/tonne. As a result, the rate of diversion from landfill has also increased. The following table shows the increase in diversion rate from 2000 to 2010 based on tonnage data.

	Strategy Projected for 2000	**2002-03**	**2006-07**	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**
Private Diversion (incl. C&D)	42,000	75,000	70,099	76,575	89,802	93,920	92,528	92,268
Organics	14,333	12,862	14,333	14,937	15,386	16,291	16,569	16,615
Recycling (Private and MRF)	35,000	47,500	47,102	46,465	47,381	48,312	49,157	49,372
Refuse	48,300	88,481	89,444	88,665	87,795	84,356	80,678	80,059
Total	**145,300**	**223,843**	**220,031**	**226,642**	**240,364**	**242,879**	**238,932**	**238,314**
Diversion Total	**91,333**	**135,362**	**131,534**	**137,977**	**152,569**	**158,523**	**158,254**	**158,255**
Diversion	**62.9%**	**60.5%**	**59.5%**	**60.8%**	**63.5%**	**65.2%**	**66.2%**	**66.4%**

10.3 BENCHMARK ANALYSIS

In order to fully assess the current performance of the HRM Waste Resource System, a comparison to similar jurisdictions in Canada was conducted. Jurisdictions used were chosen primarily based on similarities in population and geography to HRM.

It should be noted however, that comparison to other jurisdictions is difficult and sometimes skewed due to a number of factors including:

- Diversion percentages are calculated using different methods;
- Accepted materials differ;
- Markets for finished compost and recyclables vary;
- Inclusiveness of system costs varies;
- Age of facilities, equipment, and technology varies;

- Performance of systems varies;
- Level of provincial involvement, legislation, targets and objectives varies; and
- Unique features of the HRM system where all refuse is processed and stabilized prior to disposal.

The results of the analysis showed that most jurisdictions do not provide waste management collection services to the ICI sector. In some jurisdictions waste collection is provided only to certain small ICI establishments while others accept ICI waste at municipally operated facilities but do not offer collection (like the HRM).

Where services are provided to a portion of the ICI sector, waste is not processed prior to disposal. The HRM model is unique in this regard. Other landfills in Nova Scotia do not operate a FEP and therefore cannot process materials on a tipping floor. They do however inspect loads at the tipping face of the landfill and reject loads that are not in compliance. There are currently 6 approved landfills in Nova Scotia and most accept waste from the local as well as neighboring municipalities. In some cases, where municipalities find themselves too far from the landfill, they operate waste transfer stations. Most of these waste transfer stations do conduct some level of pre-processing of waste before loading and transferring to the landfill for disposal.

10.4 RECOMMENDATIONS

One of the objectives identified in the most recent Business Plans and Budget reports to Council is to deliver an efficient and sustainable resource oriented solid waste program for both residential and ICI sectors by expanding existing education and compliance operations. This includes implementation of multi-year business park inspection program. As directed by Council, it was recommended that a public engagement plan to educate and communicate with the public on evolving the waste management program be developed and revisions to By-law S-600 in support of increasing diversion from landfill for both the residential and commercial sector be considered.

A recommendation to Council was made in February 2007 to amend By-law S-600 to prohibit the mixing of source separated materials (recyclables and organics) from ICI properties by haulers in the same collection vehicle compartment as waste. The effectiveness of that By-law change should be assessed and re-evaluated. Consideration to further amend By-law S-600 to require waste haulers to provide services that support HRM's waste management strategy throughout the entire collection process will help increase waste diversion.

Consideration should also be given to allow a cash transaction payment option for ICI organics customers delivering to the composting facilities that are currently not on account. This could increase the diversion of organics delivered by small ICI haulers collecting from lawn maintenance companies and small apartment properties.

Many cities in the US use a permit/franchise arrangement for waste collection, using private service providers for collection of single family and multi-family residential waste, as well as commercial waste. The following are just two examples of cities employing this business model.

The State of California mandates that all apartment and condo complexes of five or more units must recycle. The City of San Diego operates with a mixture of City-certified recyclers or franchise waste haulers that serve multi-family locations. All multi-family locations are required to report on their diversion programs on an annual basis. The City maintains a list of City-certified recyclers or franchise waste haulers who will report building compliance on behalf of the owner. Owners who contract with companies that are not City-certified must submit an annual Recycling Reporting Form to demonstrate compliance themselves.

The City has developed a certification process for private recycling collectors which is voluntary; however, certified recyclers are listed on the City's website. Certification is valid for up to two years; and involves completion of an application form, an application fee of $130.00, provision of proof of insurance and an agreement to comply with certain requirements of the Municipal Code. Garbage collection is provided by the City of San Diego.

The City of Portland has operated a "Pay as you throw" program and recently moved to bi-weekly garbage collection. The City regulates the residential collection of garbage and recycling by local companies who have specific boundaries in which they can provide services to residents. Since 1992, residential collection has been undertaken through the franchise system; subsequently the program was expanded for collection of ICI waste (including multi-family). There are now about 52 companies serving this sector.

This business model is not commonly used in Canada as in many provinces licensing is a provincial responsibility and is not under the control of municipalities. Notwithstanding, HRM has waste flow control within its jurisdiction and this is a mechanism that could be employed/evaluated further toward enforcement.

Other recommendations for the ICI program include:

- Continuing to provide processing services for the ICI sector to support existing operational costs, generate economies of scale, and assist in the compliance with provincial legislation.

- Continuing to carefully evaluate the results of waste characterization studies to prioritize the types of materials to target for increased diversion through education, partnerships, monitoring and enforcement.

- Encouraging ICI diversion through continued education programs and other initiatives. Larger organizations could be targeted initially and new legislation could be considered to require compliant programs. All new developments should be required to implement a compliant source separation program. Consideration should also be given to the inclusion of source separation programs in development agreements or zoning requirements for apartment building development.

- Potentially increasing ICI Diversion through enhanced inspections/education. The Diversion Planning Officer(s) currently administer all reports of ICI properties violating By-law S-600. Expanding enforcement requirements for the Diversion Planning Officer is not an option as the current workload is being maximized. Ensuring that an adequate amount of Diversion Planning Officer positions are filled and active is integral to the ongoing success and further diversion.

- Revising By-law S-600 to include proper communication and utilization of commercial bins to support source separation. For example, HRM has encountered ICI haulers using green tote bins and blue recycling bins for garbage. There is currently no requirement for the commercial sector to use proper colored bins for organics or recyclables, but signae is required. Many private commercial waste haulers are using containers for organics and recyclables without signage or consideration of the bin color or size. This leads to confusion for the property owner/tenant. The hauler is also not obligated to provide their clients with information on the requirements for source separation. The client, in many cases, is only provided one bin for garbage, resulting in By-law violation.

11.0 Waste Resource Partnership Opportunities in Nova Scotia Beyond HRM

11.1 BACKGROUND

In 1995, the Government of Nova Scotia released a comprehensive solid waste management plan. The plan was adopted as an initiative to place Nova Scotia at the leading edge of solid waste management in Nova Scotia and corresponded to the renewal and upgrading of landfills in several locations across the province.

The Provincial plan approached waste as a resource and included comprehensive curbside collection programs for diverting organics, paper waste, and plastics from traditional solid wastestreams. It also sought to develop economic opportunities from these former wastestreams. The end goal of the strategy was to reduce solid waste directed to landfills in the province to 50 per cent of 1989 levels by 2000 consistent with objectives set by Canada's Provincial Ministers of the Environment in 1989 to have the quantities of waste sent to incinerators or landfills. In 1989, Nova Scotia sent 641,375 tonnes of waste to landfills or incinerators or 726 kg per person. The consequent objective set by the Strategy was therefore to reduce waste to 363 kg per person.

The strategy paralleled the Waste Resource Management Strategy developed for HRM at the same time, which committed to the development of a no organics landfill that was eventually sited in Otter Lake to the west of Halifax. To reduce waste to be disposed in the new landfill and ensure that it received no organic material the newly amalgamated municipality expanded programs for separation of paper and recyclables and source, and to divert organic materials to composting. These initiatives were consistent with provincial objectives and have been emulated by other municipal units across the province.

The key to addressing the goals set by the Province has been separation of wastes at source. Paper waste, cardboards, glass and plastic recyclable (excluding refundable containers), and compostables are all separated from the general wastestream. Waste generators are expected to deal with each stream separately in accordance with prescribed procedures (e.g., blue bag for recyclables, bundling for cardboard, and compost containers for compostables). Municipalities generally pick up each waste type from residential properties at the curb. Larger multi-unit residential properties and non-residential properties normally contract for delivery to the appropriate processing facility recognizing the same separation requirements.

In addition to curbside initiatives, the Province has banned a variety of materials specified in regulations under s. 102 of the *Environment Act* (S.N.S. 1994-1995, c.1) from landfills and has established additional facilities and/or processes to deal with each. A network of 83 Enviro-depots, for example, accepts refundable containers. The Enviro-depots also accept waste paint, as do some specialized municipal facilities. The Atlantic Canada Electronics Stewardship

(ACES) Program has been established between electronics vendors in Atlantic Canada and the non-profit Resource Recovery Fund Board Inc. (RRFB) to collect, free of charge, waste electronics (e.g., televisions, stereos, and computers) at several designated locations throughout Nova Scotia. ACES does not address municipal costs of handling electronics. Cellular phones are collected free of charge through Recycle My Cell, an initiative led by the Canadian Wireless Telecommunications Association. Household Hazardous Waste (e.g., batteries, fuel oil, and other flammables; sharps; and fluorescent light bulbs) can be dropped off free of charge to many private and public handling centres throughout the province. Tire vendors are required to accept, old tires free of charge,. Construction and Demolition (C & D) waste materials are received at private landfills, although some public facilities (e.g., the two Waste Management Centres in the Valley region) also accept small amounts (less than five cubic yards) of C & D material.

In 2006, in coordination with the *Environmental Goals and Sustainable Prosperity Act of 2007*, new legislation was enacted to renew the Nova Scotia Waste Resource Management Strategy and achieve both an absolute reduction in province-wide solid waste to 300 kilograms per person per year by 2015 in addition to a 50 per cent waste diversion rate. The “renewal” of the Strategy is meant to identify which initiatives have been the most successful from the previous strategy, and what new opportunities may be available for further solid waste reduction and diversion.

EPR Canada issued an EPR Report Card[51] (2011) reporting on and grading the various EPR initiatives in each province.

Overall, the province of Nova Scotia scored a B, along with Manitoba and Quebec. British Columbia scored an A-, Ontario and PE scored a C+, Alberta scored a C, Saskatchewan, New Brunswick, Newfoundland and Labrador each scored a C-.

Comments about Nova Scotia’s programs highlighted efforts to working to transition stewardship programs for most other CCME CAP materials to EPR, the renewed 2011 waste management strategy publicly commits to EPR, mandatory source separation program and landfill bans for many materials, and commitments to harmonizing with other provinces in the Atlantic region.

11.2 BENCHMARK ANALYSIS

Biennial surveys of the waste management industry conducted by Statistics Canada provide a good overview of Nova Scotia’s position relative to the rest of Canada through summary tables compiled in the CANSIM database. CANSIM provides five tables corresponding to the headings in Table 1 identifying materials diverted from landfill, waste sources, and diversion by source, sector employment, and municipal costs. Survey data from the 2002, 2004, 2006, 2008 surveys has been posted by Statistics Canada. Stantec has divided numbers in each grouping by Statistics Canada population estimates for each province for each year. Population estimates

[51] EPR Canada, July 2012, 2011 EPR Report Card

are for individual years and include adjustments for undercount relative to Census counts taken in 2001 and 2006.

Stantec ranked the provinces by each measure available from CANSIM to benchmark Nova Scotia's performance in the sector relative to the rest of Canada. Data dealing with waste disposal and diversion show the impressive success of the Province through its solid waste management initiatives. While Nova Scotia ranks at about the middle at fourth among eight reporting provinces for overall quantity of waste diverted (i.e., the row labeled "All materials diverted" in Table 1), the province ranks last in all categories of waste disposed (see Waste by Source). The ratio between materials disposed and all materials diverted indicates that Nova Scotia diverted a larger proportion of its waste than any other province in all four years recorded and that the Nova Scotia's rate of diversion rose substantially over the years from 2004 through 2008, widening its gap over other reporting provinces. In 2004, the ratio of 2.03 suggests that Nova Scotia disposed slightly more than two times as much waste as it was able to divert. At the time, Nova Scotia's ratio between disposal and diversion was 78.8 per cent better than the ratio for all reporting provinces combined (3.63). Nova Scotia's ratio, however, fell dramatically over the next six years to just 1.22 (a 39.9 per cent decline) at which point it was only 40 per cent of the ratio recorded by all the reporting provinces, which also fell but to only 3.05. Gains were largely attributable to increased diversion of materials from non-residential sources, which doubled from 2002 to 2008 (see Materials Diverted by Source).

On the business side, Nova Scotia has a relatively high number of workers employed in waste management businesses, ranking third among 11 reporting provinces and territories. The province also has a relatively high ratio of full-time to part-time employees. Operating revenues were however low at eighth, and particularly relative to operating expenditures, by which Nova Scotia ranked sixth. The province's solid waste businesses also ranked fifth highest in terms of capital expenditures among eight reporting provinces. Operating revenues, however, were weak, ranking eighth among the provinces and territories. The difference between operating and capital expenditures and revenues, although positive in all four years recorded, ranked sixth among eight provinces for which all necessary data was available.

Municipal expenditures most clearly reflect the cost of maintaining Nova Scotia's system. Nova Scotia ranks second in terms of municipal employees per capita engaged in solid waste resource management and, as with the private sector in the province, shows a high ratio of full-time to part-time employees. In terms of overall expenditure on solid waste operations, Nova Scotia ranks first of nine reporting provinces with current expenditures that in 2008 were 28.3 per cent more than the second highest ranked province, British Columbia. Revenues to Nova Scotia municipalities, on the other hand, ranked fourth among nine reporting provinces in 2008. The deficit between revenues and expenditures for Nova Scotia was nevertheless the largest of any province in all four years surveyed. Based on calculations by Stantec based on the CANSIM data, the shortfall recorded by Nova Scotia municipalities grew from $33.4 million to $41.3 million from 2002 to 2008 (23.7 per cent). At $44.11 per 1,000 residents this cost was 77.3 per cent higher than the combined shortfall recorded by all reporting provinces ($24.88).

Type of materials diverted	Quantity				Per 1,000 Population	
	2002	2004	2006	2008	Rank 2008	No. Ranked
Materials Diverted by Type (tonnes)						
All materials diverted	192,006	239,845	275,983	289,950	4	8
Newsprint	31,031	26,972	33,128	34,771	4	8
Cardboard and boxboard	15,416	30,485	31,373	27,271	7	8
Mixed paper	3,027	7,657	8,592	7,399	6	7
Glass	3,224	2,126	1,511	1,222	4	4
Ferrous metals	5,775	2,951	2,962	4,244	5	8
Copper and aluminum	x	x	x	581	5	5
Mixed metals	x	6,105	x	1,462	6	8
White goods	0	4,584	4,700	x	2	6
Electronics	0	x	0	x	4	7
Plastics	2,460	3,846	4,540	6,303	6	8
Tires	0	x	x	x	x	7
Construction, renovation & demolition	38,871	59,355	51,263	40,368	2	9
Organics	82,341	93,458	133,934	158,419	2	8
Other materials	7,000	1,737	1,808	2,400	2	8
Waste by Disposed by Source (tonnes)						
All sources of waste for disposal	389,194	399,967	359,105	354,231	9	9
Residential sources of waste for disposal	169,649	179,262	169,337	148,060	9	9
Non-residential sources of waste for disposal	219,546	220,705	189,768	206,171	9	9
Materials Diverted by Source (tonnes)						
Residential sources of diverted materials	122,707	148,542	138,869	149,961	1	8
Non-residential sources of diverted materials	69,299	91,305	137,114	139,989	4	8
Business Sector Characteristics						
Number of businesses	87	90	56	63	4	11
Total employees	811	952	804	863	3	11
Full-time employees	743	871	716	x	3	11
Part-time employees	68	81	88	x	5	11
Operating revenues (x 1,000)	$89,468	$100,891	$120,663	$129,278	8	11
Operating expenditures (x 1,000)	$80,059	$90,856	$110,850	$116,422	6	11
Capital expenditures (x 1,000)	$8,226	$8,714	$5,688	$6,956	5	8
Local Government Characteristics						
Total employees	295	320	315	308	2	9
Full-time employees	239	271	276	275	2	9
Part-time employees	56	49	39	33	8	9
Operating revenues (x 1,000)	$32,028	$37,692	$41,092	$62,041	4	9

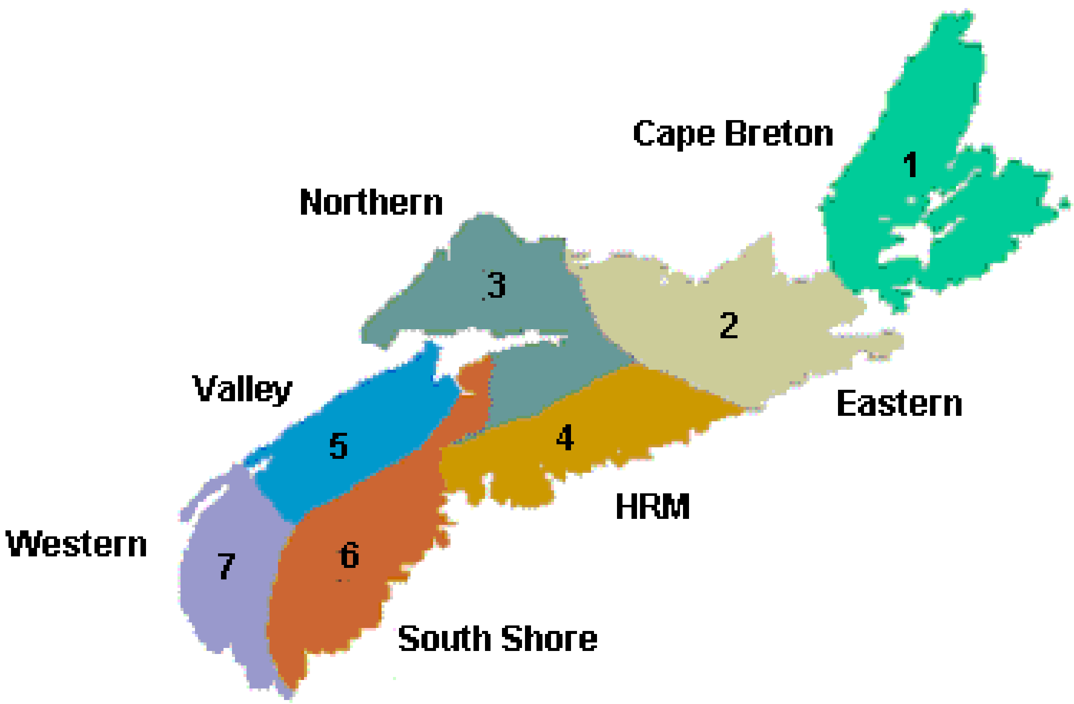
	Quantity				Per 1,000 Population	
Type of materials diverted	2002	2004	2006	2008	Rank 2008	No. Ranked
All current expenditures (x 1,000)	$65,453	$77,292	$89,276	$103,392	1	9
Collection and transportation, current expenditures (x 1,000)	$19,101	$21,242	$22,183	$26,579	4	9
Tipping fees, current expenditures (x 1,000)	$2,875	$2,729	$9,158	$10,933	2	8
Operation of disposal facilities, current expenditures (x 1,000)	$29,077	$27,864	$26,985	$26,757	1	9
Operation of transfer stations, current expenditures (x 1,000)	$1,006	$935	$4,056	$6,581	2	7
Operation of recycling facilities, current expenditures (x 1,000)	$6,213	$6,945	$7,735	$7,635	2	11
Operation of organics processing facilities, current expenditures (x 1,000)	$5,429	$5,425	$7,341	$8,511	1	8
Contributions to landfills post closure and maintenance fund, current expenditures (x 1,000)	$0	$0	$0	$4,283	1	9
Other current expenditures (x 1,000)	$1,753	$12,153	$11,818	$12,112	1	7
Capital expenditures (x 1,000)	$2,385	$11,791	$35,373	$20,851	2	8

	Ratio of Materials Disposed to Materials Diverted				Rank			
	2002	2004	2006	2008	2002	2004	2006	2008
Canada	3.63	3.55	3.36	3.05	N/A	N/A	N/A	N/A
Newfoundland and Labrador	12.39	11.33	x	x	9	9	x	x
Prince Edward Island	X	x	x	x	x	x	x	x
Nova Scotia	2.03	1.67	1.30	1.22	1	1	1	1
New Brunswick	3.16	3.18	2.03	1.79	3	4	2	2
Quebec	3.35	3.03	2.60	2.50	4	3	4	4
Ontario	4.26	4.06	4.05	3.43	7	5	5	5
Manitoba	4.15	5.89	5.92	5.67	5	7	7	7
Saskatchewan	6.84	6.96	7.80	6.03	8	8	8	8
Alberta	4.19	4.96	5.85	5.53	6	6	6	6
British Columbia	2.21	2.29	2.14	1.87	2	2	3	3
Yukon, Northwest Territories and Nunavut	x	X	x	x	x	x	x	x

11.3 STRUCTURE OF THE NOVA SCOTIA WASTE MANAGEMENT SYSTEM

One of the key decisions made by the Province in 1995 was to organize municipal units across Nova Scotia into waste management regions in the province. It was evident to authorities that many small municipal towns and rural municipalities in Nova Scotia were not capable of efficiently managing solid waste. In an effort to explicitly encourage cooperation among rural municipalities, the province created seven solid waste management districts that combined rural municipalities and towns within their limits. The seven districts with their component rural municipalities are as follows:

1. Cape Breton – Cape Breton Regional Municipality, and the Municipal Counties of Inverness, Richmond, and Victoria
2. Eastern Region – the Municipal Counties of Antigonish and Pictou, and the Municipal Districts of Guysborough and St. Mary's
3. Northern Region – The Municipal Counties of Colchester and Cumberland, and the Municipal District of East Hants
4. Halifax Regional Municipality – HRM alone
5. Valley Waste -- The Municipal Counties of Annapolis and Kings
6. South Shore/West Hants Region – The Municipal Districts of Chester, Lunenburg, Shelburne, and West Hants, and the Region of Queens.
7. Western Region – The Municipal Districts of Argyle, Barrington, Clare, Digby, and Yarmouth.



The Government of Nova Scotia provided resources for each district, and facilitated the development of several regional solid waste resource management partnerships, such as Valley Waste Resource Management and Region 6 Solid Waste Management. The Government of Nova Scotia has also established the non-profit Resource Recovery Fund Board Inc. (RRFB) to provide educational and awareness programs for solid waste reduction and diversion, develop stewardship opportunities with the private sector and municipalities, and to manage 83 Envirodepot locations throughout the province. A report prepared in 2011 by William Hagg for the Province of Nova Scotia highlighted opportunities for improvement within the current program.

Each region, furthermore, manages a range of solid waste management facilities (Table 2). Not all regions provide a full suite of required facilities. Many municipal units transfer waste materials and/or recyclables to other regions. Several facilities have become particularly prominent in this role, most notably the Lincolnville landfill in Guysborough and the Little Forks Landfill in Cumberland County. Following is a summary of the key facilities operated by each of the province's seven regions:

Cape Breton

Cape Breton has one C&D facility, one municipal household special waste (MHSW) facility, two composting facilities, and three recycling facilities, as well as three waste transfer locations. Solid waste is collected at transfer stations in Sydney, Port Hood, and Baddeck from which it is delivered to the Lincolnville Landfill Site in the Municipal District of Guysborough.

Eastern

Eastern Region contains four C&D facilities, two MHSW facilities, three composting facilities, and four waste transfer locations. The Lincolnville Landfill Site is a second generation landfill accepting solid waste from 20 municipalities in the Eastern and Cape Breton Districts. Fees range from $38.50-$45.10/tonne for solid waste, C&D waste, and composting material, to $210.68/tonne for recyclables. Recycling is consolidated at the landfill site, and transferred to the Colchester County Recycling Centre. Residents of the District of Guysborough can drop off waste free of charge.

Northern

Northern Region has five C&D facilities, two MHSW facilities, three composting facilities, two recycling centres, one balefill site, one landfill, and 11 waste transfer locations. Fees for the balefill site in Kemptown, Colchester County, range from $30/tonne for C&D, scrap metal, wood, and organics, to $75/tonne for commercial and residential wastes, to $100/tonne for asbestos and tires. Similar fees apply at the landfill site in Little Forks in central Cumberland County; however, recyclables, and yard waste can be dropped off for no cost. The Colchester Recycling Centre received all recycling material from Eastern District.

HRM

HRM has three C&D facilities, one MHSW facility, two composting facilities, one recycling facility, one landfill, and two transfer locations. The Otter Lake Disposal Facility charges a $5 flat rate for waste weighing less than 100 kg; material weighing 100 kg or more is charged $115 per tonne.

South Shore

South Shore has one C&D facility, four MHSW facilities, three composting facilities, five recycling centres, three landfills, and two transfer locations. West Hants landfill at Walton Woods charges $40/tonne to residents, and $65/tonne to institutions, and allows scrap metal, yard waste, and HHW to be disposed free of charge. Kaizer Meadow operated in Chester charges $68.85/tonne, $51.50/tonne of C&D, and $35/tonne scrap metal, and allows organics and recyclables free of charge. Queens Municipal Landfill north of Liverpool charges $77.41/tonne of residual waste, roughly $54 for C&D and $171 for recyclables generated outside the District or by commercial operators. Residential wastes are not charged, except for unsorted C&D materials.

Valley

Valley Waste has three C&D facilities, two MHSW facilities, one composting facility, and two waste transfer locations. Solid waste is collected at transfer stations in Lawrencetown and Kentville from which it is taken to the Kaizer Meadows landfill in Chester. the two waste transfer facilities charge $77/tonne for recyclables and organics, $52/tonne of scrap metal and sorted C&D waste, and $98/tonne of solid waste or mixed C&D. individuals disposing waste from outside the Valley district are subject to a 30 per cent premium per tonne of waste. A local bylaw also forbids wastes “generated” in the Valley district to be disposed of outside the district. It’s worth noting that other than the Otter Lake Disposal Facility in HRM, all nearby landfill sites have significantly lower premiums (e.g., ~$75/tonne for residual solid waste).

Western

Western has four C&D facilities, one MHSW facility, two composting facilities, one recycling facility, and three transfer facilities. Clare Transfer station charges $98/tonne of solid waste, Yarmouth charges $128/tonne of solid waste, and $98/tonne of composting, and Digby charges $100, tonne of solid waste. Waste collected at the transfer stations is taken to the Queens Municipal Landfill near Liverpool.

C&D	HHW	Organics	Recycling	Landfill	Waste Transfer
Cape Breton					
Baddeck Sydney	Edwardsville	Baddeck	Baddeck		Baddeck
		West Arichat	Sydney		Port Hood
			Inverness		Sydney
Eastern					
Broadway	Lincolnville	Lincolnville		Lincolnville	Beech Hill
Beech Hill	Mount William	Tracadie			Lincolnville
TCH Exit 25		Mount William			Mount William
Mount William					Sherbrooke
Northern					
Stewiacke	Georgefield	Kemptown	Kemptown	Kemptown	East Hants
Little Forks	Kemptown	Brookfield	Little Forks	Little Forks	Advocate

C&D	HHW	Organics	Recycling	Landfill	Waste Transfer
Georgefield		Little Forks			Cross Roads (Parrsboro)
Dixon					Greenville
Kemptown					Oxford
					Port Howe (Seasonal)
					Pugwash
					River Hebert
					Southampton
					Wallace
					Wentworth
HRM					
Goodwood	Bayers Lake +4 mobile events	Burnside	Bayers Lake	Otter Lake	Musquodoboit
Westphal		Ragged Lake			Sheet Harbour
Harrietsfield					
Valley					
Hampton	Lawrencetown	Demsey Corners	Lawrencetown		Lawrencetown
North River	Kentville		Kentville		Kentville
Tourbrook					
South Shore/West Hants					
Whynott	Kaizer Meadow	Whynott	Shelburne	Scotts Village	Whynott
	Whynott	Brooklyn	GTI	Kaizer Meadow	Queens
	Cogmagun	East River	Whynott	Queens	
	10 Mile Lake		Falmouth		
			10 Mile Lake		
Western					
Barrington	Shelburne	South Ohio	Yarmouth		Yarmouth
Meteghan		Church Point			West Green Harbour
Digby					Little Brook
South Ohio					

The financial performance of HRM as a waste region relative to the other six regions in Nova Scotia can be assessed by reference to the annual publication *Nova Scotia Municipal Statistics*, which is compiled by Service Nova Scotia and Municipal Relations. The primary value of the document is to compare expenditures on solid waste management services. Unfortunately, tables breaking down revenue sources lump solid waste services with other Environmental Health Services (i.e., Sewage Collection and Disposal as well as Garbage and Waste Collection and Disposal), which provides little value for the current analysis. Expenditures on "Garbage and Waste Collection and Disposal" by municipal units comprising each waste management region are, nonetheless, a valuable indicator of the cost effectiveness of each regional operation. The most recent available editions of the publication are for 2009 and 2010, although the 2010 version is identified as preliminary and does not have data for Annapolis County, which has apparently not filed financial information for 2010, and Bridgetown, which was under the administration of the Province during 2010.

Expenditure data for 2009 and 2010 compiled for each solid waste region by Stantec is presented in the table below. Stantec calculated expenditures as a percentage of total expenditure as well as per capita and per dwelling unit (including unoccupied as well as occupied dwellings) to assess cost effectiveness. HRM expended a smaller proportion of its total expenditure on garbage and waste collection and disposal than any of the other six solid waste management regions in the province in 2009 and 2010. On a per capita basis in 2009, however, it ranked second and on a per dwelling unit basis in ranked third. Data for 2010, which are not official and exclude Annapolis County and the Town of Bridgewater from Valley Waste totals, found HRM fourth in per capita terms and sixth by dwelling units.

HRM tends to appear more costly by dwelling unit measures because it has a much lower proportion of unoccupied dwellings than other areas of the province where cottages and seasonal homes are a more significant component of local housing stock and where, in some cases, a noticeable portion of housing has been abandoned. HRM also has considerably more large residential, commercial, and institutional development than other areas but this should not significantly influence its costs as apartment owners with more than six units and all non-residential waste generators are responsible for contracting the pickup and disposal of their waste. Contractors handling this waste must pay tipping fees at the disposal site.

The least expensive region based on both per capita and per dwelling unit measures is the Eastern Region. Municipal units in the Eastern Region enjoy the benefits of a relatively inexpensive landfill located at Lincolnville, near the western edge of Guysborough County. Lincolnville is very accessible to the Town and County of Antigonish, as well as the Town of Mulgrave and most areas within Guysborough. In all, Lincolnville has contracts for waste disposal with 17 Nova Scotia municipal units within the Eastern Region and on Cape Breton Island. Most notably, it is the main disposal site for waste generated in CBRM.

Pictou County, which forms the western half of the Eastern Region and has the larger proportion of the waste region’s population, largely relies on a second landfill at Mount William. The Mount William landfill, which is operated by the Pictou County Shared Services Authority, an inter-municipal body serving the Towns of New Glasgow, Pictou, Stellarton, Trenton, and Westville, as well as the Municipality of the County of Pictou, is the primary disposal site for all six municipal units.

The Northern and Valley Regions are also notable for lower costs. The Northern Region, like the Eastern Region benefits from two landfills. Colchester has concentrated its balefill, MRF, and composting facilities in Kemptown north of Truro. Cumberland provides a second facility in Little Forks, between Amherst and Springhill near the centre of the county. The Valley Region also maintains two strategically located disposal sites: one in Kentville serving the eastern portion of the region and the other in Lawrencetown for the western area. Both are sorting sites, however, and materials are ultimately disposed elsewhere.

	Cape Breton	Eastern Region	Northern Region	HRM	Valley Waste	South Shore/ West Hants	Western Region
TOTAL EXPENDITURE 2009	$130 million	$63 million	$84 million	$485 million	$60,million	$75 million	$43 million
Garbage and Waste Collection and Disposal	$16 million	$5 million	$10 million	$37 million	$6 million	$13 million	$6 million
% of Total Expenditure	12.3%	8.5%	11.9%	7.6%	10.5%	17.2%	14.0%
Per Capita	$120.16	$73.78	$97.53	$96.87	$99.42	$156.58	$115.54
Per DU	$250.94	$146.23	$193.63	$209.49	$211.70	$298.46	$228.82
TOTAL EXPENDITURE 2010	$148 million	$71 million	$97 million	$600 million	$55 million	$85 million	$49 million
Garbage and Waste Collection and Disposal	$15 million	$5 million	$11 million	$43 million	$5 million	$14 million	$6 million
% of Total Expenditure	10.1%	7.6%	11.1%	7.2%	9.5%	15.9%	12.7%
Per Capita	$114.08	$73.76	$103.94	$112.39	$82.90	$164.34	$120.12
Per DU	$235.66	$145.76	$206.69	$245.26	$176.77	$312.94	$235.74

[1] 2010 figures for Valley Waste do not include the Municipal County of Annapolis or the Town of Bridgetown

Source: Nova Scotia Municipal Statistics, 2009 and 2010

11.4 OPPORTUNITIES FOR PARTNERSHIPS

As the most populated waste management region in the province, HRM benefits from some operational economies of scale compared to more rural regions. As the 1995 Strategy was being implemented and refined over the years, there was little in the way of shared services between HRM and other waste regions. This was understandable given the long haul distances and the fact that each region was in the process of a major overhaul of its waste management infrastructure. One recent example of cooperation with waste authorities beyond HRM is the development of agreements for “contingency” waste disposal at landfills beyond HRM. These agreements establish tipping fees for disposal of HRM generated waste in the event that the Otter Lake disposal facility is not operational for any particular reason.

As HRM begins the planning process to renew its infrastructure, it is timely to enter into discussion with other waste regions on the possibility of sharing capacity in modern to-be-constructed facilities. For example, if a new HRM MRF is planned to be operational in 2019, there is time to establish partnerships to share recyclable processing capacity with another region. Other regions may also be considering MRF replacement and sharing one facility could represent significant capital savings.

Similarly as HRM expands its organics processing capacity, smaller regions may benefit by utilizing available capacity. HRM would charge a fee which is both fair to the neighbour, but provides a financial net gain to HRM.

Stantec recommends that HRM Council provide staff with authorization to commence preliminary partnership discussions with other waste regions to establish the general level of interest, and to identify specific opportunities requiring more detailed negotiations.

These partnerships could involve certain materials moving in one direction, and other materials being shipped back (backhaul) in the other direction. This approach fully utilizes transportation resources. Initial negotiations should not exclude any particular materials as recyclables, organics and waste residue are all shared challenges in each region.

HRM is also likely to benefit by having material generated in its most distant zones, received by adjacent regions with facilities near the waste region border. Transporting all materials generated in HRM to the Halifax/Dartmouth area may not be the most cost-effective transportation solution for the relatively small quantities generated. These types of arrangements must of course have the agreement of all parties involved. Each party must have a clearly defined benefit or the partnership is unlikely to be established or maintained.

12.0 Conclusions and Recommendations

12.1 CONCLUSIONS

The Halifax Regional Municipality (HRM) has over the last 15 years implemented an effective waste resource and reduction strategy. Its residential diversion rate from landfill has increased from approximately 5% in 1995 to 52% currently. Program implementation was guided by an *Integrated Waste Resource Management Strategy* report (1995 Strategy) which was developed by community volunteers. While the principles described in the 1995 strategy remain valid today, most of the program elements have now been implemented.

Much of the physical infrastructure constructed to support the 1995 Strategy will be nearing the end of its useful life in the next five to ten years. HRM has retained Stantec Consulting Limited (Stantec) to review current programs and services and to recommend an updated strategy to guide HRM decision making over the next 20 years. A key element of this review is to compare local program costs to similar municipal operations. An example is the per tonne cost to operate the Otter Lake processing and disposal site. At a current cost of $170/tonne (including capital, operating and perpetual care), expenses at Otter Lake far exceed more typical industry costs of $50 to $100/tonne for all costs related to landfill disposal. Pre-processing of waste is rarely undertaken elsewhere.

While maintaining the original principles of the 1995 Strategy, the three stated goals of this review are as follows:

- *Reduce program costs through the implementation of service delivery efficiencies;*
- *Upgrade or replace necessary infrastructure to meet existing and near to mid-term capacity and regulatory requirements; and*
- *Maximize the opportunity for program revenue generation from recovery of and/or processing of waste resource materials and increased diversion.*

The following specific constraints were identified which restrict the range of program choices available to HRM over this planning horizon:

- Organic wastes are banned from landfill in Nova Scotia;
- The industrial/commercial/institutional (ICI) sector have no reasonable option currently available for processing organics except for HRM facilities;
- HRM by-law No. S-600 provides HRM with legal control of the import and export of waste generated within the municipality;

- Existing facility locations, capacities and operating agreements; and
- The current waste system in HRM is highly integrated with many interdependencies.

Based on a comprehensive review of HRM's complete waste resource systems, Stantec has generated the following conclusions:

1) The total diversion rate is high in HRM compared to other municipalities, but realistic opportunities exist to improve the recovery of residential and ICI recyclables and organics in accordance with provincial legislation.
2) The front-end processing (FEP) and waste stabilization facility (WSF) at Otter Lake do not provide a useful function compared to their stated purpose in the 1995 Strategy.
3) The landfill liner design specification in Nova Scotia is more stringent than most comparable state and provincial jurisdictions, and potential modifications could significantly reduce future capital costs.
4) An opportunity exists to significantly extend the life of the landfill at Otter Lake, and reduce the site per tonne capital costs by increasing the finished grade by 10-15 metres.
5) The two composting operations in Halifax and Dartmouth do not provide a sufficiently finished product to meet applicable guidelines which become effective in the near future.
6) Composting facilities are at capacity and additional processing capacity is required in the short and longer term.
7) Alternative composting technologies may improve the processing of ICI organics.
8) Collection programs are cost effective and meet most customer needs however there are opportunities to improve diversion by increasing the frequency of collection.
9) Opportunities exist for more collaborative use of resources with other waste management regions in Nova Scotia.
10) Energy-from-Waste and developing waste reduction technologies are not considered appropriate investments for HRM at this time.
11) Overall program costs in HRM are high and represent a greater financial burden on both the private and public sectors compared to similar communities.
12) HRM would benefit from the creation of a centralized waste resource campus, rather than having facilities at four different locations in Halifax and Dartmouth. Development can be staged over time to match the end-of-useful-life of current infrastructure and incorporate new elements for HRM such as outdoor windrow compost curing pads;

permanent educational and household hazardous waste facilities; and the development of a materials transfer capability.

12.2 RECOMMENDATIONS

Stantec has developed recommendations for an updated HRM waste resource strategy (Waste Resource Strategy Update) to guide program and service implementation over the next 10-20 years. Consistent with the three stated goals of this assignment, recommendations have been grouped into three sections below. The following list identifies issues representing fundamental change. Other more minor recommendations are included within the body of this report. As discussed previously, an integrated waste system such as that currently operating in HRM includes many program interdependencies. The following recommendations cannot necessarily be addressed in isolation, and contingent activities are noted where applicable. A conceptual implementation schedule on Figure 12.1 based on the these recommendations follow.

Opportunities for Cost Reductions

A1 – Closure of the FEP and WSF by the end of 2013

The FEP and WSF do not function in a manner envisaged in the 1995 Strategy. These facilities were intended to stabilize organic wastes and produce a low grade compost product. Few organics are now actually processed, and the multiple shredding of the waste prior to disposal may actually increase the generation of landfill gas over the short term in the period before gas collection systems can be installed. This may contribute to additional odours from the site. Implementation of this recommendation is contingent on HRM implementing a separate collection for white goods (stoves; refrigerators) rather than the current practice of loading these items in with the regular curbside waste and then removing the appliances from the waste at the FEP. The annual cost to operate the FEP and WSF is reported to be $8.9 million per year. Most of this amount could be recognized as sustainable savings less any contractual commitments.

A2 – Request Modification of the Nova Scotia Landfill Liner Specification

The current landfill liner specification is more stringent than most comparable state and provincial jurisdictions. Given the context in HRM and Nova Scotia in the 1990s, this conservative specification was considered prudent at the time. However, the current specification results in relatively high capital construction costs which in turn lead to increased expenses for the ICI sector and HRM. Based on examples from other jurisdictions, HRM capital costs for liner construction could be reduced by approximately $3.4 million for a typical cell ($10.2 million over the remaining life of the site) if Nova Scotia were to adopt a specification consistent with most similar jurisdictions.

A3 – Extend Life of Otter Lake Landfill through Vertical Expansion

The current design for the finished elevation of the landfill will result in a landform that will be consistent with surrounding topography. While this approach has merit, an extension of approximately 17-23 years to the life of the landfill can be achieved by a 10-15 metre increase in the finished grade of the site. Given the potential benefit to the broader community and the remote locale of the site, Stantec recommends that HRM consider a vertical expansion of the landfill subject to input from the immediate neighbours of the landfill.

Upgrade and Replacement of Infrastructure

B1 – Create a Centralized Waste Resource Campus

Current infrastructure is located at four different properties in Dartmouth and Halifax. With the exception of the Otter Lake facility, sites are of limited size and prevent the consideration of co-collection of materials at the curb in a single truck. Stantec recommends HRM establish a large acreage waste resource campus (Campus) in a location of sufficient size to meet changing infrastructure needs (excluding landfill disposal) for on the order of 50 years. The benefits would include the potential to optimize collection routing and fleet size, lands for compost curing, a common location for infrastructure replacements when needed, and a location for contingency waste transfer. Possible components and timing are presented below.

- Secure lands, obtain approvals and complete site servicing 2013/2014
- Construct and operate compost curing pads 2014/2015
- Construct scales, offices and educational centre 2015
- Construct multi-use transfer facility for white goods/waste/HHW 2015
- Construct anaerobic composter for ICI organics 2015/2016
- Construct replacement MRF 2017/2018
- Optional aerobic composting processing capacity 2018+
- Optional advanced waste reduction(gasification or other) 2020+
- Other long-term waste reduction infrastructure needs 2020+

B2 – Relocation of MRF to Campus

The existing MRF in Halifax is operating satisfactorily and equipment is suitable for current needs and until the expiry of a contract extension to 2019. As identified above, it is recommended that this activity be relocated to the Campus in anticipation of a 2019 contract start date.

B3 – Increase Organics Processing Capacity

The aerobic composting facility south of Halifax is not considered a strategic asset and could be decommissioned at the end of the current contract in 2019. Equivalent organics processing capacity for the Halifax collection zone is recommended to be realized at Otter Lake by repurposing the WSF. The Dartmouth organics processing facility can meet Dartmouth area needs until at least 2030 by constructing an anaerobic processing facility by 2015/2016 at either the current site or at an alternative location.

Maximize Program Revenue and Increase Diversion

C1 – Improve Recovery of Recyclables and Organics

Based on the results of annual waste composition studies completed recently by SNC Lavalin and CBCL, 30% of residential and up to 50% of ICI materials currently sent to landfill could be recovered as recyclables or compostable organics. This is an opportunity for HRM to optimize existing programs and increase diversion.

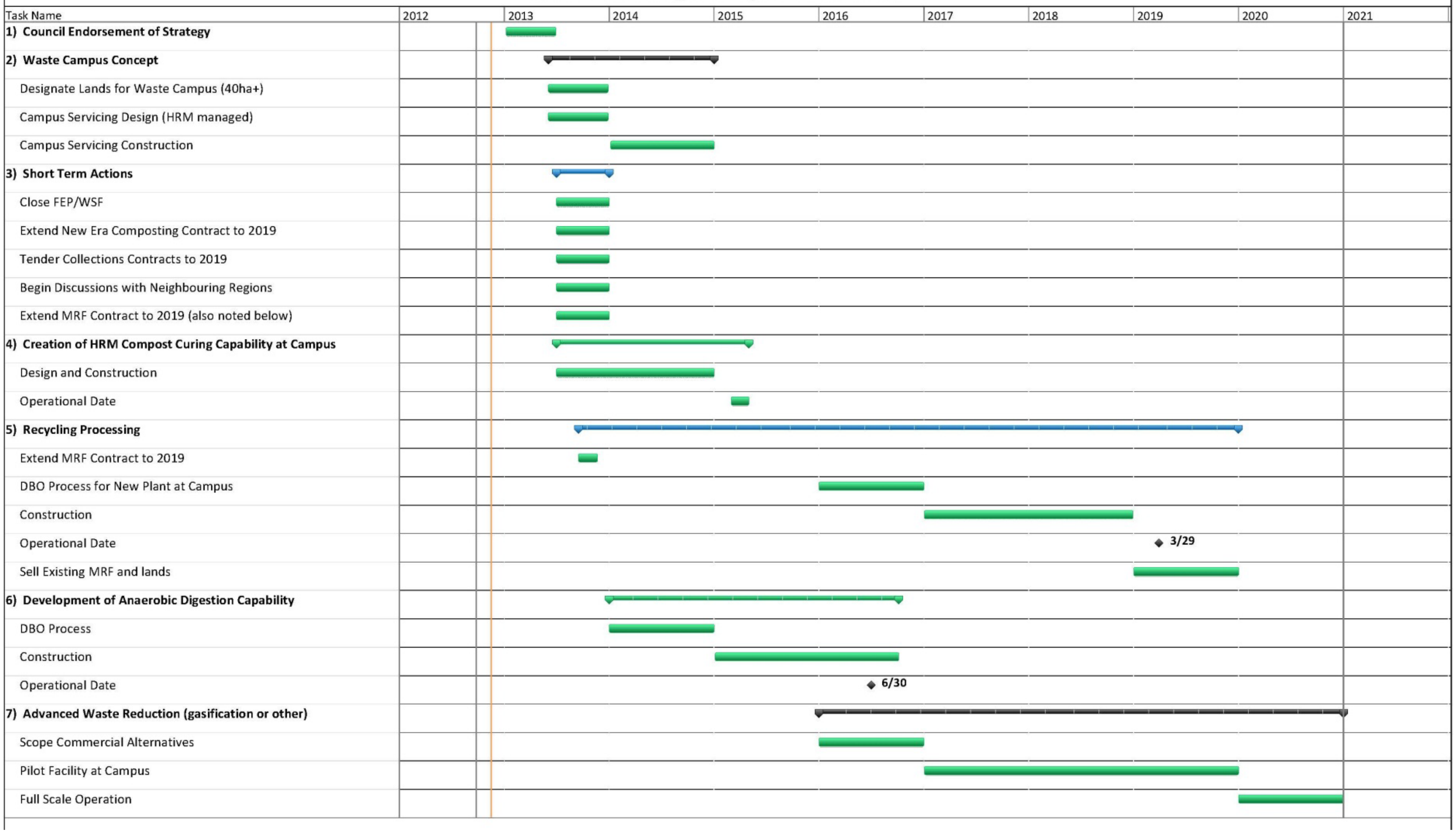
C2 – Control Curing and Sale of Finished Compost

Once organics are processed at facilities in Dartmouth and Halifax, the unfinished product is sold at a nominal fee of $1/tonne at both facilities. HRM has no control over the final maturation process and foregoes the potential for an increase in net revenue generation. The final maturation (also termed “curing”) process typically requires a period of up to one year in outdoor open windrows to meet CCME guidelines and become a saleable product. It is recommended that HRM control the final curing process to ensure guidelines are being met with its compost, and also to gain the benefit of enhanced product value at final maturation.

C3 – Improve Curbside Collection Frequency

Challenges with recovery of divertible materials at the curb are often linked to the frequency of collection. Whether the entire collection system is weekly or every 2 weeks, this does not change the amount of material to be collected on a monthly basis. Residents are far more likely to divert organics and recyclables if collection is performed on a weekly basis so that odour and storage constraints do not affect participation.

Figure 12.1
HRM Waste Resources Strategy Update
Recommended Long-Term Implementation Schedule



13.0 Signatures

This document entitled Waste Resource Strategy Update was prepared by Stantec Consulting Ltd. for the Halifax Regional Municipality. The material in it reflects Stantec's best judgment in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibilities of such third parties. Stantec Consulting Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

All of which is respectfully submitted;

STANTEC CONSULTING LTD.

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APPENDIX A

Dillon Consulting Memo dated September 17, 2012

Dillon Consulting Memo dated September 26, 2012

MEMO

DILLON CONSULTING

TO: Steve Copp –MIRROR NS

FROM: Christopher Shortall

DATE: September 17, 2012

SUBJECT: Potential Maximum Height of the Residuals Disposal Facility – Desktop Viewplanes' Sitelines

OUR FILE: 12-5940

As part of the review of the potential maximum height of the Residuals Disposal Facility (RDF) a desktop exercise of the potential viewplanes from the surrounding communities was completed.

The current permitted maximum elevation of the top of the RDF is 113.0 metres. To determine what the potential visual impact could be if the maximum elevation of the RDF was increased by 1.0 m, 5.0 m, 10.0 m and 15.0 m five view positions were established in the surrounding communities. These locations (assumed a widow on the second floor of a two storey house) along with the sitelines, as identified in **Figure No.1**, were located at:

- McDonald Lake Drive in Hatchet Lake;
- Old Coach Road in Goodwood;
- 4th Street in Lakeside;
- Sprucewood Avenue in Greenwood Heights; and
- Charles Road in Timberlea.

The top of Cell 6 was used as the RDF view position. Five metre mapping from Municipal Services was used to provide contouring. Representative vegetation between the RDF and the view position included tree heights ranging from 8.0 to 12.0 m.

Sightline profiles from the five view positions are discussed below and are presented in **Figure No. 2**.

- McDonald Lake Drive in Hatchet Lake – Line 1
    - The view position is lower in elevation than the RDF with undeveloped land consisting of mature forest between the view position and the RDF. Topography along the profile consists of a gradual slope toward the RDF from the view position with the land leveling off and sloping toward the RDF. Presently, the RDF does not appear to be visible. However, if the height is increased and a different view position selected, the RDF may become visible.
- Old Coach Road in Goodwood – Line 2
    - The view position is lower in elevation than the RDF with undeveloped land consisting of mature forest between the view position and the RDF. Presently, the RDF does not appear

to be visible. However, if the height is increased and from a different view position the RDF may become visible.

- 4th Street in Lakeside – Line 3
  - The view position is somewhat lower in elevation than the RDF with undeveloped land consisting of mature forest, Highway 103 and hilled topography between the view position and the RDF. With a potential increase in height the RDF should not be visible. However, from a different view position selected, the RDF may become visible.

- Sprucewood Avenue in Greenwood Heights – Line 4
  - The view position is lower in elevation than the RDF with undeveloped land consisting of mature forest and Highway 103 between the view position and the RDF. Topography along the profile consists of a gradual slope from the view position to the RDF. Presently, the potential exists that the RDF may now be visible from different view positions in the area. It is probable that the RDF would be visible from this or other view positions if the height is increased.

- Charles Road in Timberlea – Line 5
  - The view position is slightly lower in elevation than the RDF with undeveloped land consisting of mature forest, the Nine Mile River and Highway 103 between the view position and the RDF. Houses in this area are currently visible from the top of Cell 5 as shown in **Photo No. 1**. Buildings in Bayers Lake Industrial Park are visible from the back of Cell 5 as shown in **Photo No. 2** and apartment buildings in Clayton Park are also visible from the back of Cell 5 as shown in **Photo No. 3**. An increase in height would increase the visibility of the RDF to the selected and other view positions in this area.

Please do not hesitate to contact us if you have any questions regarding this submission.

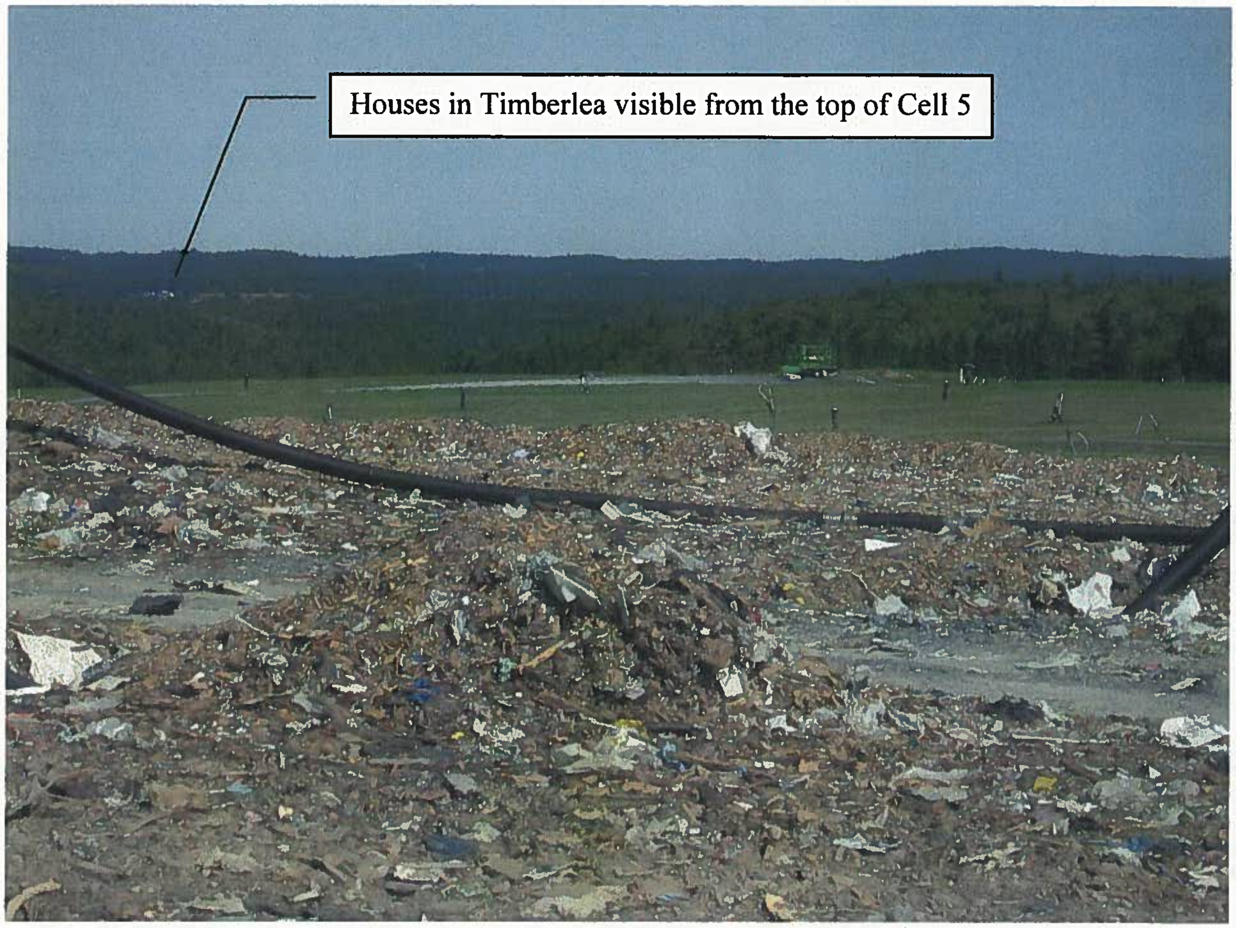


Photo No. 1

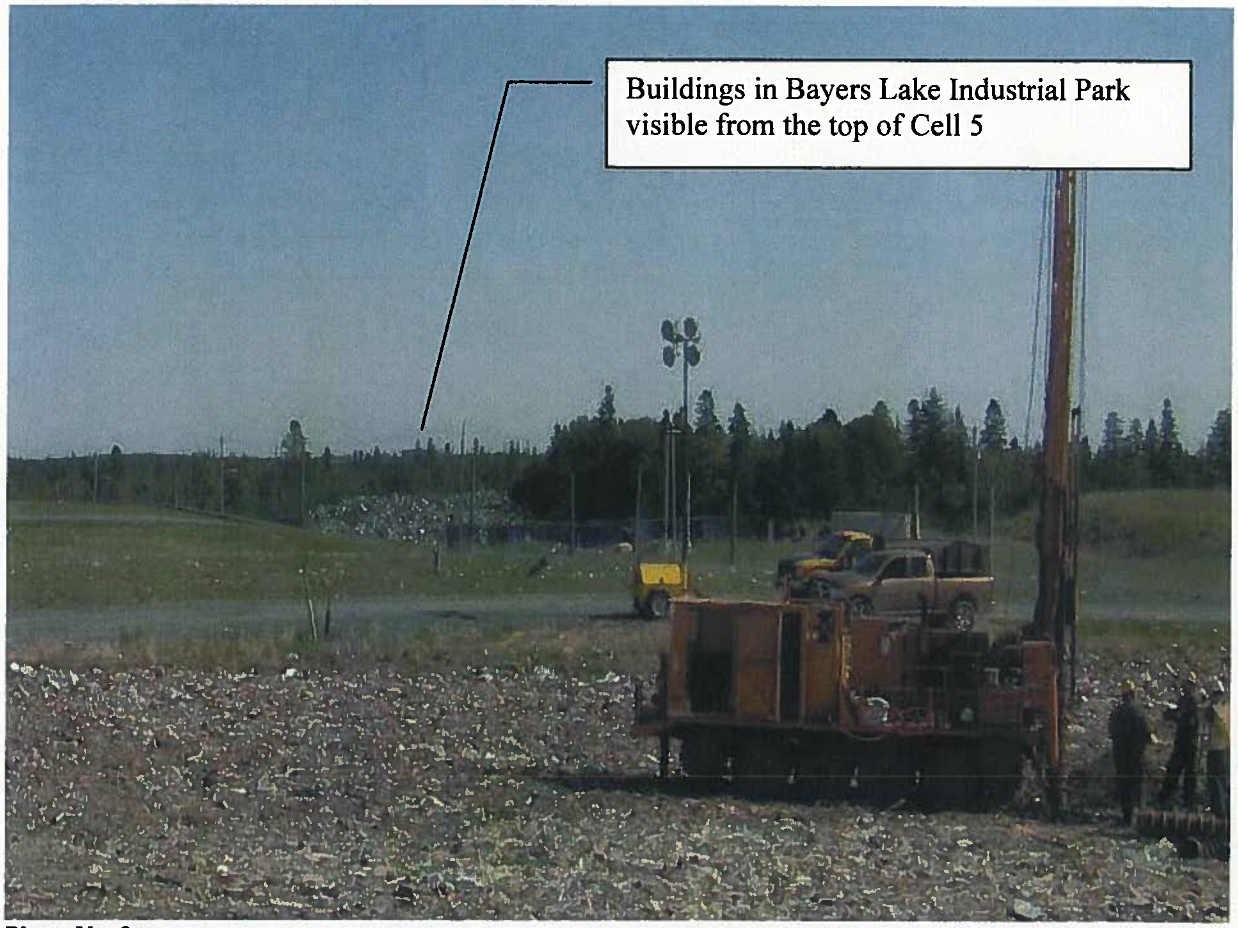
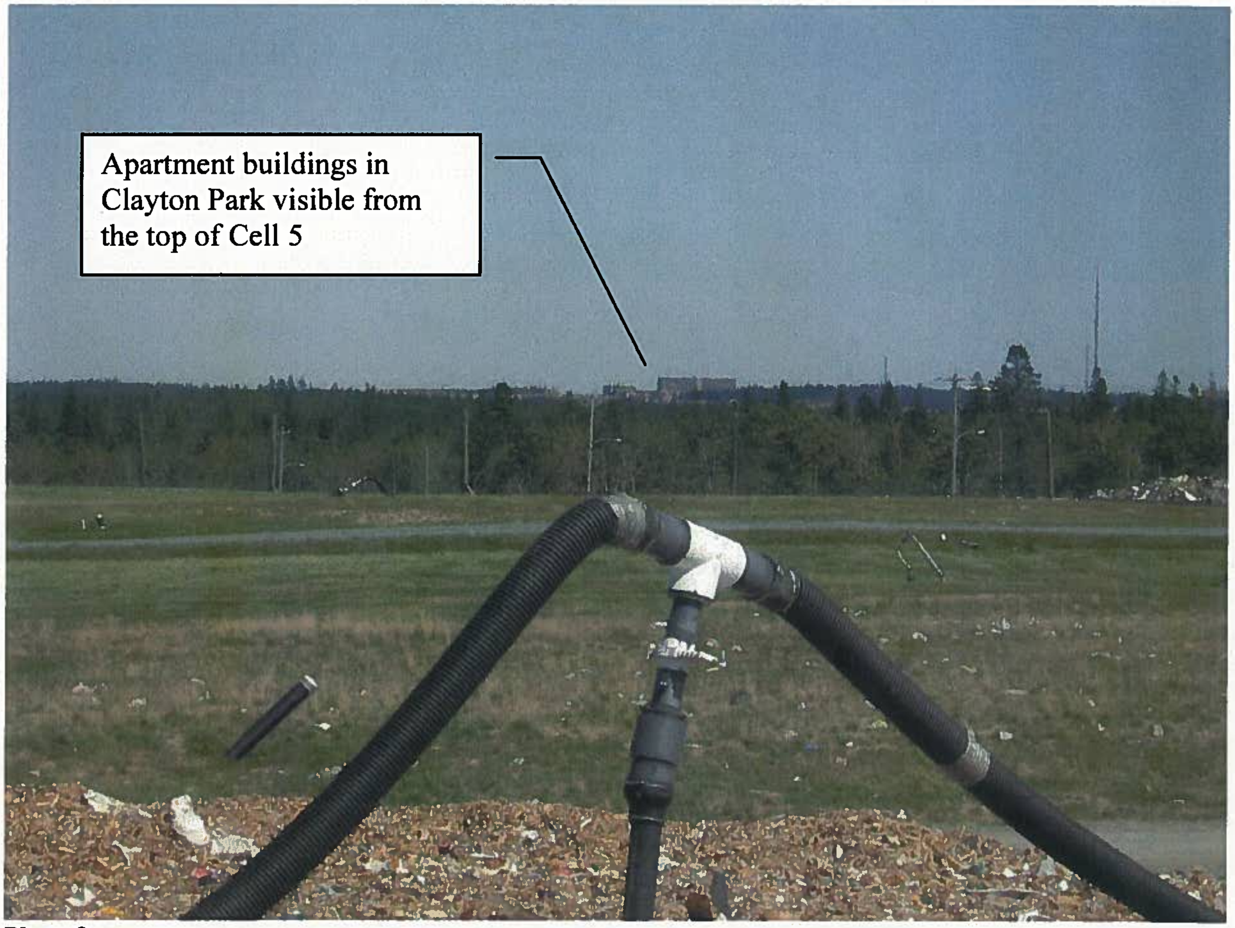
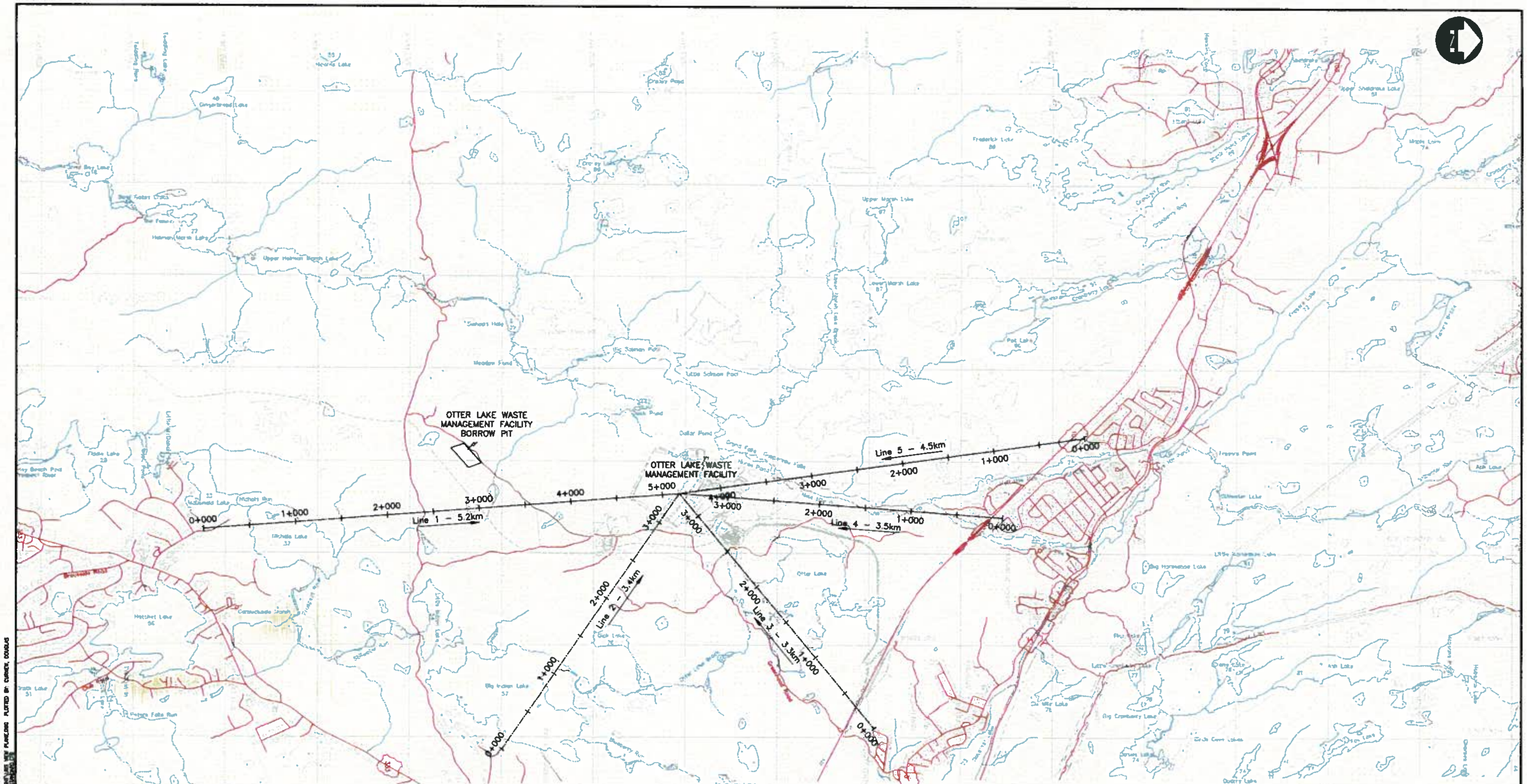

Buildings in Bayers Lake Industrial Park
visible from the top of Cell 5

Photo No. 2


Apartment buildings in
Clayton Park visible from
the top of Cell 5
Photo 3



CAUTION:
HAZARDOUS MATERIALS MAY BE PRESENT ON OR AROUND THE AREA OF WORK.

THERE IS AN EXPLOSIVE HAZARD ON THE SITE DUE TO POTENTIAL METHANE GAS BUILD UP.

Conditions of Use

Verify elevations and/or dimensions on drawing prior to use. Report any discrepancies to Dillon Consulting Limited.

Do not scale dimensions from drawing.

Do not modify drawing, re-use it, or use it for purposes other than those intended at the time of its preparation without prior written permission from Dillon Consulting Limited.

MIRROR NS

DILLON CONSULTING

OTTER LAKE WASTE MANAGEMENT FACILITY
MAXIMUM LANDFILL HEIGHT

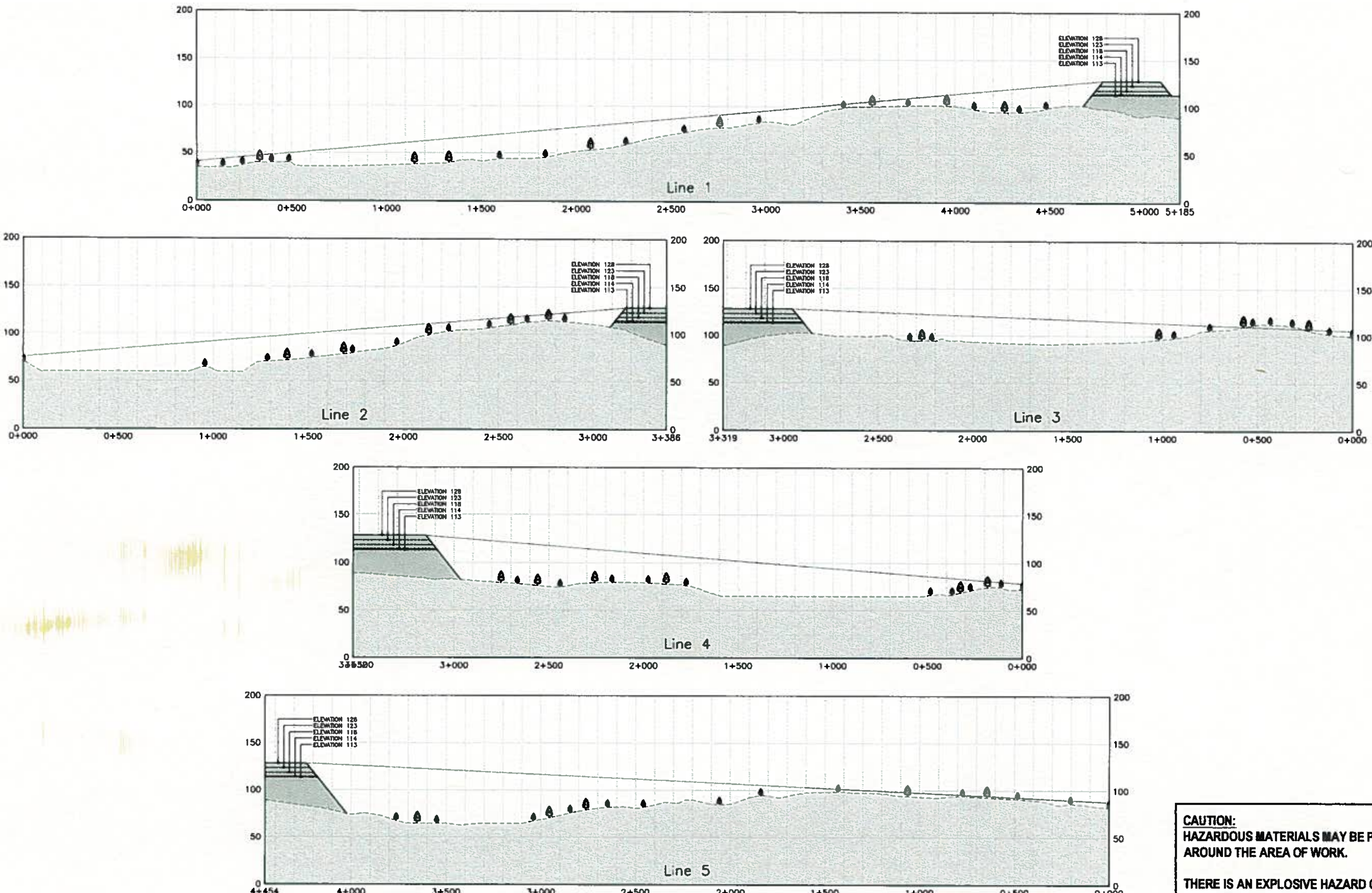
SITE PLAN

JULY 2012

1:20000

12-5940

1



CAUTION:
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MIRROR NS

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JULY 2012

1:10000
1:2000

OTTER LAKE WASTE MANAGEMENT FACILITY
MAXIMUN LANDFILL HEIGHT

PROFILES

12-5940

2

MEMO

TO: Steve Copp – MIRROR NS

FROM: Christopher Shortall

DATE: September 26, 2012

SUBJECT: Potential Maximum Height of the Residuals Disposal Facility – Potential Capacity Modifications

OUR FILE: 12-5940

As part of the review of the change to the potential maximum height of the Residuals Disposal Facility (RDF) a desktop exercise was completed to determine the impact on the potentially available volume/tonnage if the height of the RDF was increased.

The current permitted maximum elevation of the top of the RDF is 113.0 meters. To determine what the potential impact on the available volume/tonnage would be the height of the maximum elevation of the RDF was increased by 1.0 m, 5.0 m, 10.0 m and 15.0 m. The change the potentially available volume and associated tonnage was based on the following information and assumptions.

- Topographic survey of April 2011 of the top of cover in Cell 1 to 4;
- Designed top of Cell 5;
- Topographic survey of December 2010 of the existing ground for Cell 6;
- Topographic survey based on 1996 Air Photo contours for Cells 7 to 9;
- Liner system in Cells 7 to 9 based on the existing liner system;
- Cover in Cells 1 to 4 is removed;
- RDF has 4:1 side slopes
- Density of 800 kg/m^3; and
- A monthly tonnage of 12,000 tonnes.

Based on the above information and assumptions the following tables outline the potentially additional tonnages in Cells 1 to 5 and Cells 6 to 9.

Table 1

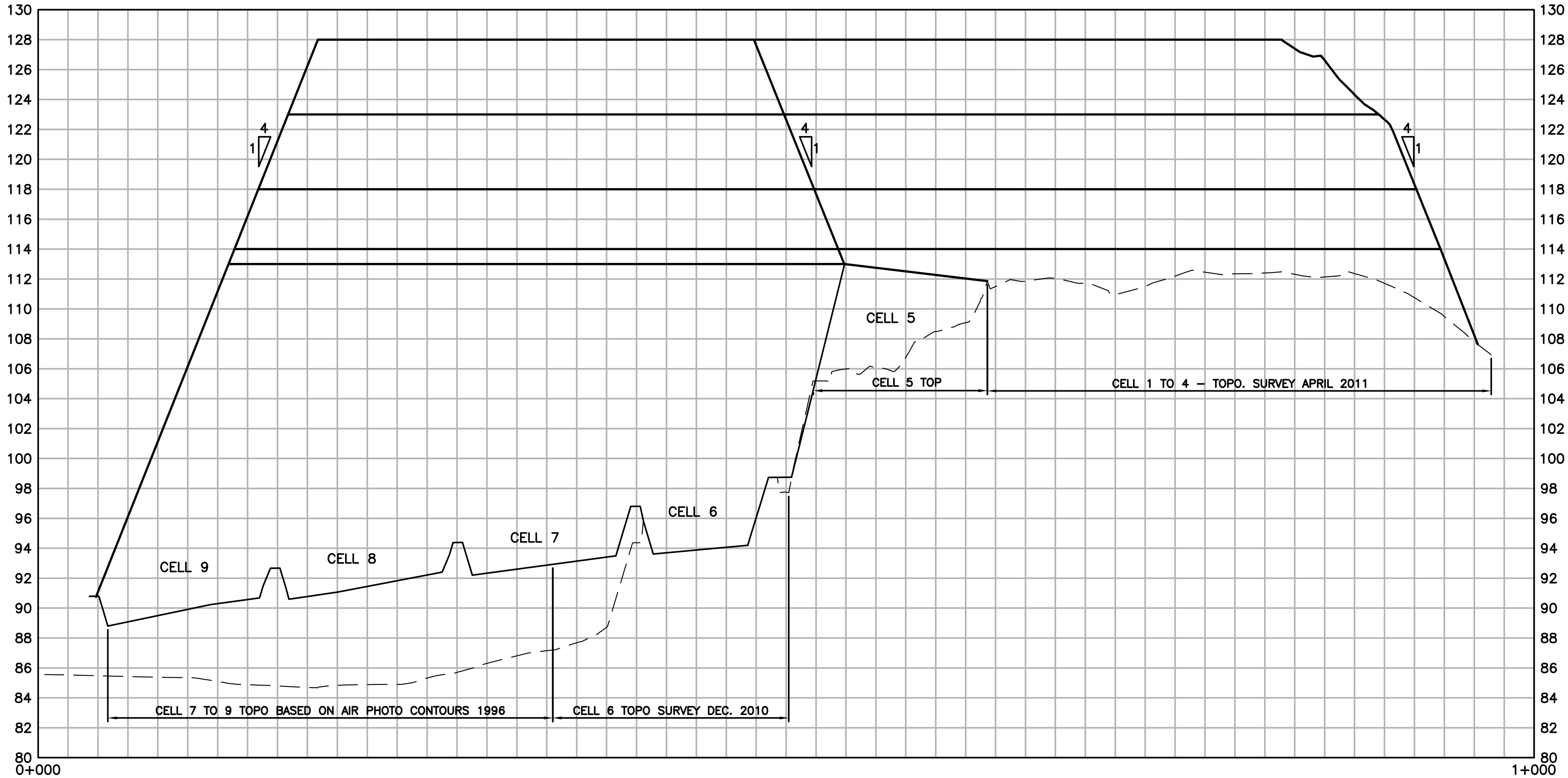
Option	Opinion of Potential Change to Available Tonnage (tonnes)	Opinion of Potential Additional Time (months)
Top of RDF Cell 1 to 5 at elevation 114	294,000	25
Top of RDF Cell 1 to 5 at elevation 118	795,000	66
Top of RDF Cell 1 to 5 at elevation 123	1,350,000	113
Top of RDF Cell 1 to 5 at elevation 128	1,830,000	152

Table 2		
Option	Opinion of Potential Change to Available Tonnage (tonnes)	Opinion of Potential Additional Time (months)
Top of RDF Cell 6 to 9 at elevation 114	140,000	12
Top of RDF Cell 6 to 9 at elevation 118	660,000	55
Top of RDF Cell 6 to 9 at elevation 123	1,190,000	99
Top of RDF Cell 6 to 9 at elevation 128	1,603,000	134

It should be noted that an increase in the height of the top of the RDF may have the following impacts that should be addressed prior to any decision being made to increase the height of the RDF and/or open the existing closed cells:

- Cells 6 to 9 will take longer to fill, increasing the operating duration of each cell.;
- An increase duration between capping events, as Cells 6 to 9 will take longer to reach final grade;
- View-plane impacts for Cells 1 to 5 and Cells 6 to 9;
- Raising the elevation in Cells 1 to 5 essentially requires the replacement of the existing cap systems; only the vegetative cover soils would be reusable. Accordingly, raising the elevation by only one meter would likely not be economically feasible.
- Change in the timeline of the installation and operation of landfill gas collection wells, possibly requiring:
    - the installation of horizontal collection wells,
    - additional vertical wells,
    - longer periods utilizing the temporary collection piping, and
- Operational challenges including:
    - longer and steeper access roads possibly on the top of existing cells increasing differential settlement in the cover,
    - increased leachate production, and
    - tighter coordination of the cell construction and capping cycle.

If you have any questions regarding this submission please do not hesitate to contact us.



N.T.S.

DILLON CONSULTING

PROJECT
OTTER LAKE WASTE MANAGEMENT FACILITY
OTTER LAKE RDF WORK - MAXIMUM LANDFILL HEIGHT

PROJECT NO. **12-5940**

TITLE
PROPOSED INCREASE IN THE MAXIMUM ELEVATION OF THE RDF

FIGURE NO. **1**

DATE **SEPTEMBER 2012**

FileName:g:\cad\125940 otter lake rdf\cell 6 to 9 maximun landfill height\fig1.dwg

APPENDIX B

Drawing No. 01 – Landfill Liner Designs

Stantec
49 FREDERICK STREET
Kitchener, Ontario/Canada
N2H 6M7
Tel. 519.579.4410
Fax. 519.579.6733
www.stantec.com

Consultants

Legend

Notes

1) 60mil = 0.06 inches = 1.5mm

2) Generic option 1 shown. Site specific and generic option 2 also accepted.

Revision	By	Appd.	YY.MM.DD
1 FINAL REPORT	JA	JA	13.01.14
0 DRAFT FOR REVIEW	JA	JA	12.10.17
Issued	By	Appd.	YY.MM.DD

File Name: 161111137_FIG 1.dwg	DC	JA	LY	12.09.26
	Dwn.	Chkd.	Dsgn.	YY.MM.DD

Permit-Seal

Client/Project

HALIFAX REGIONAL MUNICIPALITY

WASTE RESOURCE STRATEGY UPDATE

Halifax, Nova Scotia

Title

LANDFILL LINER DESIGNS

Project No.	Scale	
161111137	NTS	
Drawing No.	Sheet	Revision
01	of	1