Niagara Region and
City of Hamilton

Addendum to:

Evaluation of “Alternatives To” and Selection of a Preferred Disposal System

- DRAFT-

Joint Study on Waste Disposal

July 20, 2007

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Mr. Lydia Torbicki
Manager, Waste Policy and Planning
Public Works Department, Niagara Region
2201 St. David's Road
P.O. Box 1042
Thorold, ON L2V 4T7

and

Ms. Pat Parker
Manager of Solid Waste Planning
City of Hamilton
Solid Waste Management Division
71 Main Street West
Hamilton, ON L8E 4W8

Re: Niagara Hamilton WastePlan, Addendum to Evaluation of "Alternatives To" And Selection of a Preferred Disposal System Report

Dear:

GENIVAR (Formally MacViro), in association with Jacques Whitford Limited, is pleased to provide this Addendum Report to the Niagara Hamilton WastePlan 'Draft Report on the Evaluation of "Alternatives To" and Selection of a Preferred Disposal System' (hereinafter referred to as the Draft Report), which was completed as part of the EA for the Niagara-Hamilton WastePlan Study.

This Addendum Report summarizes the activities that have taken place on the project since December 2005.

The final draft of this report including our responses to the input received will be included as part of an overall package that will comprise the final report on the "Evaluation of Alternatives To" for this phase of the Niagara/Hamilton WastePlan EA Study, to be considered by the Joint Working Group at their scheduled meeting in August, 2007.

Yours truly,

Genivar

D.O. Merriman, M.B.A., P.Eng.
Project Director

Jacques Whitford Limited

Steve Plaice, MCIP, RPP
Environmental Assessment Lead

Executive Summary

ES-1 Why Has This Report Been Prepared?

On December 8th, 2005 the Niagara Hamilton WastePlan 'Draft Report on the Evaluation of "Alternatives To" and Selection of a Preferred Disposal System' (hereinafter referred to as the Draft Report) was presented to the Niagara Hamilton Joint Working Group (JWG) and was then publicly released for review and comment over a 60-day period ending on February 6th, 2006. While approximately half of the comments received were supportive of the recommended long-term disposal system, there were a number of recurring and potentially substantive issues identified in approximately 25% of the comments received. On March 9th, 2006 a Discussion Paper on the Substantive Issues was presented to the Joint Working Group for the purpose of determining a course of action. The Joint Working Group decided to delay the study timelines to allow for additional studies and information collection that, once completed, would allow the municipalities to make their decision on a preferred course for moving forward.

The activities and additional work included:

- A JWG visit to the Otter Lake Waste Stabilization and Landfill facility in Halifax, Nova Scotia;
- Completion of a Stabilized Landfill Study by a third party consultant to confirm assumptions used in the Environmental Assessment (EA) Mechanical Biological Treatment (MBT)/Landfill Systems;
- Completion of a review of available industrial lands within the urban boundaries of the two municipalities;
- Completion of a sensitivity analysis on the original comparison of alternative systems to confirm or adjust, as required, the outcome of the systems evaluation.

In addition to the additional work, there have been developments outside of WastePlan that have also been reflected in the sensitivity analysis and this Addendum Report including:

- Approval of the expansion of the Niagara Waste Systems (NWS) Landfill;
- Niagara Region's Review of Long-term Landfill Utilization;
- New Provincial Regulation on Waste Management (enacted March 23,07) and Policy Statement (draft issued for review);
- Consultant Team Review of Available Life Cycle Analysis Tools;
- Updated Data on Existing Facility Performance for System Alternatives; and
- Updated Municipal Diversion Rates.

This Addendum Report has been prepared to:

- Document the activities and additional work that has been completed and address developments that have occurred since the Draft Report was issued; and
- Examine how the additional information and data would potentially impact on the recommended "Alternatives To" system, System 2b) Thermal Treatment with recovery of metal.

ES-2 What Are The Findings Of The Additional Work?

Tour of the Otter Lake Waste Stabilization Facility

The tour of the Otter Lake Waste Stabilization Facility provided the JWG a better understanding of the operation of an MBT System and stabilized landfill operation, based on a low to medium intensity composting approach and some understanding of the siting requirements for this type of facility.

Stabilized Landfill Study

The Stabilized Landfill Study (SLS):

- Reviewed site-specific data from two conventional and three stabilized landfills (including the Otter lake facility);
- Reviewed information available in the literature on other stabilized landfills located in the European Union (EU) and general experience with such landfills in the EU; and
- Reviewed information available on the overall policy context within which stabilized landfills were developed within the EU.

Some of the key conclusions of the SLS include:

- The landfilling of highly stabilized waste results in lower emissions of some parameters in leachate and reduced landfill gas production.
- Waste stabilization can have some beneficial effects on landfill operations such as reduced odour and bird nuisances, increase in service life of leachate collection systems and reduced landfill settlement.
- Waste stabilization can have some negative effects on landfill operations related to blowing litter and increased potential for leachate seeps.
- The assumptions used in the Draft Report for elements such as landfill size, height, depth, and waste density are generally supported by the data collected in the SLS.
- The WastePlan EA assumptions regarding facility location (i.e., that a stabilized landfill facility could not likely be sited within an urban or industrial area) cannot be refuted or substantiated based on the limited number of stabilized landfill site settings examined as part of this research study and the absence of information regarding the siting processes used in the EU and other site specific impact management information (e.g.,

compensation, community relations measures, etc). While the likelihood of siting success and the magnitude of impacts will be very site specific and dependent upon the nature of the siting process, the data collected regarding highly stabilized landfills in the EU and domestic experience with conventional landfill sites suggests that the siting of a highly stabilized landfill site is possible in a variety of land use settings.

Screening of Lands in Urban Designation for Stabilized Landfill

The screening of stabilized landfill opportunities included:

- Contact with the municipal properties divisions in Niagara and Hamilton to determine if there is an inventory of industrially designated publicly owned lands;
- Contact with the planning departments of the Region of Niagara and City of Hamilton, as well as with the local municipal planning departments within the Region of Niagara to identify industrial land in regards to both Official Plan and Zoning designation;
- Documenting the initial screening of industrial lands and other opportunities that have the potential for siting a stabilized landfill for the residual wastes from an MBT facility.

Based on the review completed, there are limited parcels of sufficiently sized lands to support a stabilized landfill of sufficient size for Niagara/Hamilton residues (30 – 50 hectares). It should be noted however, that this determination is prior to the application of any typical landfill siting constraints such as sensitive hydrogeological or natural environments; suitable / unsuitable background locations (e.g. some brownfield site conditions may represent a constraint to landfill development); and sensitive land uses.

ES-3 What Are The Findings Of The Sensitivity Analysis?

The intent of the sensitivity analysis was to determine

- The degree to which the results of the evaluation of "Alternatives To" as documented in the Draft Report released in December 2005 are reasonable considering the results of public review of the document and updated information that has become available since December 2005; and
- The degree to which the results would change if updated information or 'improved' assumptions are used to determine the potential effects of the alternative systems. Will it change the outcome of the evaluation process significantly, slightly or not at all?

The methodology used to undertake the sensitivity analysis and determine the degree to which one alternative system is preferred over another was developed to address the results of additional work, new information resulting from developments outside of WastePlan and the substantive issues identified through public consultation. It is not a traditional sensitivity analysis where only one parameter is varied to determine if this would result in a change in the outcome of system evaluation.

In this case, to address the substantive issues and new information, a number of parameters have been combined to develop improved system assumptions, and these improved assumptions have been used to complete a comparative evaluation of 'improved systems', as follows:

1. The development of improved system assumptions to address concerns expressed during the review of the study documentation, or where new information indicates that improved assumptions are warranted.

2. Comparing updated alternative systems based on the improved assumptions, using the qualitative pair-wise comparative evaluation methodology used in the EA Study. This comparative evaluation was undertaken based on applying the same criteria used in the evaluation of alternative systems as documented in the Draft Report, and the same relative priority of the criteria that was confirmed through public consultation.

3. Determining if, as a result of the comparative evaluation of systems based on improved assumptions, revisions are warranted to the evaluation of the alternative systems.

Improved system assumptions were developed and applied for the following systems:

- MBT & Stabilized Landfill (System 1, representing a generic system with biological treatment based on use of aerobic composting, noting any differences if anaerobic digestion were used);
- Municipal Solid Waste (MSW) Landfill with LFG Recovery (System 3b);
- Thermal Treatment of MSW with Metals Recovery (System 2b);
- Thermal Treatment of Alternative Fuel (System 2c).

The key improvements to the system assumptions included:

- Assuming that at-source diversion rates improve from 65% to 70% over the planning period, and that as a result the annual quantity of residual waste remains as 151,000 tonnes per year over the 25 year planning period notwithstanding population growth;
- Use of an improved Life Cycle Analysis (LCA) model, the Municipal Solid Waste, Decision Support Tool (MSW-DST) to determine net emissions to Air and Water and net Energy Generation;
- Assuming for System 1, the production of a highly stabilized waste material through MBT in accordance with a high-intensity composting process as discussed in the Stabilized Landfill Study; and siting of the stabilized landfill component of the system on a suitably sized area of urban/industrial land, assuming land of this nature and size is available within the study area. In addition, the effect on landfill size assumptions of Niagara using the NWS site for disposal of its portion of well-stabilized waste and the marketing of Class B compost is noted.
- Assuming for System 3b) that Niagara Region uses the NWS site for the disposal of its share of residual waste, and that new landfill capacity is developed for Hamilton waste.
- Assuming for System 2b), that emissions controls would be based on best available technology, that both electrical and heat energy would be recovered and marketed; and that bottom ash would be processed to recover granular material for use in construction applications.
- Assuming for System 2c), that the MBT component of the system would generate a Refuse Derived Fuel (RDF) material that is marketed either inside or outside the study area for use

as a substitute fuel for industrial processes that currently use coal, oil or petroleum coke (e.g. a cement kiln).

The comparative evaluation of the systems, based on the improved system assumptions indicates that:

a) When comparing the two landfill based systems, System 1 MBT/Stabilized Landfill and System 3b), System 1 remains the more preferred system, having lower overall potential for impacts to the environment and social/cultural impacts related to siting.

b) When comparing the two thermal based systems System 2b) and 2c) under improved assumptions, System 2c) Thermal Treatment of Alternative Fuel would be preferred over System 2b) as it has lower overall potential for environmental impacts as well as slightly lower system costs and no need for a new thermal facility. However, if the improved assumptions for System 2c) on the ability to market Refuse Derived Fuel (RDF) for use in industrial applications are determined not to be reasonable, System 2b) under original or improved assumptions would be preferred.

c) When comparing System 2c) and System 1, System 2c) would be preferred over System 1 as it has lower overall potential for impacts to the natural environment and social/cultural impacts as well as lower overall system costs.

Application of improved system assumptions in this sensitivity analysis indicates that:

- The results of the evaluation of "Alternatives To" as documented in the Draft Report released in December 2005 are reasonable. While the application of improved system assumptions did result in some changes in the advantages and disadvantages of the systems, based on application of the study criteria and consideration of study priorities, thermal treatment systems continue to be preferred.
- If the improved system assumptions have equal probability of occurring, that is if both a market for heat from a thermal facility were available in Niagara/Hamilton and there was a market for RDF in an industrial application, then System 2c) could be more preferred then System 2b). However, if a market for RDF is not available, then System 2b) would continue to be the preferred system.

ES-4 What Has Been Concluded?

The Draft Report identified System 2b) *Thermal Treatment of MSW and Recovery of Materials from the Ash/Char*, as the preferred system based on broad consideration of potential impacts to the natural, social/cultural, technical, economic/financial and legal/jurisdictional environment. Since the Draft Report was issued in December 2005, no new information has been received that brings into question the integrity of the original study assumptions or the results of the comparative evaluation of the systems.

The following variables would have to increase in probability to justify a change to the system analysis that was originally presented in the Draft Report:

- For System 1, sufficiently sized suitable lands located in more urban / industrial rather than agricultural / rural resource lands would have to be available within the Study Area. These lands would have to be free of other constraints that would prevent their use as stabilized landfill. Land area requirements and impacts would be further reduced if the NWS landfill were used for disposal of Niagara's portion of residue and/or if a portion of the stabilized material was marketed as Class B compost.

- The availability of an adjacent industrial user of heat (in the form of steam or hot water), or increased feasibility for a district heating system would decrease the net air emissions from a thermal treatment plant and improve the economics or cost benefit of System 2b) reducing the most significant disadvantages of the system.
- To increase the potential for System 2c) to be preferred, industrial markets for RDF are required. Although the approvals process for producers and users of RDF has improved, it remains to be seen if over the next few years, industries such as the cement industry in Ontario seek and receive approval to use RDF in lieu of fossil fuels.
- The outcome of negotiations between Niagara Region and Niagara Waste Systems for use of private sector landfill space could increase the potential for System 1 or System 3b) to be preferred, but only if the priorities for the study were significantly altered such that costs are considered to be paramount.

The conclusions reached in the Draft Report are reasonable and would not change as a result of the public consultation or additional study over the past 18 months, or as a result of the sensitivity analysis documented in this addendum. However, if future conditions should arise that increase the probability of the improved system assumptions, the results of system analysis and evaluation could change.

For example the results of the sensitivity analysis indicate that System 2c) may be more preferred to 2b) if RDF generated by System 2c) could be marketed to an industrial user such as a cement kiln, replacing fossil fuels (e.g. coal, petcoke) that would normally be used. In this situation there would be no need to develop a Niagara/Hamilton thermal treatment facility and only the MBT component of this system would be required to produce RDF.

ES-5 What Now?

Since the issuance of the Draft Report in December 2005, some of the impetus to proceed with the Niagara/Hamilton WastePlan EA Study has decreased. Niagara Region now has the option to secure additional landfill capacity at the expanded Niagara Waste Systems landfill. The Glanbrook landfill in Hamilton has sufficient disposal capacity for approximately 20 to 30 years.

Allowing for some additional time prior to proceeding with selection and approval of a preferred long-term disposal system would provide an opportunity for both municipalities to determine if:

- circumstances could support any of the improved assumptions for the disposal systems.
- a partnership approach is required to implement the system that best suits the needs of each municipality; and/or
- community priorities have changed to the extent that the criteria and priorities used in the evaluation of Alternatives To for the WastePlan study are no longer applicable.

The following next steps are recommended for consideration by the Niagara/Hamilton Joint Working Group in the event that the municipalities are not ready to proceed with the selection of the preferred system and the next steps of the WastePlan EA Study:

Recommendation 1

That the "Evaluation of Alternatives To, and Selection of a Preferred Disposal System" be concluded at this point in time, with the retention of Systems 1, 2b) and 2c) for consideration if and when the municipalities are ready to proceed with the WastePlan EA Study.

It is recommended that these three systems be retained as:

a) under both the conservative assumptions applied in the Draft Report and under the improved assumptions assumed in Section 5 of this Addendum Report, these systems have greater advantages than the landfill only System 3b); and

b) the outcome of the comparative evaluation of Systems 1, 2b) and 2c) can change based on the application of conservative or improved assumptions.

Recommendation 2

If and when it is determined by Niagara Region and the City of Hamilton that the WastePlan Study should resume, a final determination of the preferred system would be undertaken to consider conditions or circumstances that may have changed to increase the probability for successful implementation of any of the Systems 1, 2b) and 2c) under the improved system assumptions.

Recommendation 3

If and when it is determined by Niagara Region and the City of Hamilton that the WastePlan Study should resume, an initial public consultation step be undertaken to determine if there have been any changes in community priorities before completing the selection of the preferred system.

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Part A – Addendum Background & Purpose

1. Introduction and Background

1.1 Purpose and Scope of Addendum Report

This Addendum Report has been prepared for the purpose of responding to public and agency comments received on the December 2005 Niagara Hamilton WastePlan 'Draft Report on the Evaluation of "Alternatives To" and Selection of a Preferred Disposal System' (hereinafter referred to as the Draft Report) which presented the consultant team's evaluation of alternative disposal systems and a recommended preferred system. Most of 2006 was spent by the consultant and staff team and the Joint Working Group completing additional work necessary to respond to comments. This report presents the results of that additional work. Given the lapse in time since release of the Draft Report, this addendum also provides updates in existing conditions (e.g. policy environment, existing program and facility performance, etc.) that have arisen over the last year.

It is intended that this Addendum Report provide the Joint Working Group and the respective municipalities the required information to make a decision on how best to proceed with the planning of required future waste disposal capacity.

1.2 Report Content

This report has been prepared in eight sections, which describe the background, data collected, its analysis and development of corresponding recommendations. Also included are a series of Appendices which provide additional detail in support of the main text and recommendations should this be required by the reader. The following overviews the purpose and content of the respective report sections and appendices:

- **Section 1** describes the purpose of this addendum and relevant background including a summary of the public and agency comments on the December 2005 draft report, the identification of resulting issues, and direction from the Joint Working Group (JWG) on how to proceed with addressing certain issues. This section also overviews some key updates in existing conditions that have developed since March 2006 when the JWG last considered the alternative systems' evaluation.

- **Section 2** describes a tour of the Otter Lake Waste Stabilization Facility in Halifax, Nova Scotia taken by representatives of the JWG. This facility was referenced by a number of parties that had concerns with the results of the original system evaluation.

- **Section 3** overviews the results of a Stabilized Landfill Study (SLS) which was undertaken by an independent consultant team to review existing systems and facilities both locally and internationally for the purpose of confirming assumptions on facility design and level of impact used during the original evaluation. This Section also provides an assessment of the SLS results for the purpose of application to the alternative systems with an improved set of performance assumptions described in Section 5.

- **Section 4** describes the review of potentially available lands for the development of a stabilized landfill within the urban designation and off of designated rural/agricultural lands should it be determined that a stabilized landfill is a suitable use for location within the urban designation. This review is undertaken with consideration to potentially revised site area requirements as a result of the Stabilized Landfill Study described in Section 3.
- **Section 5** describes the results of a sensitivity analysis on the evaluation of alternative systems using a revised set of performance/impact assumptions that were developed based on public and agency feedback on the original evaluation and on updated facility performance data that has been made available since 2005. The revised assumptions essentially result in a set of improved operating conditions for each of the systems evaluated and allow for their consideration under 'best-case' scenarios in the future. This section also describes the application of a different life-cycle analysis modelling tool which became available to the project team during 2006 and which allows for a more thorough evaluation of the alternative systems. The rationale and results of using this model on both the original and improved system operating conditions is described.
- **Section 6** describes the results of a recent review of long-term landfill utilization options undertaken by Niagara Region, which considers the potential availability of 'third party' disposal capacity to the Region and its potential impact on the need to continue the WastePlan EA study in partnership with the City of Hamilton at this time.
- **Sections 7 and 8** provide the key conclusions and recommendations resulting from the analysis undertaken and presented in this Addendum Report.

1.3 Draft Report on Recommended Long Term Disposal System

The Draft Report on the "Evaluation of "Alternatives To" and Selection of a Preferred Disposal System" was presented to the Niagara Hamilton Joint Working Group on December 8th, 2005 and was then publicly released for review and comment over a 60-day period ending on February 6th, 2006. In this report and accompanying series of annexes, the results of this initial EA step – identification of a preferred long-term waste disposal system for Niagara and Hamilton – was presented along with the background studies and supporting rationale. Based on the comparative evaluation process the Draft Report identified System 2B – Thermal Treatment of Mixed Waste, with Recovery of Energy followed by Recovery of Materials from Ash/Char and landfilling of residues –as the system which offers the preferred balance of advantages and disadvantages given the environmental priorities established by the study area communities and Joint Working Group.

1.4 Public and Agency Review of Draft Report

A formal 60-day commenting period for the Draft Report began on December 8th, 2005 and ended on February 6th, 2006. During that period:

- The draft report and supporting documents were made available on the WastePlan web site (www.wasteplan.ca), hard copies of the executive summary, full report and annexes were distributed upon request and as appropriate to municipal facilities and committees and various agencies to facilitate review of the document.

- Three delegation sessions were held on January 11, 2006 (Stoney Creek Municipal Office, 9 to 11 a.m.); January 16, 2006 (Hamilton City Hall, 7 to 9 p.m.); and January 17, 2006 (Niagara Region Headquarters, 7 to 9 p.m.);
- Presentations were made on the draft report to the Hamilton Waste Reduction Task Force; Niagara Waste Management Advisory Committee; Hamilton Public Works Committee and Niagara Joint Public Works and Planning Committee.

As noted in Section 2.1, comments were received from a number of members of the public, non-governmental organizations, governmental agencies, boards, commissions and authorities and waste management industry representatives.

1.5 Issues Discussion (March 10, 2006 JWG Meeting)

A total of 106 comments were received on the Draft Report in writing and at delegation meetings. While approximately half were in support of the recommended system, there were a number of recurring and potentially substantive issues identified in the comments received.

Recognizing that some of the issues identified would require additional work to address, a discussion paper was prepared representing an initial response to some of the more substantive issues identified during the review of the Draft Report on the “Evaluation of “Alternatives To” and Selection of the Preferred Disposal System”. A copy of the Discussion Paper on Substantive Issues is included in Appendix I. This paper was presented to the Joint Working Group on March 9th, 2006 for the purpose of determining a course of action for the substantive issues. Detailed responses to all of the comments received have been prepared and are included in Appendix II of this report.

As noted above, over the course of the commenting period on the Draft Report on “Alternatives To”, a total of 106 comments were received in writing and at delegation meetings from:

- The general public in Niagara and Hamilton;
- Some members of the general public outside the Study Area;
- Waste management, environmental and ratepayer committees in Niagara and Hamilton;
- Non-governmental organizations both within and outside the Study Area;
- Municipal government departments and area municipalities;
- Local boards, commissions and authorities;
- Provincial Agencies; and
- Waste management industry companies and organizations.

Of these comments:

- Half were supportive of the recommended long-term disposal system with many of these submissions offering additional comment on the recommendation;

- 25 or roughly 25% of the comments were critical in nature and offered comments on the recommendation;
- 28 or roughly 25% of the comments fell under the category of 'Other' comments, being either neutral in regards to the recommendation or addressing other matters related to the EA process or waste management in general.

Appendix II presents a summary table of the comments provided regarding the Draft Report and responses to these comments. The primary source for the substantive issues identified by commenting parties were non-governmental organizations, some of which were organizations based in the study area and some from organizations from outside the study area. From those parties with concerns, the following potentially substantive issues were identified related to the recommended long-term disposal system and the Draft Report:

- Adequacy of EA Process
- Adequacy of Evaluation Criteria and Application of Criteria
- Adequacy of Evaluation Methodology
- Nature and Fate of Contaminants from Recommended System
- Relationship of Recommended System and Waste Diversion
- Alternative System Design and Siting Assumptions
- Consideration of Costs and Affordability
- Consideration of the 2C- Alternative Fuel System.

1.6 JWG Decision on Next Steps – March 10, 2006

On March 10th, 2006 the Joint Working Group issued a media release announcing a delay in the study timelines to allow for additional studies and information collection that, once completed, would allow the municipalities to make their decision on a preferred course for moving forward. The JWG also approved the following activities and additional work to be completed:

- A JWG visit to the Otter Lake Waste Stabilization and Landfill facility in Halifax, Nova Scotia;
- Completion of a Stabilized Landfill Study by a third party consultant to confirm assumptions used in the EA regarding MBT/Landfill Systems;
- Completion of a review of available industrial lands within the urban boundaries of the two municipalities;
- Completion of a sensitivity analysis on the original comparison of alternative systems to confirm or adjust, as required, the outcome of the systems evaluation.

This additional work has now been completed and the results are presented in this Addendum Report.

1.7 Discussion of Developments Since March 2006

Since the Joint Working Group directed that additional work be undertaken there have been some developments that relate to the management of waste for one or both of the municipalities. Some of these developments are not directly related to the EA study under consideration but could have an impact on how or if the study proceeds in accordance with the existing approved EA Terms of Reference. These are briefly described below and are expanded upon, as required, throughout the report.

Niagara Waste Systems Landfill Approval

In November 2006 the Province issued Environmental Assessment Act (EAA) approval for an expansion to the existing Niagara Waste Systems Limited (NWS) landfill owned by Walker Industries and located in the City of Niagara Falls. This approval included a provision for the NWS landfill to accept 100,000 tonnes per year of waste from the Region of Niagara over an approximate 20 to 25 year period. Section 6 of this report provides additional detail on Niagara Regions review of long-term disposal options.

New Provincial Policy and Regulation on Waste Management

On March 23, 2007 the Ministry of the Environment enacted regulations amending the EAA approval requirements and processes for obtaining approvals for certain waste management facilities. Of particular relevance to the WastePlan EA study was the provision of a more focussed screening process for EAA approval of thermal facilities with an energy component and an allowance for existing studies considering a thermal option to convert to this process. Both Niagara and Hamilton considered this option and while Niagara Council agreed with keeping the options open Hamilton Council did not support the option of the screening process. As such the WastePlan EA process is continuing in accordance with the approved EAA Terms of Reference.

Subsequently, in June 2007, the Ministry of the Environment released a draft policy statement on waste management planning entitled 'Best Practices for Waste Managers'. In this draft statement, the Province formally identifies a hierarchy of waste management practices entitled the 'Waste Value Chain', which is premised on the resource value of waste materials. The policy statement maintains a Provincial diversion goal of 60% and identifies both thermal treatment and landfill as potential disposal options for residual materials. The background system planning and work completed to date on the WastePlan EA by Niagara and Hamilton is consistent with this draft policy statement and, in fact, exceeds its diversion expectations.

Review of Available Life Cycle Analysis Tools

The original life-cycle analysis modelling was completed during 2005 using the Integrated Waste Management (IWM) modelling tool which was deemed the best available at that time for Niagara and Hamilton's EA study purposes. Since that time, there have been developments in other models that have been reviewed on an ongoing basis and applied by the EA consultant team. These models, and in particular the United States Environmental Protection Agency (US EPA) Municipal Solid Waste Decision Support Tool (MSW-DST) have been found to better represent a full life-cycle analysis allowing for specific local conditions and that would better accommodate some of the system scenarios originally evaluated by the WastePlan study and other scenarios being considered in this Addendum Report. Additional detail on this model and its application to the WastePlan EA study is provided in Section 5 of this Addendum Report.

Updated Data on Existing Facility Performance for System Alternatives

Over the course of 2006 and into 2007 additional data has been compiled related to performance assumptions on various system components and in particular those related to stabilized landfill and thermal facilities. This additional data is from existing facilities operating around the world. Section 3 of this Addendum Report discusses the additional data on stabilized landfill sites compiled by a Stabilized Landfill Study during 2006. Section 5 of this Addendum Report identifies additional data compiled from emissions monitoring at existing facilities in North America and its consideration in the updated systems comparison.

Municipal Diversion Rates

Both Niagara and Hamilton have continued to make progress to meet diversion goals. Municipal diversion rates for 2005 in both municipalities have been reported as 46% for Niagara Region and 30% for the City of Hamilton. Niagara Region does not have a final diversion rate for 2006, however Hamilton has confirmed their rate has increased to 40%.

Part B – Results of Additional Work on Evaluation of Alternatives

2. Tour of Halifax's Otter Lake Waste Stabilization Facility and Landfill

A tour of the Otter Lake Waste Stabilization Facility was undertaken by a contingent of staff and Joint Working Group (JWG) members in June 2006 and was reported upon at the July 13, 2006 JWG meeting. The observations from this tour were intended to provide the JWG a better understanding when receiving the results of a Stabilized Landfill Study being commissioned to obtain a broader perspective on this type of operation and to assist in reviewing the siting requirements for this type of facility.

A memorandum prepared by the consultant team on observations from this tour and considering some historic data / observations provided by the Halifax Regional Municipality is provided in Appendix III.

3. Stabilized Landfill Study (SLS)

3.1 Purpose and Background for Stabilized Landfill Study (SLS)

Some of the comments received on the EA Study documentation reporting the initial results of the comparison of alternative disposal systems questioned several of the siting, design and operational assumptions related to the stabilized landfill Systems 1a) and 1b). In particular, the March 9, 2006 Issues Discussion Paper presented to the JWG summarized the issue as (italics represent text copied directly from this Discussion Paper):

> *“The assumption that the landfill component of the Mechanical Biological Treatment (MBT) system would need to be sited in a rural/agricultural area is flawed. Once the residual wastes have been stabilized, they could be landfilled at a site in an urban/industrial area.”*

The initial response to the issue provided in the Substantive Issues Discussion Paper was as follows:

> *“Throughout the evaluation of alternative systems it has been assumed that even with an MBT component for the intended purpose of ‘stabilizing’ waste prior to landfilling, a ‘stabilized landfill’ would still need to be sited in a rural/agricultural setting away from receptors of potential nuisance impacts from a landfill operation. Based on the consultant team’s first-hand experience with these types of operations and in particular the Otter Lake Residual Waste Stabilization and Disposal Facility in Halifax, Nova Scotia, the stabilized landfill being contemplated in Alternative System 1 would be characterized as follows:*
>
> - *Generation of a ‘weaker’ strength landfill leachate (particularly with regard to BOD compared to leachate from a typical MSW disposal facility) requiring treatment at a water pollution control plant;*
> - *Speculation that the contaminating lifespan of the landfill will be reduced compared to a typical landfill due to advancement in the decomposition of the organic materials by way of the stabilization facility;*
> - *The absence of birds and rodents on the site – likely due to the absence of any readily accessible food waste material for scavenging;*
> - *Windblown litter on and around the landfill facility similar to that which one would experience at a typical MSW landfill disposal facility;*
> - *Generation of particulate (i.e. dust) similar to that which one would experience at a typical MSW landfill disposal facility;*
> - *Generation of landfill gas, resulting in the need to construct a full landfill gas collection system including flares; and,*

- *Placement, compaction and covering of the 'stabilized waste materials' in the landfill in a manner that would not readily facility future removal of materials for which recycling markets may develop in the future.*

A recent and ongoing review of MBT systems elsewhere[1]*, and in particular Europe where the use of MBT is most prevalent, has not identified any circumstances comparable to that being contemplated for System 1 (i.e. of the facilities identified all include an RDF/alternative fuel component for thermal treatment) nor a situation where the landfill component has been sited in an urban/industrial area.*

Based on these observations, which from a nuisance standpoint appear to mimic a typical MSW landfill operation, it would be unreasonable to assume that such a facility could be located in an urban area. Even if this approach to siting was pursued, it is questionable whether or not a sufficient area of industrial lands could be secured that would provide for a sizable buffer area around the waste footprint. A cursory review of industrial land availability in Niagara and Hamilton could be undertaken to confirm this suspicion. If such a facility were developed in an urban industrial area it could have a significant negative economic impact on neighbouring industrial development within the host community and remove other economic development opportunities for serviced industrial lands.

The only other alteration to the siting assumption of rural/agricultural lands for a System 1 landfill could be a review of existing landfill operations in both municipalities (e.g. remaining approved or potential expansion capacity as of 2013) or the potential availability of private sector waste disposal capacity for the purpose of disposing a 'stabilized' waste stream."

Subsequent to the preparation of this response it was decided by the JWG to initiate a Stabilized Landfill Study to obtain a broader understanding of these operations and to undertake a cursory review of industrially designated lands in Niagara and Hamilton to determine availability for the establishment of a stabilized landfill operation.

3.2 Scope of Stabilized Landfill Study (SLS)

To obtain a 'third party' assessment of the pros and cons of stabilized landfill technology relative to conventional landfill technology and to enhance the data base on this disposal approach, the Joint Working Group commissioned a Stabilized Landfill Study and retained the services of Gartner Lee Limited (GLL), in association with Golder Associates Limited, to conduct the study. A copy of the full study report dated March 2007 is provided in Appendix IV of this Addendum Report. The balance of this section describes the scope and results of the study in the context of the WastePlan Joint Study on Waste Disposal.

Scope of Work Completed

To complete the study, GLL undertook the following activities and analyzed information from the following:

[1] Mechanical-Biological Treatment: A Guide for Decision Makers, Processes, Policies and Markets, published by Juniper Consultancy Services Ltd., March 2005, Version 1.0.

”a) Site-specific data from five sites including general site information, geological/hydrogeological setting, waste characteristics, containment systems, leachate quality and management, and gas characteristics and management. The sites consisted of:

- *Two MSW sites in Ontario: Trail Road Landfill, and Moose Creek Landfill;*
- *Three stabilized landfills: Otter Lake in Nova Scotia, and Cavaglia and Villafalleto in Northern Italy.*

b) A review of information available in the literature on other stabilized landfills located in the European Union (EU) and general experience with such landfills in the EU. The search focussed on the EU because of the relatively large number of MBT/Stabilized Landfill sites present there relative to North America or elsewhere.

c) A review of information available on the overall policy context within which stabilized landfills were developed within the EU.”

3.3 Stabilized Landfill Study (SLS) Conclusions

The conclusions of the Stabilized Landfill Study (SLS) are included along with the supporting detail as part of the full report in Appendix IV. For reference within the main body of the report the conclusions are listed as follows (italics represent text copied directly from the SLS Report):

“a. Stabilized waste is produced when municipal solid waste is subjected to mechanical/biological treatment (MBT), which typically includes processing to remove recyclables and possibly Refuse Derived Fuel, shredding, and either aerobic or anaerobic composting. The properties of stabilized waste can vary significantly from conventional municipal solid waste and the differences in properties are highly dependent on the degree of processing.

b. Characteristics of highly-stabilized waste relative to conventional solid waste can include:

- *one tenth the leachable TOC, COD and Total N content;*
- *half the total organic matter content;*
- *similar range of in-place apparent waste density;*
- *similar friction angle;*
- *potentially lower apparent cohesion (due to the smaller particle sizes following shredding;*
- *half the settlement potential from waste decomposition; and*
- *potentially lower hydraulic conductivity (due to smaller/platy particles following shredding, which can align horizontally at high compactive effort and form a low permeability layer).*

c. The total landfill gas production potential for well-stabilized waste (<10-45 L/kg) is approximately 10% of that for unstabilized waste (200-500 L/kg), reflecting the removal of the readily degradable organic fraction by composting. For the same reason, the peak landfill gas generation rate for well-stabilized waste (<3 L/m$_2$/hr) may be less than half of that for unstabilized waste (~6 L/m$_2$/hr).

d. Comparison of the literature concentrations for stabilized waste leachate with those for unstabilized waste leachate from the Trail Road and Moose Creek sites indicate that stabilized waste leachate *has lower levels of ammonia-N, BOD, COD, DOC and volatile organic compounds. Leachate concentrations for heavy metals and inorganic salts (e.g., sodium, calcium and chloride) are comparable for stabilize and unstabilized waste, indicating that these parameters are not significantly affected by the pre-processing.*

e. Waste stabilization can have a number of beneficial effects on landfill operations relative to unstabilized waste, including:

- *reduction of odour emissions;*
- *less off-site development restrictions;*
- *fewer bird nuisance issues;*
- *potential increase in the service life of leachate collection systems;*
- *smaller total and differential settlement of the waste mass, which facilitates final cover construction and after-use implementation.*

f. Waste stabilization can have some negative effects on landfill operations relative to unstabilized waste, including:

- *greater potential for wind-blown litter from the working face (although this potential is reduced if RDF is removed); and*
- *lower permeability and 'platy' nature, which increases potential for horizontal leachate flow in the waste mound leading to leachate seeps.*

g. MBT treatment and stabilized landfill technology is practiced much more extensively in Europe than North America. A key reason for this difference is the requirements of the European Union's Landfill Directive 1999/31/CE which states:

- *only pre-treated wastes are allowed to be landfilled after July 2001; and*
- *the amount of biologically degradable MSW to be landfilled must be reduced in a phased approach to 75% by July 2006, to 50% by July 2009, and to 35% by July 2016 of the total amount of biologically degradable MSW produced in 1995.*

h. The treatment process at the Otter Lake facility in Nova Scotia consists of mechanical shredding followed by aerobic composting for a period of 3 weeks. This is a lower degree of processing than is often carried out in Europe (especially Germany) which often includes longer composting periods (e.g., four to six months) as well as drying (bio-desiccation) of the product.

i. The WastePlan EA Facility Land Assumptions were reviewed relative to the data collected during this study. The assumptions for elements such as landfill size, height, depth, and waste density are generally supported by the data collected.

j. A sensitivity analysis was carried out during this study to examine how variations in assumed apparent waste density and waste depth can impact site land requirements. It was found that if apparent waste density is increased from 750 t/m^3 to 1,000 t/m^3 (e.g. to the maximum value identified in the data collection) and the waste depth below grade is increased from 5 m to 10 m (e.g. to a landfill design depth that may be reasonable depending on location in the Niagara and Hamilton areas) the minimum site area required (e.g. waste footprint plus 100 m buffer) decreases by about 27%. It is recognized that these variables are affected by numerous factors including degree of waste stabilization, landfill equipment used, waste to cover ratio, site specific conditions, and landfill design approach).

k. The WastePlan EA assumption regarding facility location (i.e., that a stabilized landfill facility could not likely be sited within an urban or industrial area) cannot be refuted or substantiated based on the limited number of stabilized landfill site settings examined as part of this research *study and the absence of information regarding the siting processes used in the EU and other site specific impact management information (e.g., compensation, community relations measures, etc). While the likelihood of siting success and the magnitude of impacts will be very site specific and dependent upon the nature of the siting process, the data collected regarding highly stabilized landfills in the EU and domestic experience with conventional landfill sites suggests that the siting of a highly stabilized landfill site is possible in a variety of land use settings."*

3.4 Consideration of WastePlan EA Study Assumptions and Stabilized Landfill Study Conclusions

This section provides an overview of the key study findings from the Stabilized Landfill Study (SLS) in the context of important assumptions and inputs used in the EA Study comparative evaluation of alternative systems and in particular those related to Systems 1a) and 1b).

From the standpoint of leachate and landfill gas emissions from a stabilized landfill operation it was generally concluded in the SLS that these elements could be substantially reduced for a highly or well stabilized waste material unlike the Otter Lake facility which employed a lower degree of stabilization. Although not specifically stated, the SLS report implies that these facilities would still require leachate and likely landfill gas management systems although it is reasonable to assume that the scope and reliance on these systems could be less than a conventional landfill operation. This could particularly be the case regarding landfill gas in that stabilization of the organics in an aerobic or anaerobic stabilization unit (where methane generation would be avoided in aerobic conditions and collected in a controlled environment for energy generation in anaerobic conditions) would likely make landfill gas collection unnecessary and uneconomic for the purposes of energy generation.

The SLS report predicts a similar contaminating lifespan as conventional landfill, which is contrary to the EA assumption that this lifespan may be decreased. With regards to leachate management, it is speculated in the SLS report that the service life of the leachate collection system could be increased. This appears to be related to reduced sediment loadings in the leachate, which tend to clog conventional landfill collection systems when not properly maintained.

With regards to nuisance impacts the SLS generally concluded that as the level of stabilization increases, the potential for odours and the attraction of birds decreases compared to a conventional landfill operation. In the case of windblown litter, it is suggested in the SLS report that the potential for this nuisance is greater – likely due to a smaller particle size and low density of the stabilized waste components. This lower density corresponds to drier operating conditions after the organics are stabilized. It is further noted in the SLS report that this impact is usually alleviated where Refuse Derived Fuel (RDF) is added as a component of the stabilization / MBT facility (i.e. the lighter fraction of the dry stream is captured as RDF). The report identifies no advantages or disadvantages related to dust and particulates compared to conventional landfill.

From the standpoint of applying the SLS results to the original EA assumptions it is noted that there is no quantifiable relationship or identified magnitude of the relationship between the level of stabilization and the level of emissions or off-site nuisance potential. Rather, the study results are limited to establishing a direct relationship of reduced nuisance potential with increased stabilization. The EA study's assumed buffer of 100 metres is identified, along with the other design assumptions for stabilized landfill to be generally supported by the SLS data collected.

Accordingly, with regards to site area requirements, there was no specific conclusion provided regarding the assumed waste fill and buffer areas used in the comparison of alternative systems (an approximate 20 percent reduction from 62 hectares for conventional to 49 hectares for stabilized landfill was applied – primarily due to reduced quantity landfilled). The report does provide a case whereby the in situ waste density and depth of excavation are increased resulting in a 27 percent reduction in site area. This presumably would apply to all landfill scenarios and would decrease the required stabilized landfill area from 49 hectares to 36 hectares.

Exceptions where landfill design and site size data included in the SLS report did not correspond with that used in the original EA assumptions included the following:

- Lower waste densities for the stabilized landfills compared to the conventional landfills reviewed (opposite was assumed in the original EA comparison of systems); and,
- Flatter side slopes (4 to 1 ratio) compared to the EA assumption of (3 to 1 ratio) for landfill design.

Both of these exceptions represent the conservative nature of the original EA comparison. Other exceptions were noted with regards to facility location and impact zone and are discussed below.

The SLS report is inconclusive about the assumed facility location (i.e. urban versus rural), indicating that a limited number of stabilized site settings were examined. The SLS consultant was not able to ascertain the approach to siting and related siting methodologies nor the specific siting issues that were present at the time of siting for any of the stabilized landfills identified in the SLS report or referenced in the background material. Accordingly, questions remain as to the role or significance of waste stabilization in the siting process (versus the need to follow an EU or national mandate) and whether or not a conventional landfill could be sited in the same location. Specifically, on facility location, conclusion k) in the SLS report states that the EA assumption "…*cannot be refuted or substantiated based on the limited number of stabilized landfill site settings examined as part of this research study and the absence of information regarding the siting processes used in the EU and other site specific impact management information (e.g., compensation, community relations measures, etc*). "

It is noted that of the three examples reviewed in detail, the one comparable in size to the WastePlan needs (i.e. Otter Lake) was sited remotely and purposefully due to the stigma attached to landfill. Further, the two smaller Italian sites are located in rural areas surrounded by a range of typical rural land uses including rural residential (e.g. single residential lots severed from an agricultural land holding), forest, agriculture, aggregate, etc. It is also noted that there is no information on which land uses were established first.

With regards to facility location and the SLS study conclusions, it is suggested in the SLS report and recognized by the EA consultant team that **site specific conditions may exist allowing for the siting of a landfill operation without impacting rural land resources**. The report also suggests that the **siting of a highly stabilized landfill is possible in a variety of land use settings**. The manner in which these SLS report conclusions or suggestions are applied at the systems comparison stage of the WastePlan EA could have implications on the siting exercise that would be undertaken at the next stage of the EA. These implications are discussed below under the points on how the WastePlan EA should incorporate the results of the SLS.

The SLS report makes several references to highly or well stabilized wastes and provides some examples of the infrastructure requirements associated with achieving this level of stabilization. The scope of the study did not, however, address the costs for varying degrees of stabilization or land area / location requirements associated with this MBT component of the infrastructure.

Therefore, based on the SLS results as overviewed and interpreted above and detailed in Appendix IV and after a review of the original EA Study assumptions and results associated with stabilized landfill, the following is the suggested direction should the current EA study advance:

Location of Stabilized Landfill

- The assumption regarding a typical landfill location (i.e. assume that a site for a stabilized landfill would be located in a rural/agricultural area) applied during the EA Study comparative evaluation remains a 'most-likely' scenario and the one that maintains the most flexibility moving forward into siting should a stabilized landfill option be selected. Should the consideration of rural / agricultural lands for landfill be assumed not possible in the evaluation of alternative systems then the EA process would dictate that these lands not be included in the siting process as well. Accordingly, Niagara and Hamilton would be obliged by established EAA planning practice to look at only those lands not considered a rural / agricultural resource in the search for sites. Aside from the land use policy and planning implications of siting a landfill in an urban area (e.g. low employment on a relative vast tract of employment or industrial lands) this requirement could be overly restrictive in subsequent EA siting steps given the land area requirements for even a stabilized landfill.

- It is, however, acknowledged that a stabilized landfill operation may exist in proximity to a variety of land uses and that specific opportunities may exist within and outside the urban area for the siting of a landfill without impacts on surrounding land resources and population. This has also been viewed as the case for some well operated conventional landfills (e.g. Waterloo Landfill). However, there have been no cases identified where the landfill siting process sought to locate a new landfill facility in proximity to potential nuisance receptors. Rather, over time in cases like the Waterloo Landfill, other land uses have encroached on the landfill operation due to a dwindling supply of developable land.

- Should the EA study proceed to a siting step, and a search for a stabilized landfill location, the removal of designated urban areas as a siting constraint (it is likely that sensitive urban land uses would be re-applied as a constraint) could be undertaken thus allowing for a search of site-specific opportunities in the urban areas. It should be noted however, that, reciprocally, the site search area for a thermal facility would not need to be expanded to include areas outside of the urban designations. Accordingly, when comparing the thermal versus landfill based systems, the landfill based systems, including systems 1a) and 1b), continue to represent a greater potential for impacts on land resources.

- Additional discussion on the potential use of industrially designated and employment lands in an urban designation is provided in Section 4 of this Addendum Report.

Assumed Land Requirements for a Stabilized Landfill Operation

- The original EA study comparative evaluation provided for an approximate 20 percent reduction in landfill site size for a stabilized versus conventional landfill operation (49 hectares versus 62 hectares). The SLS report did not address the potential for additional diversion at the MBT/stabilization facility. The assumed reduction of 20 percent is considered reasonable in the cases where materials leaving the stabilization facility are landfilled. The literature review in the SLS report identified several MBT facilities that included an RDF component. In the case of WastePlan, should some of these materials be directed to an RDF facility, then the footprint could be even smaller. The footprint could also be smaller if a Class B compost material is recovered and marketed.

- The SLS report identified the potential to further decrease the landfill footprint size if the maximum in-place density observed as part of that study (i.e. 1,000 kg/m^3) were applied. The 750 kg/m^3 density applied for stabilized landfill in the comparative evaluation represents an average and was considered a conservative increase in density from that assumed for conventional landfill (i.e. 700 kg/m^3). It is generally understood that if RDF is recovered the density of the remaining material would increase relative to MSW however increased stabilization/biodrying and/or marketing of class B compost can decrease the density of the remaining material relative to MSW. Section 5 of this report notes that the high stabilization of residual MSW without removal of RDF (as represented in Systems 1a) and b)) results in a decrease in overall density.

- It is concluded that a relatively large tract of land (estimated to be in the order of 35 to 40 hectares for a single Niagara-Hamilton site) will remain to be required for the siting of a stabilized landfill. These areas would represent a best case scenario for the stabilized landfill systems. Further, the best case related to the siting of these lands would be off of lands providing or supporting a rural / agricultural resource. The identification of these lands would be subject to availability after the application of constraints (e.g. hydrogeology) to the study area.

Costs to achieve high stabilization.

- Although the SLS report made frequent reference to a highly stabilized waste to landfill, there was no review of the MBT design requirements and associated costs provided. This was not identified as a study component in the study ToR. Notwithstanding, in Section 5 of this Addendum Report, costs have been adjusted to represent an MBT designed to produce highly stabilized material and the assumptions identified above for stabilized landfill.

4. Screening of Lands in Urban Designation for Stabilized Landfill

Based on feedback from the public and direction from the JWG it was decided that a review of industrial lands in the Study Area would be completed to determine the availability and feasibility of locating a landfill for stabilized wastes on lands considered more appropriate and compatible for such a use compared to rural settings and agricultural lands. At a broader level, this adjusted assumption would seek to remove the disadvantages associated with consumption of rural and agricultural land resources presented by the original assumptions for the stabilized landfill Systems 1a) and 1b).

An initial screening of industrial lands was undertaken to determine the potential for siting a landfill for MBT residual wastes as considered under the System 1 alternative. The intent of the review was to assess the availability and feasibility of locating a landfill for MBT residual wastes on lands considered more appropriate and compatible for such a use compared to rural settings and agricultural lands.

The methodology used to undertake the screening of stabilized landfill opportunities included:

- Contact with the municipal properties divisions in Niagara and Hamilton to determine if there is an inventory of industrially designated publicly owned lands;
- Contact with the planning departments of the Region of Niagara and City of Hamilton, as well as with the local municipal planning departments within the Region of Niagara to identify industrial land in regards to both Official Plan and Zoning designation;
- Documenting the initial screening of industrial lands and other opportunities that have the potential for siting a System 1 landfill for MBT residual wastes.

For the purpose of this exercise and to protect the integrity of a subsequent siting process and the finalization of a siting methodology and criteria, the specific locations of properties have not been identified in this report but have been reviewed extensively with respective municipal staff to ensure accuracy.

4.1 Niagara Region

Two sources of information were reviewed to complete an inventory of industrial land within Niagara Region; The Regional Municipality of Niagara Industrial Land Survey Atlas and the Niagara Economic Development Corporation.

The Regional Municipality of Niagara Industrial Land Survey Atlas, completed in 2002, includes an inventory of all the industrial land parcels in Niagara Region that may be made available for development. This includes partially occupied and unoccupied or vacant properties. The partially occupied properties may have existing buildings on them that are in use. While the unoccupied or vacant properties may have existing buildings that are not in use. The location of each of the properties has been documented and mapped using GIS software. A database of information has also been created which includes details about each of the industrial properties. For example, the property location, address, size, and amount available for development are included. Regional Official Plan land use designations and Zoning By-Law classifications are also provided. The database can be easily sorted to show which properties are of a particular size, etc, and the properties can be mapped to show their location within the Region. The inventory shows that there are 644 unoccupied or vacant sites, 269 partly occupied sites, for a total of 913 industrial sites in the Region. According to the inventory, there is a total of 3264 hectares of developable urban industrial land. The average site size is 4 hectares.

The Niagara Economic Development Corporation (NEDC) was consulted to ensure that the inventory of industrial lands for the Region was as up-to-date as possible. The NEDC maintains a list of industrial properties in Niagara Region and tracks them through a database called the Niagara Commercial Properties (NCP) System. The database maintains a list of industrial properties in the Region, identifying among other things if the property is sold, leased, or available for sale or lease. The NCP System is available on-line and enables you to search by land use classification, lot size, listing price, and required utilities. Industrial, commercial and agricultural properties are updated nightly through the Niagara Association of Realtors' MLS system. Additional properties can also be posted to the site by registered users, such as Realtors, Property Owners, Property Managers and Economic Development Professionals. Properties that were put into the system will move into inactive or expired status if the property has not been viewed on the site or updated by a registered user in over a year. Therefore properties classified under these statuses may still be available for sale or lease. The information available through the NCP System changes on a daily basis. For the purposes of this part of the study, the NCP System was reviewed and sorted on March 20, 2007. At that time 230 properties were on the list.

Properties were removed from the list if they were not available for sale or lease, no longer designated as industrial land, if their locations were unknown, and if they were already included in the Regional Municipality of Niagara Industrial Land Survey Atlas.

The revised list from the NCP system showed 25 vacant sites and 6 occupied sites, for a total of 31 industrial sites that may be available for sale or lease in the Region.

According to the revised list, there is a total of 598 hectares of developable industrial land that may be for sale or lease in the City. The average site size is 19.3 hectares.

Therefore, the total amount of developable industrial land within the Region includes 913 sites from the Regional Municipality of Niagara Industrial Land Survey Atlas and 31 sites from the NEDC NCP System, for a total of 944 industrial sites, and a total of 3862 hectares. The average site size is 4 hectares.

It should be noted that Niagara Region is currently completing an inventory of all of its brownfield sites. This study was not complete in time to compare against or add to the data from the provided from the Regional Municipality of Niagara Industrial Land Survey Atlas and the Niagara Economic Development Corporation.

For the purposes of creating an inventory of industrial lands within the Region, the results of the Land Survey Atlas and list of industrial lands from the NCP System were combined, and any duplicate properties were omitted. The industrial lands within the Region are located within the urban boundary of the Region, primarily near the QEW and Highways 406, 58 and 20. They are located mostly within industrial land use designations, away from city centres.

4.2 City of Hamilton

Two sources of information were reviewed to complete an inventory of industrial land within the City of Hamilton; The City of Hamilton Business Park and Industrial Land Use Inventory and the City of Hamilton's Property Search Tool.

The City of Hamilton maintains an inventory of all of its Business Parks and designated industrial land. The inventory categorizes properties as Vacant or Industrial. Vacant properties are those that are vacant of any structure. Industrial properties are those that have a physical structure on them with the purpose of industrial use regardless of whether it is currently being used. The location of each of the properties has been documented and mapped using GIS software. A database of information has also been created which includes details such as the address and area for each of the properties. Land use designations and Zoning By-law classifications are not provided.

The database can be easily sorted to show which properties are of a particular size and the properties can be mapped to show their location within the City. The inventory shows that there are 366 vacant sites, 1211 occupied sites, for a total of 1577 industrial sites in the City. According to the inventory, there is a total of 3668 hectares of developable urban industrial land. The average site size is 2.3 hectares.

The City of Hamilton provides a property listing of Industrial/Commercial MLS listings, which is updated on a daily basis. The information is made available on line via the City of Hamilton's website. Maps and aerial photos, along with demographic and business directory information related to specific properties are available through this site. For the purposes of this part of the study, the property listing was last reviewed for industrial properties within the City on May 29, 2007. At that time the property listing showed 7 vacant sites and 1 occupied site, for a total of 8 industrial sites available for sale in the City. According to the property listing, there is a total of 23 hectares of developable industrial land for sale in the City. The average site size is 2.9 hectares.

The sites from the property listing were compared against the City's Business Park and Industrial Land Use Inventory. The comparison showed that none of the 8 sites were found in that inventory. Therefore the amount of developable industrial land within the City of Hamilton includes 1577 sites from the Business Park and Industrial Land Use Inventory and 8 sites from the City's Property Search Tool, for a total of 1585 industrial sites, and a total of 3691 hectares. The average site size is 2.3 hectares.

For the purposes of creating an inventory of industrial lands within the City, the results of the Business Parks and designated industrial land inventory and the City of Hamilton property listing website were combined, and any duplicate properties were omitted. The industrial lands within the City are located within the urban boundary of the City, primarily near the QEW and Highways 403 and 6, and the Lincoln M Alexander Parkway. They are located mostly within industrial land use designations, away from city centres.

4.3 Lands Potentially Available for Stabilized Landfill

Based on the review completed, there are limited parcels of sufficiently sized lands to support the stabilized landfill requirements for Systems 1a) and 1b) (30 – 50 hectares). It should be noted however, that this determination is prior to the application of any typical landfill siting constraints such as:

- Sensitive hydrogeological or natural environments;
- Suitable / unsuitable background locations (i.e. some brownfield site conditions may represent a constraint to landfill development); and,
- Sensitive land uses.

Notwithstanding the above summary conclusion, it is recognized and would continue to be recognized moving forward that unique opportunities representing conditions outside of the study assumptions may become available. This has been one of the challenges facing Ontario's environmental assessment process in the past and has established the need to review study results should there be reasonably significant changes in underlying conditions or assumptions. For example, should a tract of land become available in the future with optimum conditions for the establishment of landfill disposal capacity outside of the rural / agricultural area with or without a stabilization component, then the system including this opportunity may rise to a preferred status. A similar case would exist whereby third party landfill disposal capacity was offered for waste, stabilized or not. These types of occurrences then represent, at this point, a set of 'what ifs' that are / were not reasonably predicted to occur (and cannot be reasonably assumed, for the purpose of study and evaluation across Niagara and Hamilton, to exist prior to system implementation) but if they did, could warrant a review of previous work completed in the study, and/or the terms of the Agreement for Joint Study of Waste Disposal.

As will be discussed in Section 5 of this document, the sensitivity of the evaluation process to these types of unique situations given their likelihood of occurring and relative importance in the broader scope of comparative factors is being considered and is reported. Accordingly the 'what if' circumstances that would need to exist to elevate the stabilized landfill or other systems to preferred status will be identified.

Part C – Sensitivity Analysis of Alternative Systems Evaluation

5. Sensitivity Analysis of Alternative Systems

5.1 Evaluation Methodologies

5.1.1 Evaluation Methodology Applied in the Draft Report on the Evaluation of Alternatives To (Draft Report)

In the Draft Report on the Evaluation of "Alternatives To", eight alternative disposal systems were formulated, with each system being capable of managing the residual waste that will remain after 65% diversion. These systems were developed by combining viable technologies that can meet the regulatory requirements for management of waste in the Province of Ontario, while serving the residual disposal needs of the residents of Niagara and Hamilton. All of the systems can meet regulatory requirements designed to protect the people and the environment. However, they differ in regards to their potential net effects on the broadly defined environment. The potential net effects to the environment were determined through the application of criteria and the consideration of priorities that reflected the broad areas of concern for the community.

Table 5.1 presents an overview of the criteria that were developed in the approved EA Terms of Reference through a public consultation process, and confirmed through further consultation early in the EA Study.

Table 5.1 Evaluation Criteria Applied for the Evaluation of "Alternatives To"

Environmental Category	Evaluation Criteria
Natural Environmental	1. Environmental burden at a global or macro-environmental scale.
	2. Consumption/preservation of non-renewable environmental resources.
	3. Potential for destruction or disruption of sensitive terrestrial and/or aquatic habitats.
	4. Potential to increase disposal diversion rate and/or make best use of residual (post-diversion) waste materials.
Social / Cultural	5. Potential for land use conflicts from siting of facilities required for system.
Technical	6. Technical risks associated with waste management system.

ENVIRONMENTAL CATEGORY	EVALUATION CRITERIA
ECONOMIC / FINANCIAL	7. Net system costs per tonne of waste managed – in a systems context. 8. Sensitivity of system costs and affordability to external financial influences.
LEGAL	9. Legal/contractual risks associated with waste management system.

The relative priority of the criteria determined through public consultation during the EA Study and adopted by the Niagara/Hamilton Joint Working Group was as follows:

ENVIRONMENTAL CATEGORY	RELATIVE PRIORITY
• **Natural Environmental**	⇒ **Most Important**
• **Social / Cultural**	⇒ **Important**
• **Economic / Financial**	⇒ **Important**
• **Technical**	⇒ **Important**
• **Legal / Jurisdictional**	⇒ **Less Important**

The application of different criteria and/or priorities could result in identifying different systems as being preferred. For example, given that all of the systems can meet regulatory requirements designed to protect the people and the environment, it could be decided in other studies that it is not reasonable to apply broad environmental criteria in the selection process and that instead, the selection of a preferred system would be made based on costs. Within the context of this EA Study however, the selection of a preferred system and the sensitivity analysis on the process must be based on the criteria set out in the approved EA ToR, and on the priorities determined through consultation with the community.

The preferred system (System 2b)) was selected based on the application of the following evaluation methodology:

- The original evaluation criteria were applied to each of the eight alternative disposal systems and potential effects identified.
- The net effects associated with each disposal system under each criterion were compared and a list of relative advantages and disadvantages associated with each alternative disposal system were developed.
- The relative advantages and disadvantages of each alternative disposal system were compared in a pair-wise fashion, considering the context of priorities established in consultation with the public and a preferred system was selected. The preferred system identified in the Draft Report was the one exhibiting the most advantages and fewest

disadvantages considering the significance of environmental categories and criteria established by the public.

During the evaluation of 'Alternatives To', consistently conservative assumptions were applied to determine the potential effects for all major parameters, including: emissions to air and water; energy generation; land requirements and land-use settings; diversion potential; and net system costs. The analysis and evaluation of the systems as undertaken in the Draft Report was based on conservative data, as the assumptions used represented those that had a reasonable probability of occurring and holding true through completion and implementation of the EA Study.

5.1.2 Methodology Used For Sensitivity Analysis (Application of Improved System Assumptions)

The intent of the sensitivity analysis is to determine:

- The degree to which the results of the evaluation of "Alternatives To" as documented in the Draft Report released in December 2005 are reasonable considering the results of public review of the document and updated information that has become available since December 2005;
- The degree to which the results would change if updated information or 'improved' assumptions were to be used to determine the potential effects of the alternative systems. Will it change the outcome of the evaluation process significantly, slightly or not at all?

As noted in Section 1 of this report, additional study activities and developments outside of the WastePlan Study have provided updated information that can be considered relative to the alternative systems examined in the Draft Report, including:

- Information on the performance of MBT technologies and the landfilling of stabilized waste, as documented in the Study of Stabilized Landfill Final Report issued in March 2007. This information has a potential impact on Systems 1a) and 1b).
- Information on the performance of Thermal Treatment Technologies, both in regards to efficiency of energy recovery and performance of Air Pollution Control (APC) systems. This information has a potential impact on Systems 2a) through 2d).
- Results of the review of Life Cycle Analysis models, that has a potential impact on the modelling of emissions to air and water and net energy generation calculations for all Systems.
- The enactment in March 2007 of the new Waste Projects Regulation under the Environmental Assessment Act in Ontario, that allows for use of Refuse Derived Fuel (RDF) generated by MBT systems in industrial applications without a requirement for a full individual environmental assessment. Within the last few months there has been a high level of renewed interest by industry in using RDF as a substitute for non-renewable fuels such as coal and petcoke. Also, municipal/industry initiatives to generate and market RDF have made progress. Although this regulation would also allow for thermal treatment projects that recover energy to avoid requirements for an individual environmental assessment if an Environmental Screening Process is completed, it is not proposed for the WastePlan project.

This information has a potential impact on the potential use of Refuse Derived Fuel (RDF) generated in Systems 2c) and 2d).

- Approval by Niagara Region to use a combination of landfill space provided through the expanded Walker Industries (Niagara Waste Systems) landfill and existing Niagara Region landfill site capacity to meet Niagara Region's long term landfill disposal requirements. This information has the most significant impact on Systems 3a) and 3b).

Public review of the Draft Report identified the following substantive issues that warranted examination in the sensitivity analysis, and that were the subject of additional study undertaken during 2006:

- The nature and fate of contaminants from the recommended system particularly in regards to air emissions and health related impacts.
- The relationship between the recommended system and waste diversion.
- Alternative system design and siting assumptions. In particular, concerns that the assumption that the landfill component of the Mechanical Biological Treatment (MBT) system would need to be sited in a rural/agricultural area is flawed. Once the residual wastes have been stabilized, they could be landfilled at a site in an urban/industrial area.
- The costs associated with the preferred system are too high and may not be affordable to the municipalities.
- The availability of new and developing technologies that could be incorporated into a 2c) Alternative Fuel system. New information demonstrating proven capability and performance may become available by the time the decision on a specific technology/vendor is considered and may lead to support for a System 2c) preference. These technologies should not be eliminated from consideration prematurely at this time.

The methodology used to undertake the sensitivity analysis and determine the degree to which one alternative system is preferred over another was developed to address the updated information and the substantive issues resulting from public consultation. It is not a traditional sensitivity analysis where only one parameter is varied to determine if this would result in a change in the outcome of system evaluation.

In this case, to address the substantive issues and new information, a number of parameters have been combined to develop improved system assumptions, and these improved assumptions have been used to complete a comparative evaluation of 'improved systems', as follows:

1. The development of improved system assumptions to address concerns expressed during the review of the study documentation, or where new information indicates that improved assumptions are warranted.
2. Comparing updated alternative systems based on the improved assumptions, using the qualitative pair-wise comparative evaluation methodology used in the EA Study.
3. Determining if, as a result of the comparative evaluation of systems based on improved assumptions, revisions are warranted to the evaluation of the alternative systems.

Table 5.2 provides an overview of how the substantive issues or new information were addressed through the development of improved system assumptions.

Table 5.2 Overview of Development of Improved System Assumptions

Substantive Issue / New Information	How Addressed in Improved System Assumptions
Fate of Contaminants, Air Emissions Updated Information on Performance of Air Pollution Control (APC) Systems Review of LCA Models	Application of MSW-DST Model for System Evaluation. Emissions for thermal facilities based on updated information on performance of APC systems.
Relationship of Preferred System with Waste Diversion Review of Diversion Performance	Assuming higher diversion rate achieved over planning period for all systems (up to 70%)
Alternative System Design and Siting Assumptions Stabilized Landfill Tour Stabilized Landfill Study Screening of Industrial Lands	Assuming high stabilization of residual waste through Mechanical/Biological Treatment for MBT/Stabilized Landfill systems. Updating design assumptions for Stabilized Landfill systems. Assuming stabilized landfills could be sited in urban/industrial areas. Updating system design for thermal systems to address markets for heat and/or fuels where appropriate.
Use by Niagara of Capacity at Niagara Waste Systems	Reducing landfill capacity requirements of systems where appropriate.
New Technologies for System 2c) (thermal treatment of alternative fuel) New Waste Projects Regulation	Updating assumptions for System 2c) to address affect of marketing fuel.
System Costs	Updating assumptions for all systems to reflect the other parameters that have changed (as noted above).

Eight (8) systems were originally modelled and compared in the Draft Report and the potential net effects of these systems were compared in a pair-wise fashion. The Level 1 pair-wise comparison was undertaken to compare and bring forward:

- the best MBT/landfill system (1a or 1b);

- the best landfill system (3a or 3b);
- the best thermal treatment of MSW system (2a or 2b); and
- the best thermal treatment of Alternative Fuel system (2c or 2d).

The consistent application of improved assumptions to all eight systems would not affect the results of Level 1 pair-wise comparison, as the improved assumptions would apply to each of the pairs of systems equally. For example, in comparing Systems 2a) and 2b), the improved assumptions related to energy efficiency and air pollution controls would affect both systems equally, therefore System 2b) would still be selected to bring forward as the recovery of metals from ash results in better environmental performance over System 2a).

Therefore improved system assumptions were developed and applied only for those systems that were carried forward as a result of the Level 1 pair-wise comparison:

- MBT & Stabilized Landfill (System 1, representing a generic system with biological treatment based on use of aerobic composting, noting any differences if anaerobic digestion were used);
- MSW Landfill with LFG Recovery (System 3b);
- Thermal Treatment of MSW with Metals Recovery (System 2b);
- Thermal Treatment of Alternative Fuel (System 2c).

5.2 Improved System Assumptions

5.2.1 Tonnages

For the comparison of "Alternatives To" an analysis of the potential quantity and composition of the wastes generated in Niagara and Hamilton was completed and used to support the analysis of the potential effects of the systems, and was documented in Annex C-1 of the Draft Report. Certain assumptions were made regarding the materials that would be managed within a Niagara/Hamilton system, with the focus primarily on the residual waste generated by the residential sector after the achievement of 65% at-source diversion. For the purpose of comparing systems, it was estimated that in the order of 151,000 tonnes of residual waste per year (primarily generated by the residential sector in both communities) would be managed by the potential systems beginning in 2013.

In these tonnage projections, the following was assumed for year 1 (2013) of a Niagara/Hamilton waste management system:

Table 5.3 Projected Waste Materials (Draft Report on Evaluation of "Alternatives To")

Material Category	Total Material Generated Tonnes	Total Material Diverted At-Source		Total Residual Waste to Disposal	
		Tonnes	%	Tonnes	%
Fibre	84,000	70,540	84%	13,360	16%
Plastic	21,900	6,650	30%	15,250	70%
Metals	14,400	10,933	76%	3,493	24%
Glass	17,700	12,000	68%	5,900	32%
HHW	2,500	2,000	72%	469	28%
Organics	194,500	139,494	72%	54,907	28%
Other Material	92,500	34,771	37%	57,816	63%
Total	**427,500**	**276,388**	**65%**	**151,195**	**35%**

In order to achieve the projected diversion rate of 65%, the assumed diversion rates for many materials was very high, including:

- Over 90% diversion of newsprint;
- 80% diversion of PET;
- 80% diversion of Aluminium cans;
- 76% diversion of food waste;
- 93% diversion of yard waste; and
- 90% diversion of wood waste.

The Terms of Reference for the EA Study require that the workplan for the evaluation of "Alternative methods" (the siting process for a preferred system) includes the need to re-examine the tonnage projections in order to determine overall capacity and minimum site size requirements for the preferred system. It is recommended that prior to proceeding with any future steps to select a site or facilities for a preferred residual waste system, that a review of long-term waste quantity projections and system requirements be undertaken as part of the siting process.

This is particularly required for Niagara Region where there are streams of waste materials other than residential waste (municipal and commercial waste) that the Region may choose to continue to manage in the future pending the results of a review of service levels and programs that is currently being undertaken.

The review of waste projections and system requirements would include:

- Reviewing assumptions for the long-term management of residual waste generated by the:
  - single-family residential sector
  - multi-family residential sector
  - municipal operations

  - commercial/industrial sector

- Review of tonnage information for materials managed by diversion and disposal system components in both municipalities over the past 5 years (2002 to 2006), in order to generate an average per capita residual waste generation rate for the study area.
- Reviewing assumptions related to:
  - Future waste generation rates (including population projections, trends in per capita waste generation rates etc.)
  - annual fluctuations in waste quantities
  - the performance of at-source waste diversion programs
- Development of updated residual waste quantity projections, and assumptions as to which components of the preferred long-term disposal system would manage various waste streams.

5.2.2 Diversion Projections

During the public review of the Draft Report on the evaluation of "Alternatives to" some concern was expressed regarding the assumption that the 65% at-source diversion rate would remain static over the planning period. Notwithstanding the need to examine the performance of at-source diversion programs at the point when facility siting may begin, as part of the sensitivity analysis the assumptions of overall at-source diversion over the 25 year planning period from 2013 onwards, have been adjusted to allow for a small incremental increase in at-source diversion over the 25-year period of time from 2013 to 2037 from 65% to 70% diversion.

Revised diversion estimates are presented in Table 5.2. The increase in waste diversion over time is offset by the waste increase resulting from population growth, such that the overall quantity of residual waste that must be managed remains at just over 151,000 tonnes. As a result of the increase in diversion the total quantity of residual waste that would have to be managed/disposed over the planning period decreases from 4.5 million tonnes (Draft Report, Table 9-1) to 4.1 million tonnes.

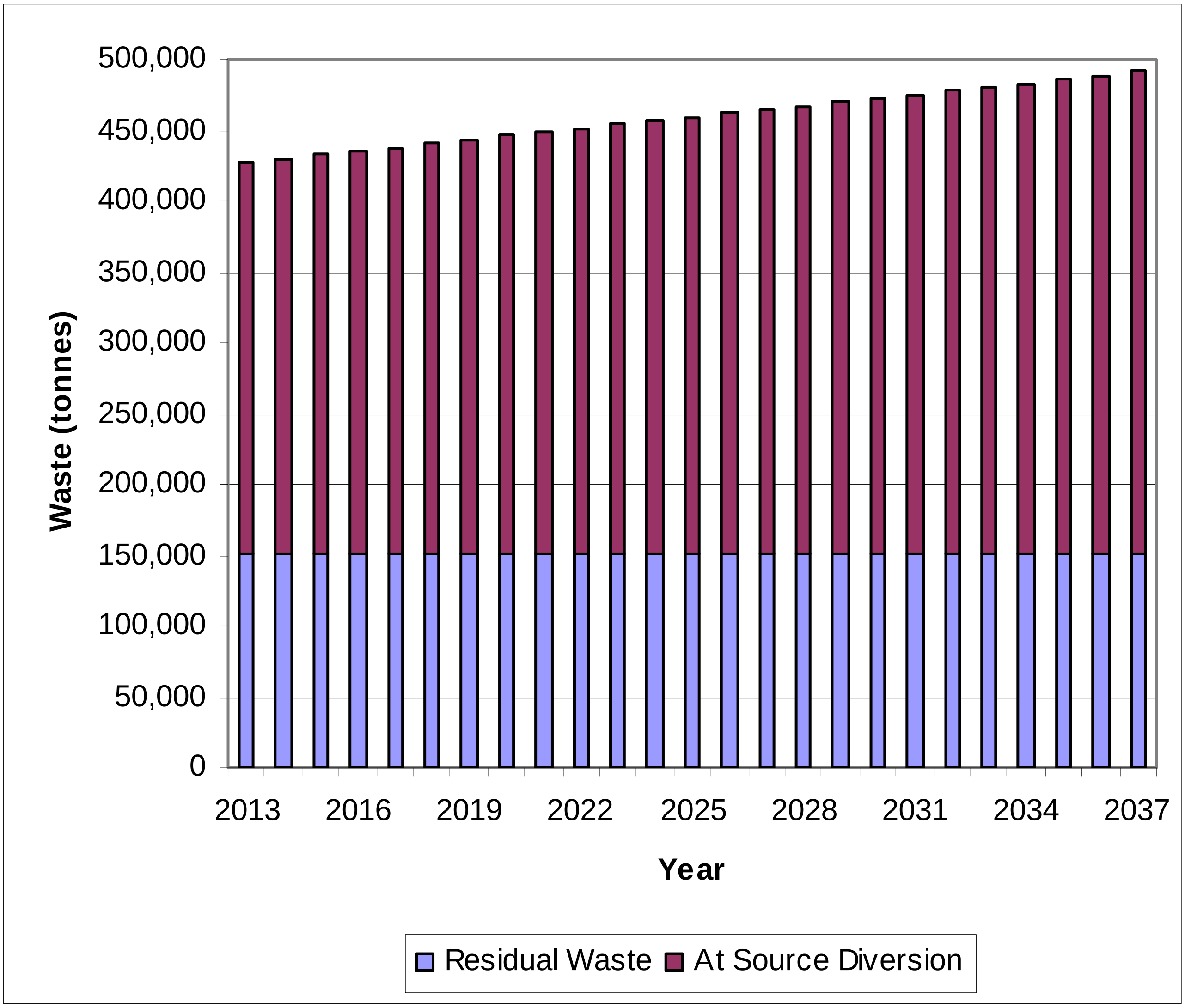
As noted in section 5.2.1, the review of waste projections and system requirements undertaken prior to facility siting, would further refine the waste projections potentially increasing or decreasing tonnages and diversion assumptions. However, the key in the sensitivity analysis is the use of a consistent set of projections applied to all systems to determine potential effects. It is also important to note that much of the data generated and used to compare the systems (mass balance, energy balance, life cycle analysis) are based on the projected quantity and composition of the waste in year 1 (2013) and do not change as a result of the revised waste projections. The revised projections do affect the cost projections and landfill size assumptions.

Table 5.4 Revised Waste Projections, Achievement of 70% Diversion by 2037

For the 2013 to 2037 Period	2013	2037
Estimated Total Material Generation (Residential)	428,000 tonnes	491,000 tonnes
Estimated Annual Quantity Diverted At-Source	276,000 tonnes	340,000 tonnes
Estimated Annual Residual Quantity Requiring Management	151,000 tonnes	151,000 tonnes
Average Monthly Residual Quantity Requiring Management	12,600 tonnes	12,600 tonnes
Approximate Average Daily Residual Quantity Requiring Management (1)	600 tonnes	600 tonnes
25 Year Total Residual Wastes Quantity Requiring Management	Approximately 4,100,000 tonnes	

(1) Annual quantity divided by 250 operating days per year.

Figure 1 Annual Waste Projections, Achievement of 70% Diversion by 2037



5.2.3 Modelling of Net Life Cycle Emissions to Air and Water, and Annual Energy Balance

For the analysis of environmental life cycle inventories, the Municipal Solid Waste, Decision Support Tool (MSW-DST) model developed in the U.S. was used. The MSW-DST model, allows for the modelling of direct and indirect emissions to air and water associated with all facilities that are part of a system (i.e. composting plant, MRF, EFW, landfill), emissions associated with transportation of materials, offsets associated with the remanufacturing of materials recovered through recycling and offsets associated with generating energy that replaces electricity and/or energy from other sources.

Although the Integrated Waste Management (IWM) model was used for the generation of data in the "Alternatives To" documentation including the Draft Report, the IWM model is limited in its ability to model complex systems. The rationale for selecting the MSW-DST model for the sensitivity analysis is summarized below:

- There are issues with the modelling of life cycle GHG emissions using the IWM model. To date, the issues with the IWM model have not been addressed and the model has not been updated;
- The IWM model is not capable of modelling complex systems. Consequently, each component of the system must be run as a separate module. This process is time consuming and not ideal.
- The IWM model does not allow for factoring in fuel substitution and thermal energy recovery to the system assumptions. These assumptions are critical for the analysis of the improved system assumptions.
- The MSW-DST model is very flexible in terms of modelling complex systems and has a large database of North American life cycle inventories.
- The MSW-DST model has undergone extensive stakeholder input and peer review (including a separate review by the US EPA).

Although the IWM model is useful for certain waste management applications, the complexity of the improved system assumptions necessitates the use of the MSW-DST model.

Sections 5.3.1, 5.3.2 and 5.3.3 present the original IWM results as well as the results of applying the MSW-DST model for both the original assumptions and the improved assumptions for Systems 1, 2b), 2c) and 3b) used to determine net emissions to air and water and well as net energy generation. The detailed results of the applying the MSW-DST are provided in Appendix V. The MSW-DST has been applied using both the original and improved assumptions as it is not possible to directly compare the results of the LCA modeling as presented in the Draft Report, with the modeling for the improved systems, due to the difference in the models used.

Application of the MSW-DST has been undertaken by RTI International. RTI International is a research institute, that offers research and technical solutions to governments and businesses worldwide in the areas of health and pharmaceuticals, education and training, surveys and statistics, advanced technology, democratic governance, economic and social development, energy, and the environment.

5.2.4 Assumptions for MBT & Stabilized Landfill System (System 1)

The improved assumptions for Mechanical and Biological Treatment (MBT) & stabilized landfill System assume:

a) Production of a well-stabilized waste material through MBT based on a longer 'high-rate'* and 'low-rate' decomposition periods in accordance with a high-intensity composting process as discussed in the Stabilized Landfill study; and

b) Siting of the stabilized landfill component of the system on a suitably sized area of urban/industrial land, <u>assuming land of this nature and size is available within the study area</u>.

*Note: for the purpose of modelling the improved System 1, it was assumed that the method used for high-rate decomposition would be aerobic composting not anaerobic digestion, as overall there were few differences found in both approaches when originally modelled in the Draft Report. Potential differences in the net effects related to the use of anaerobic digestion (slightly better energy balance, slightly higher costs, slightly better net emissions to air and water) are noted in Section 5.3, which discusses the results of analysing these systems.

The following table includes only the assumptions for System 1. The comparison of results is provided in Section 5.3.

Table 5.5 Assumptions for System 1 MBT & Stabilized Landfill

Original Assumptions, Draft Report on the Evaluation of "Alternatives To"	Improved Assumptions applied for Sensitivity Analysis
Design of System:	***Design of System:***
- 65% at-source diversion, with 35% residual waste managed by the system over the planning period	- 65% at-source diversion as of 2013, **increase in at-source diversion rate to 70% over the planning period** with the remaining residual waste being stabilized and increased diversion rates offsetting population growth.
- All residual waste to MBT	- All residual waste to MBT
- Mechanical equipment to remove recyclables (trommel screens, belt magnets, optical sorting)	- Mechanical equipment to remove recyclables (trommel screens, belt magnets, optical sorting)
- Organics processing including, one week in-vessel high rate aerobic composting phase and one month curing phase	- Organics processing including, **three week in-vessel high rate aerobic composting phase and four month curing phase**.
- MBT components co-located at residual landfill site	- MBT components co-located at residual landfill site. Note: this option results in overall lower land requirements and therefore represents an improvement over the original assumptions.

Original Assumptions, Draft Report on the Evaluation of "Alternatives To"	Improved Assumptions applied for Sensitivity Analysis
- Stabilized landfill in accordance with landfill standards, including gas collection and flaring. Recompacted clay liner used for low cost estimates. Waste to cover ratio of 80:20 - Stabilized landfill located in rural/agricultural area	- Stabilized landfill in accordance with landfill standards, including gas collection and flaring. Re-compacted clay liner used for cost estimates. Reduced landfill cover requirements. **Waste to cover ratio of 90:10. Note: gas generation calculated based on the composition of the waste landfilled, where no volatile organics are present in the materials.** - Stabilized landfill located in serviced urban/industrial area
Mass Balance and Diversion Estimates *(As per Annex E-1 of the Draft Report):* - Incoming material received and unacceptable materials removed (40,661 tonnes) and sent straight to landfill. This material consists of oversized and other waste materials (furniture, demolition waste) that is not suitable for processing through an MBT facility. - Mechanical treatment of over 110,000 tonnes of materials, recovery of over 6,000 tonnes of materials including gable top cartons, aseptic containers, PETE, HDPE, Aluminium and Ferrous metals - Organics processing of remaining 104,000 of materials. Removing from the residual waste approximately 60% of all organics, 10% paper fibre and between 10 and 15% of other fibrous materials. Note: loss of mass due to both moisture loss and decomposition. - All materials not recovered/removed from the residual waste stream sent to landfill. - No Class B compost marketed. - No RDF recovered	***New Mass Balance and Diversion Estimates*** *(see Appendix VI):* - Incoming material, same as Draft Report - Mechanical treatment, same as Draft Report - Organics processing of remaining 104,000 tonnes of materials. **Removing from the residual waste 75% of food and animal wastes, 65% of all other organic materials, 15% of all paper fibre** (except newsprint that remains at 10%). **Increase in diversion through organics processing related to increased aerobic composting period.** Note: loss of mass due to both moisture loss and decomposition. - All materials not recovered/removed from the residual waste stream sent to landfill. - No Class B compost marketed. - No RDF recovered

Original Assumptions, Draft Report on the Evaluation of "Alternatives To"	Improved Assumptions applied for Sensitivity Analysis
Facility Land Requirements *(as per Annex E-2 of the Draft Report):*	***New Facility Land Requirements***
- 25-year life for the stabilized landfill	- 25-year life for the stabilized landfill
- in-place density of 750 kg/m3	- **in-place density of 700 kg/m3. The in-place density is reduced due to increased removal of moisture from the stabilized material**. Note: if the heavy/small fraction of the residual stream is removed for use as a low grade soil enhancer then density would be further reduced or if the light/large fraction is removed as RDF the density increases.
	- **Cover requirements reduced as the heavy/small fraction of the residual stream is used in lieu of some of the soil cover requirements**.
- 25 m maximum height of waste above grade, 5m below grade. Note: depth below grade based on reasonable landfill design. Site specific conditions could allow for deeper excavation.	- 25 m maximum height of waste above grade, 5m below grade. Note: depth below grade based on reasonable landfill design. Site specific conditions could allow for deeper excavation.
- 3:1 side slopes	- 3:1 side slopes
- additional area for roads, scales, buildings etc. included in footprint area	- additional area for roads, scales, buildings etc. included in footprint area
- landfill site size includes 100m buffer, cost of facility includes purchase of lands within 300m of footprint	- landfill site size and cost estimates includes 100m buffer on three sides, **and 300 m buffer on one side to provide sufficient area to accommodate the MBT facility** (co-location of the MBT and landfill reduces combined footprint requirements).
- 5 hectares for MBT facility, 2 hectares for outdoor windrow curing accommodated within 100 m buffer of landfill	- **larger area required for MBT facility, plus more area for outdoor windrow curing accommodated within 300 m buffer along one side of landfill**
Electrical Energy Balances *(as per Annex E-3 of the Draft Report):*	***New Electrical Energy Balances:***
- electrical load for mechanical and	- increased electrical load for high rate

Original Assumptions, Draft Report on the Evaluation of "Alternatives To"	Improved Assumptions applied for Sensitivity Analysis
biological processes	aerobic biological processes Note: If high-rate decomposition involved anaerobic digestion, slight decrease in electricity balance due to use of biogas to generate electricity.
Financial Analysis and Cost Estimates *(as per Annex E-4 of the Draft Report):* - co-location of MBT facility at landfill - costs as per system design as noted above - rural location land costs of $50,000 per hectare - lower revenue per tonne of recyclables due to degradation of materials in co-mingled waste stream - no Class B compost - both High and Low Cost assumptions	***New Financial Analysis and Cost Estimates:*** - co-location of MBT facility at landfill - **costs as per system design as noted above, including higher cost for longer high rate aerobic composting phase and low rate/curing phase** - **urban/industrial location land costs of $200,000 per hectare** - lower revenue per tonne of recyclables due to degradation of materials in co-mingled waste stream - no Class B compost - **Reasonable Cost assumptions**
Environmental Analysis *(emissions to Air and Water as per Annex E-5 of the Draft Report):* - Used Integrated Waste Management (IWM) Model - custom Ontario grid assumed (all coal replaced with natural gas fired plants) - emissions to air and water from MBT based on total quantity of material processed and energy usage, less virgin material displacement credits from recycling various materials	***Environmental Analysis (emissions to Air and Water):*** - Uses Municipal Solid Waste, Decision Support Tool (MSW-DST) Model - **2015 projected Ontario grid (assumes increased renewables and replacement of coal with natural gas)** - **emissions to air and water from MBT based on total quantity of material processed and energy usage, less virgin material displacement credits from recycling various materials. Energy usage will be higher for biological component, and resulting air emissions may be slightly higher for MBT component.**

Original Assumptions, Draft Report on the Evaluation of "Alternatives To"	Improved Assumptions applied for Sensitivity Analysis
- 50% default landfill gas recovery, captured and flared - 0% energy recovery from landfill gas (insufficient gas for energy recovery) - landfill is lined with 90% leachate collection efficiency - no landfill carbon sequestration assumed - annual precipitation average for Niagara-Hamilton - water emissions from landfill associated with total tonnes disposed.	- 50% default landfill gas recovery, captured and flared - 0% energy recovery from landfill gas (insufficient gas for energy recovery) - landfill is lined with 90% leachate collection efficiency - no landfill carbon sequestration assumed - annual precipitation average for Niagara-Hamilton - water emissions from landfill associated with total tonnes **and composition of waste disposed**

5.2.5 Assumptions for MSW Landfill with LFG Recovery (System 3b)

The improved assumptions for MSW Landfill with landfill gas recovery, will address the change in overall landfill requirements for the Region of Niagara given that the Region has chosen to use capacity at the Niagara Waste Systems (NWS) landfill for the disposal of up to 100,000 tonnes per year of its waste.

The estimates of the annual and overall quantities of waste that would require disposal over the planning period have been reduced by the portion of residual waste that Niagara would send to the NWS landfill over the term of a contract (note such a contract has yet to be negotiated). It is anticipated that the NWS landfill would accept all of Niagara's residual waste for the planning period (20 to 25 years). Based on the waste projections, the annual tonnes sent by Niagara to the NWS landfill would be approximately 45% of the overall residual tonnes, or 68,000 tonnes per year. Approximately 55% of the overall residual tonnes, or 83,000 tonnes per year would be sent by Hamilton to either the Glanbrook landfill or another landfill location.

The following table includes only the assumptions for System 3b). The comparison of results is provided in Section 5.3.

Table 5.6 Assumptions for System 3b) MSW Landfill with LFG Recovery

Original Assumptions, Draft Report on the Evaluation of "Alternatives To"	Improved Assumptions applied for sensitivity analysis
Design of System: - 65% at-source diversion, with 35% residual waste managed by the system over the planning period - All residual waste to conventional landfill - Landfill in accordance with landfill standards, including gas collection and recovery of electrical energy from LFG. Recompacted clay liner used for low cost estimates. Waste to cover ratio of 80:20 - Landfill located in rural/agricultural area	***Design of System:*** - 65% at-source diversion as of 2013, **increase in at-source diversion rate to 70% over the planning period with increased diversion rates off-setting population growth** - All residual waste to conventional landfill, **Niagara Waste Systems (NWS) landfill for Niagara residual waste and a landfill located elsewhere for Hamilton residual waste** - NWS assumed to be conventional landfill with electrical energy recovery from LFG, costs in accordance with Niagara Report - Landfill for Hamilton residuals built in accordance with landfill standards, including gas collection and recovery of electrical energy from LFG. Recompacted clay liner assumed. Waste to cover ratio of 80:20. - Located in rural/agricultural area
Mass Balance and Diversion Estimates *(As per Annex E-1 of the Draft Report):* - 151,195 tonnes residual waste to landfill.	***New Mass Balance and Diversion Estimates*** *(see Appendix VI)* - **Hamilton only residual waste of 83,047 tonnes to landfill** - **Niagara only residual waste of 68,148 tonnes to NWS landfill**
Facility Land Requirements *(as per Annex E-2 of the Draft Report):* - 25-year life for the landfill - in-place density of 700 kg/m3	***New Facility Land Requirements*** - 25-year life for the landfill - in-place density of 700 kg/m3 - **Smaller Hamilton-only landfill assumed to have:**

Original Assumptions, Draft Report on the Evaluation of "Alternatives To"	Improved Assumptions applied for sensitivity analysis
- 25 m maximum height of waste above grade, 5m below grade - 3:1 side slopes - additional area for roads, scales, buildings etc. included in footprint area - landfill site size includes 100m buffer, cost of facility includes purchase of lands within 300m of footprint	▪ 25 m maximum height of waste above grade, 5m below grade; ▪ 3:1 side slopes; ▪ additional area for roads, scales, buildings etc. included in footprint area ▪ landfill site size and cost estimates includes 100m on-site buffer to determine affected area and for costing purposes a 300m assumed buffer
Electrical Energy Balances *(as per Annex E-3 of the Draft Report):* - electrical energy generated from LFG	***Electrical Energy Balances:*** - electrical energy generated from LFG, split between two sites
Financial Analysis and Cost Estimates *(as per Annex E-4 of the Draft Report):* - costs per design to meet landfill standards, low cost assumptions assume recompacted clay liner, high cost assumptions assume double composite liner - rural location land costs of $50,000 per hectare	***New Financial Analysis and Cost Estimates:*** - **NWS landfill costs based on Niagara Report** - Costs for Hamilton landfill based on design to meet landfill standards - **Reasonable cost assumptions assume recompacted clay liner** - Rural location land costs of $50,000 per hectare
Environmental Analysis *(emissions to Air and Water as per Annex E-5 of the Draft Report):* - Used IWM Model - custom Ontario grid assumed (all coal replaced with natural gas fired plants) - 50% default gas recovery, combustion to produce electrical energy is 30% efficient - landfill is lined with 90% leachate collection efficiency - no landfill carbon sequestration assumed - annual precipitation average for Niagara-	***Environmental Analysis (emissions to Air and Water):*** - **Uses MSW-DST** - **2015 projected Ontario grid (assumes increased renewables and replacement of coal with natural gas)** - **60% default gas recovery**, combustion to produce electrical energy is 30% efficient - landfill is lined with 90% leachate collection efficiency - no landfill carbon sequestration assumed - annual precipitation average for Niagara-

Original Assumptions, Draft Report on the Evaluation of "Alternatives To"	Improved Assumptions applied for sensitivity analysis
Hamilton - water emissions from landfill associated with total tonnes disposed.	Hamilton - water emissions from landfill associated with total tonnes **and composition of waste disposed**

5.2.6 Assumptions for Thermal Treatment of MSW with Metals Recovery (System 2b)

The improved assumptions for System 2b) are based on most recent operating experiences and facility performance information for modern thermal facilities operating in North America and Europe. The Draft Report on evaluation of systems, assumed facility performance based on a 2003 Request for Expressions of Interest (REOI) process undertaken by Niagara Region and very conservative estimates of energy recovery from thermal facilities.

The improved assumptions are based upon:

a) Emissions control based on new facilities for which current emissions performance data is available. New information from such facilities indicate that with Best Available Technology (BAT) flue gas management systems, the emissions are significantly less than European and Ontario A-7 emissions limits set to protect health and much less than the assumptions used in the Draft Report.

b) More efficient recovery of energy from waste, based on the recovery of both electricity and heat (i.e. combined heat and power), <u>assuming that a heat-load or other user of the heat generated by such a facility would be available during the majority of the planning period.</u>

c) Processing of the bottom ash to produce granular material for use in construction applications.

The following table includes only the assumptions for System 2b). The comparison of results is provided in Section 5.3.

Table 5.7 Assumptions for System 2b) Thermal Treatment of MSW with Metals Recovery

Original Assumptions, Draft Report on the Evaluation of "Alternatives To"	Improved Assumptions applied for sensitivity analysis
Design of System: - 65% at-source diversion, with 35% residual waste managed by the system over the planning period	***Design of System:*** - 65% at-source diversion as of 2013, **increase in at-source diversion rate to 70% over the planning period with increased diversion rates off-setting population growth**

- All residual waste to Thermal facility - Some pre-sort to remove unacceptable materials that are sent to landfill also bottom ash to landfill disposal. Assumed private sector landfill for purpose of cost estimates - Air Pollution Control (APC) system includes: • Lime injection to control acid gases; • Carbon injection to control heavy metals and dioxins; and • Bag house to capture particulate. - Fly ash/APC residue to hazardous waste disposal (4% by weight of gross input to thermal component of system). - Recovery of metals from bottom ash - Thermal facility located in urban/industrial area - Solid non-hazardous residue to private sector landfill	- All residual waste to Thermal facility - Some pre-sort to remove unacceptable materials that are sent to landfill also bottom ash to landfill disposal. Assumed private sector landfill for purpose of cost estimates - Air Pollution Control (APC) system includes: • Lime injection to control acid gases • Carbon injection to control heavy metals and dioxins. • Baghouse to capture particulate matter • **Selective Catalytic Reactor (SCR) with catalyst to control NOx and dioxin emissions** • **Final wet polishing scrubber** - Fly ash/APC residue to hazardous waste disposal (4% by weight of gross input to thermal component of system). - Recovery of metals from bottom ash - Thermal facility located in serviced urban/industrial area - **A portion of the bottom ash is aged and is then used as a substitute for granular material in approved applications.** Remaining solid non-hazardous residue to private sector landfill
Mass Balance and Diversion Estimates *(As per Annex E-1 of the Draft Report):* - Incoming material received and unacceptable materials removed (5,270 tonnes) and sent straight to landfill. - Over 145,000 tonnes sent to thermal treatment - 5,350 tonnes of ferrous metals and aluminium recovered from bottom ash - Remaining bottom ash (32,500 tonnes) to landfill, not marketed as granular material	***New Mass Balance and Diversion Estimates*** *(see Appendix VI):* - Incoming material, same as Draft Report - Over 145,000 tonnes sent to thermal treatment - 5,350 tonnes of ferrous metals and aluminium recovered from bottom ash - **26,027 tonnes of granular material recovered from bottom ash and marketed** - 11,777 of front and back end residue to

	landfill
Facility Land Requirements *(as per Annex E-2 of the Draft Report):* - 5 hectares of land required for mixed waste thermal facility - assumed that existing or private sector landfill capacity would be used for disposal of process residues.	***Facility Land Requirements:*** - 5 hectares of land required for mixed waste thermal facility - assumed that existing or private sector landfill capacity would be used for disposal of process residues.
Electrical Energy Balances *(as per Annex E-3 of the Draft Report):* - assumed thermal processing in incinerator using a simple steam generator and steam turbine configuration - 18% net electrical efficiency used - no heat recovery - Waste energy value of 5200 BTU/lb	***Electrical Energy Balances:*** - assumed thermal processing in a mass burn incinerator using steam turbine configuration. - **18.5% net electrical efficiency used (facility recovers approximately 600 kwh electrical per tonne processed)** - **1200 kwh thermal energy recovered per tonne of waste processed, hot water 40% of the time** - Waste energy value of 5200 BTU/lb
Financial Analysis and Cost Estimates *(as per Annex E-4 of the Draft Report):* - Assumed revenue for electricity at standard market price @ $60 / MWh	***New Financial Analysis and Cost Estimates*****:** - Assumed current standard market price for electricity @ **$70 /MWh** - **Assumed heat sold at $44 /MWh (80% of avoided natural gas price).** Natural gas presently costs about $0.40 per m3. Assuming gas is burned in a conventional boiler to produce hot water for heating purpose the gas costs about $55/MWh of hot water produced. As an incentive for the sale of this district heat it is assumed that the heat from the EFW is sold at 80% of this price or $44/MWh.
Environmental Analysis *(emissions to Air and Water as per Annex E-5 of the Draft Report):* - Used IWM Model - custom Ontario grid assumed (all coal	***Environmental Analysis (emissions to Air and Water):*** - **Used MSW-DST** - **2015 projected Ontario grid** (assumes increased renewables and replacement of

replaced with natural gas fired plants) - Niagara Hamilton emission data from 2003 REOI	coal with natural gas) - **2007 State-of-the-art emission factors from Covanta.** Covanta has a series of facilities operating in the U.S. with excellent reliability and operating history

5.2.7 Assumptions for Thermal Treatment of Alternative Fuel (System 2c)

The improved assumptions for thermal treatment of alternative fuel are based upon the MBT component of the system generating a fuel material that is marketed either inside or outside the study area for use as a substitute fuel for industrial processes that currently use coal, oil or petroleum coke (e.g. a cement kiln). This was not considered as an option in the comparison of systems undertaken for WastePlan, as the regulatory environment in Ontario appeared to discourage this as an option.

As noted in the Study of Stabilized Landfill Final Report, MBT in the European context is often used to recover Refuse Derived Fuel (RDF) that is thermally treated at incineration plants or industrial facilities such as cement kilns. The recent enactment of the Waste Management Projects regulation by the Province of Ontario (Reg. 101/07) under the EAA, allows for small scale use of RDF (up to 100 tpd) as a fuel by commercial, industrial or manufacturing facilities without the need for approval under the EAA, and for larger scale use of RDF (more than 100 tpd) being exempt from the EAA subject to fulfilling environmental screening. Even though the regulatory requirements have changed, the practice of using fuel products recovered from MSW is currently not well established in Ontario.

The following table includes only the assumptions for System 2c). The comparison of results is provided in Section 5.3.

Table 5.8 Assumptions for System 2c) Thermal Treatment of Alternative Fuel

Original Assumptions, Draft Report on the Evaluation of "Alternatives To"	Improved Assumptions applied for Sensitivity Analysis
Design of System:	***Design of System:***
- 65% at-source diversion, with 35% residual waste managed by the system over the planning period	- 65% at-source diversion as of 2013, **increase in at-source diversion rate to 70% over the planning period with increased diversion rates off-setting population growth.**
- Recovery of metals and recyclables from front end processing and fuel preparation.	- Recovery of metals and recyclables from front end processing and fuel preparation.
- All RDF fuel to Thermal Treatment portion of facility	- **All RDF to be sold to market as fuel substitute at remote fuel utilization site**
- Some pre-sort to remove unacceptable	- Some pre-sort to remove unacceptable

Original Assumptions, Draft Report on the Evaluation of "Alternatives To"	Improved Assumptions applied for Sensitivity Analysis
materials that are sent to landfill also bottom ash to landfill disposal. Assumed private sector landfill for purpose of cost estimates	materials that are sent to landfill. Assumed private sector landfill for purpose of cost estimates.
- Air Pollution Control system includes: • Lime injection to control acid gases; • Carbon injection to control heavy metals and dioxins; and • Bag house to capture particulate.	- Air Pollution Control (APC) system at remote fuel utilization site includes: • Approaches equivalent to Lime injection to control acid gases and Carbon injection to control heavy metals and dioxins. • Baghouse to capture particulate matter • **SCR to control NOx emissions** - **Any ash remaining from RDF combustion (i.e. inert fraction) is incorporated into the final product (i.e. cement kiln)**
- All residual waste to landfill	- All residual waste from MBT facility to landfill
- Fly ash to hazardous waste disposal (4% by weight of gross input to thermal component of system).	- **Fly ash/APC residue managed as part of the industrial process**
- Thermal facility located in serviced urban/industrial area	- Thermal facility located in serviced urban/industrial area
Mass Balance and Diversion Estimates *(As per Annex E-1 of the Draft Report):*	***New Mass Balance and Diversion Estimates*** *(see Appendix VI):*
- Incoming material received and unacceptable materials removed (23,889 tonnes) and sent straight to landfill.	- Incoming material, same as Draft Report
- Over 145,000 tonnes sent to thermal treatment	- **72,345 tonnes of waste processed and marketed as alternative fuel (RDF)**
- 5,350 tonnes of ferrous metals and aluminium recovered from bottom ash	- **8,320 tonnes of metals and recyclables captured and recovered by front-end process**
- Remaining bottom ash (32,500 tonnes) to landfill, not marketed as granular material	- **21,483 tonnes of organics removed by bio-drying** - **Remaining residuals (49,047 tonnes) to**

Original Assumptions, Draft Report on the Evaluation of "Alternatives To"	Improved Assumptions applied for Sensitivity Analysis
	landfill
Facility Land Requirements *(as per Annex E-2 of the Draft Report):* - 6 hectares of land required for MBT/ thermal facility - Assumed that existing or private sector landfill capacity would be used for disposal of process residues.	***Facility Land Requirements:*** - **5 hectares of land required for mixed waste MBT facility generating RDF. Note: lower land area requirements then System 1 as high degree of stabilization not required and no thermal treatment on site.** - Assumed that existing or private sector landfill capacity would be used for disposal of process residues.
Electrical Energy Balances *(as per Annex E-3 of the Draft Report):* - Energy value of RDF determined to be 7,100 BTU/lb - Assumed thermal processing in incinerator using a simple steam generator and steam turbine configuration - 18% net electrical efficiency used - No heat recovery	***Electrical Energy Balances:*** - Energy value of RDF determined to be 7,100 BTU/lb - **Assumed RDF used as fuel substitute for coal**
Financial Analysis and Cost Estimates *(as per Annex E-4 of the Draft Report):* - Includes cost of MBT facility - Includes cost of thermal treatment facility	***New Financial Analysis and Cost Estimates:*** - **No revenue assumed from sale of RDF ($0 tipping fee).** While RDF would be substituted for fuels of much higher cost (i.e. cost of $40/tonne for petcoke), it is assumed that industry would not be willing to pay for RDF anything beyond a nominal fee as there are capital investments and some risk to industry to using RDF as fuel. - **Costs of thermal facility are not included** - **Costs to transfer RDF to market are included ($10/tonne)**

Original Assumptions, Draft Report on the Evaluation of "Alternatives To"	Improved Assumptions applied for Sensitivity Analysis
Environmental Analysis *(emissions to Air and Water as per Annex E-5 of the Draft Report):* - Used IWM Model - custom Ontario grid assumed (all coal replaced with natural gas fired plants) - Niagara Hamilton emission data from 2003 REOI	***Environmental Analysis (emissions to Air and Water):*** - **Uses MSW-DST** - **2015 projected Ontario grid (assumes increased renewables and replacement of coal with natural gas).** - **Achieves the equivalent of 2007 State-of-the-art emission factors from Covanta**

5.3 Comparison of the Net Effects Resulting from Applying Original and Improved Assumptions

5.3.1 Comparison of Net Annual Life Cycle Air Emissions

The following tables present the results of the net annual life cycle (LCA) air emissions for all four of the systems, including both the data generated in the preparation of the Draft Report and the data resulting from application of the MSW-DST model using both the original and improved system assumptions as set out in Section 5.2 of this report. Detailed results of the application of the MSW-DST model are provided in Appendix V including direct emissions (e.g. the emissions from a thermal facility) and indirect emissions (e.g. the emissions associated with generating electricity used by an MBT facility).

Negative numbers represent a net decrease of emissions to the environment associated with the systems based on how the materials are handled. For example, the recycling of materials recovered in Systems 1, 2b) and 2c) into new products, results in avoiding emissions that would have resulted from using raw materials to make the same products. Likewise, in System 2c) the use of RDF in lieu of fossil fuels, results in avoiding emissions that would have resulted from the extraction and processing of the fossil fuels.

Note: It has been determined that the LCA results are highly sensitive to the assumptions used for the electrical grid, i.e. the assumptions on the relative proportion of electricity generated from fossil fuels, nuclear or renewable sources. The Draft Report assumed an electrical grid with the same proportion of electricity from these sources as the current Ontario grid, except that it was assumed that natural gas would be used for all electricity generated from fossil fuels (i.e. no coal fired generating stations). The improved assumptions used in this analysis were based on assuming a new Ontario grid, where more energy is generated from renewable sources and less from natural gas. To compare the LCA results from the MSW-DST model based on the original and improved assumptions unique to each system, the same grid (assuming less energy from natural gas and more from renewables) has been used. If the current Ontario grid, or the assumed grid in the Draft Report had been used, the net air emissions from all systems would be lower, with the greatest decrease for System 2b).

Table 5.9 System 1, Annual Life Cycle Air Emissions

Parameter	LCA from Draft Report on the Evaluation of "Alternatives To" (IWM Model)	LCA based on Original Assumptions, (MSW-DST Model)	LCA based on Improved Assumptions (MSW-DST Model)
GHG (eC02 tonnes)	2,428	3,714	3,295
NOx (tonnes)	-42.50	-8	-2
SOx (tonnes)	-99.55	-45	-43
HCl (tonnes)	-1147.20	0	0
PM (tonnes)	32.96	-29	-28
VOCs (tonnes)	-2791	-8	-7
Lead (kg)	-4.33	-0.9	-0.9
Mercury (kg)	-0.02	0.0	0.0
Cadmium (kg)	-0.01	0.0	0.0
Dioxins (g TEQ)	0.000979	-0.00009	-0.00009

* Note, if high rate decomposition were undertaken using anaerobic digestion, the offsets related to the relatively small quantity of energy produced would result in small improvements to the air emissions data.

Table 5.10 System 3b) Annual Life Cycle Air Emissions

Parameter	LCA from Draft Report on the Evaluation of "Alternatives To" (IWM Model)	LCA based on Original Assumptions, (MSW-DST Model)	LCA based on Improved Assumptions (MSW-DST Model)
GHG (eC02 tonnes)	22,336	24,674	20,909
NOx (tonnes)	6.36	9	9
SOx (tonnes)	0.12	-3	-4
HCl (tonnes)	0.11	0	1
PM (tonnes)	41.94	1	1
VOCs (tonnes)	3.68	1	1
Lead (kg)	0	0.0	0.0
Mercury (kg)	0	0.0	0.0

Cadmium (kg)	0.01	0.0	0.0
Dioxins (g TEQ)	0.00169	0.000015	0.000013

Table 5.11 System 2b) Annual Life Cycle Air Emissions

Parameter	LCA from Draft Report on the Evaluation of "Alternatives To" (IWM Model)	LCA based on Original Assumptions, (MSW-DST Model)	LCA based on Improved Assumptions (MSW-DST Model)
GHG (eC02 tonnes)	4,166	6,655	-5,660
NOx (tonnes)	77.55	41	-89
SOx (tonnes)	-99.17	-169	-387
HCl (tonnes)	-1154.17	5	4
PM (tonnes)	0.25	-28	-30
VOCs (tonnes)	-59.84	11	-47
Lead (kg)	27.85	2.6	2.3
Mercury (kg)	7.29	5.2	5.1
Cadmium (kg)	3.62	0.6	0.5
Dioxins (g TEQ)	0.01	0.0069	0.0032

Table 5.12 System 2c) Annual Life Cycle Air Emissions

Parameter	LCA from Draft Report on the Evaluation of "Alternatives To" (IWM Model)	LCA based on Original Assumptions, (MSW-DST Model)	LCA based on Improved Assumptions (MSW-DST Model)
GHG (eC02 tonnes)	5,265	4,799	-71,714
NOx (tonnes)	2.36	24	-289
SOx (tonnes)	-122.43	-144	-552
HCl (tonnes)	-1276	3	-5
PM (tonnes)	20.11	-41	-139
VOCs (tonnes)	-48.38	-7	12
Lead (kg)	10.85	0.3	-3.2
Mercury (kg)	7.29	2.6	2.5
Cadmium (kg)	3.62	0.2	0.1

Dioxins (g TEQ)	0.01	0.0034	0.0013

Relative Comparison of Emissions to Air

The purpose of the LCA modelling is to compare the relative differences between the systems. The relative differences of the LCA emissions to air as determined through application of the MSW-DST model, based on the original and improved assumptions are presented in the following figures.

Figure 5-2 Life Cycle (Annual) GHG Emissions (Tonnes)

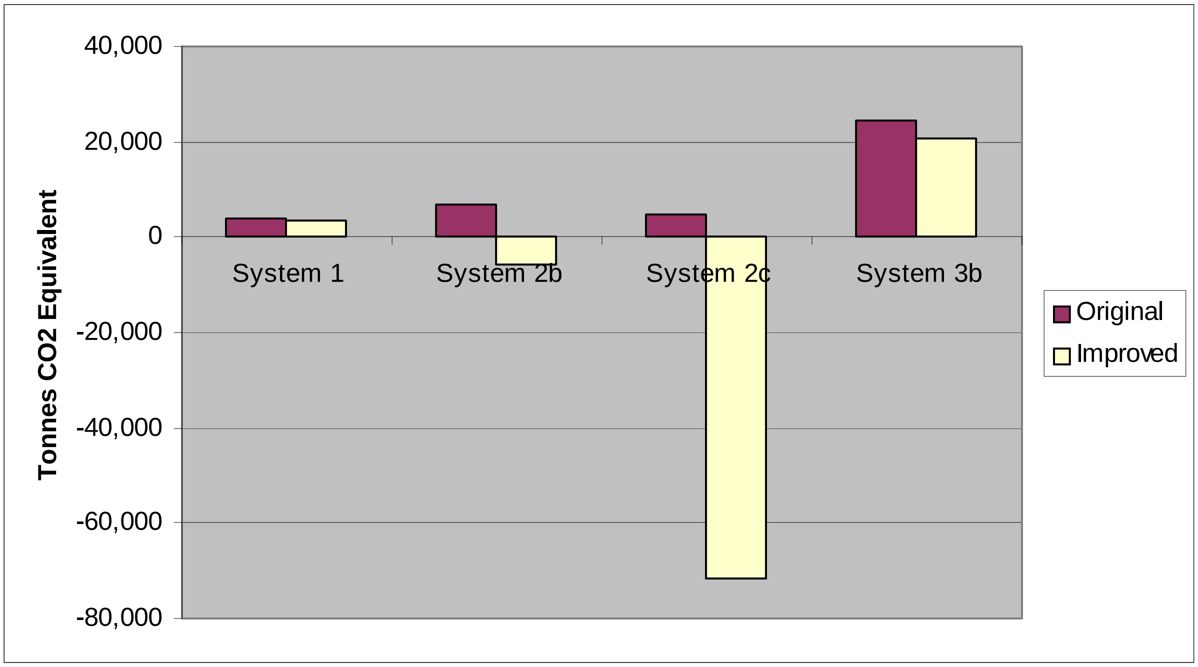


Figure 5-3 Life Cycle (Annual) Total Acid Gas Emissions (NOx, SOx, HCl) in Tonnes

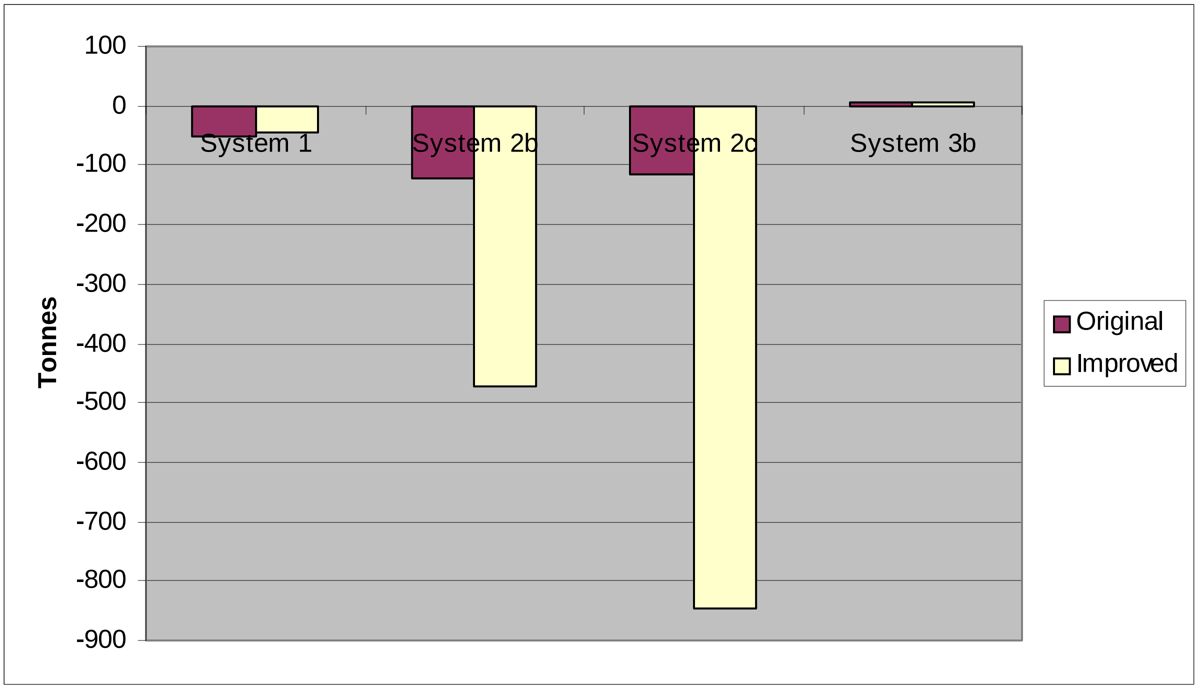


Figure 5-4 Life Cycle (Annual) Total Emissions of Smog Precursors (NOx, PM, VOC) in Tonnes

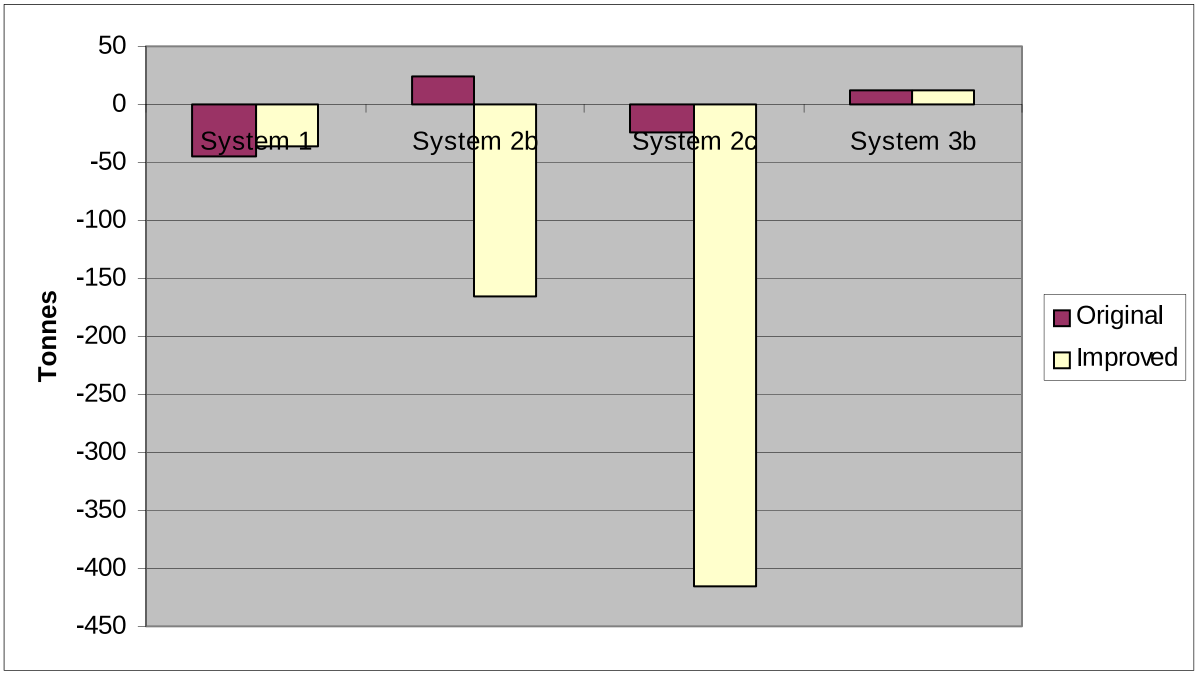


Figure 5-5 **Life Cycle (Annual) Total Emissions of Heavy Metals (lead, mercury, cadmium) in Kilograms**

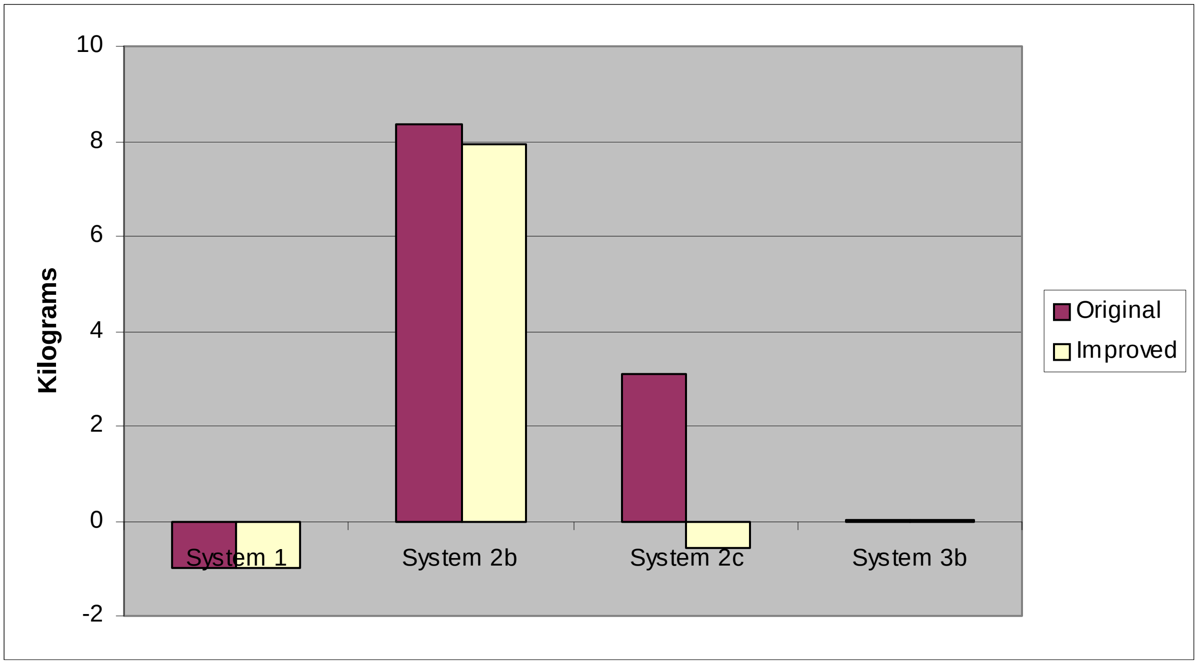
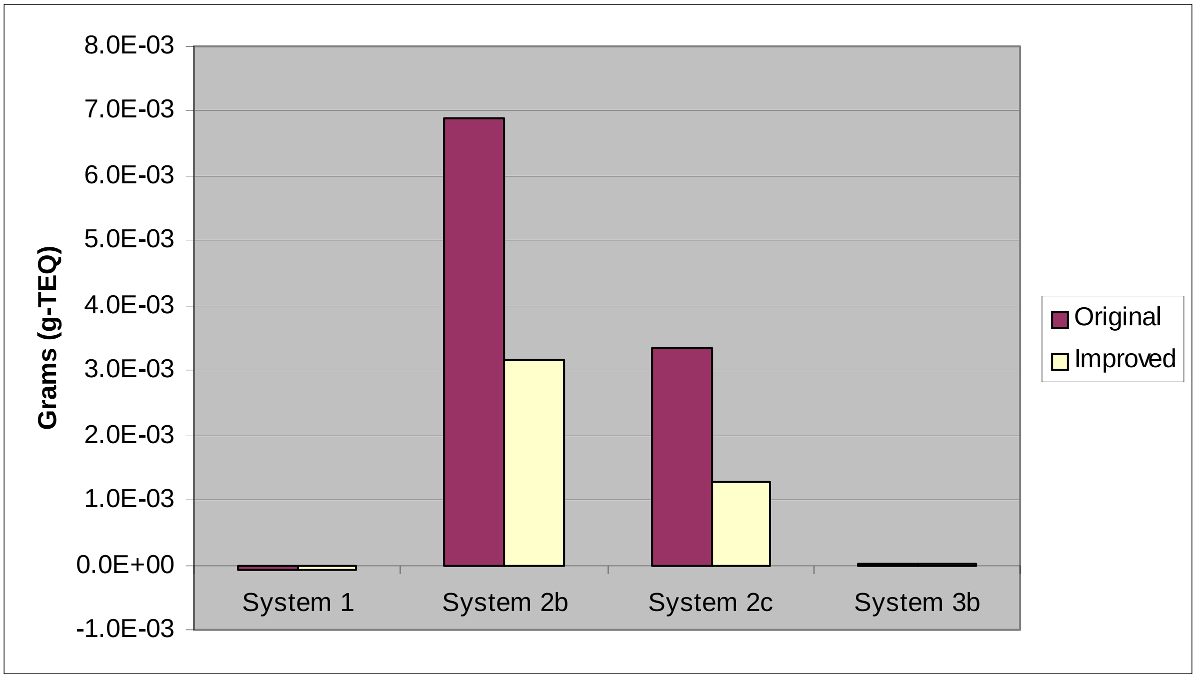


Figure 5-6 **Life Cycle (Annual) Emissions of Dioxins (grams g-TEQ)**



Under the original system assumptions: System 1 has the lowest net emissions of greenhouse gases (GHG), smog pre-cursors, heavy metals and dioxins. System 3b) has the highest overall emissions of GHG, and acid gases. Thermal Systems 2b) and 2c) have the lowest emissions of acid gases but produce the highest emissions of heavy metals and dioxins, and System 2b) has the highest net emissions of smog precursors.

With the improved system assumptions: the increased efficiency of capturing the energy in the residual waste, as presented in System 2c) through substitution of RDF for fossil fuels, has resulted in this system having the lowest net emissions of GHG, acid gases and smog precursors (NOx, PM, VOC) to the air, followed by System 2b). Systems 1 and 2c) have the lowest overall net emissions of heavy metals. System 1 has the lowest overall net emissions of dioxins, as it has no direct combustion and has increased material capture for recycling.

Note: it is not possible to compare the air emissions of System 3b) with a conventional landfill that has been in operation for some time accepting mixed waste, as the waste that is landfilled in System 3b) is assumed to have a significant proportion of organics removed through source separated organics diversion programs that are in place and are being improved in Niagara and Hamilton.

5.3.2 Comparison of Net Annual Life Cycle Water Emissions

The following tables present the results of the net annual life cycle (LCA) water emissions for all four of the systems, including both the data generated in the preparation of the Draft Report and the data resulting from application of the MSW-DST model using both the original and improved system assumptions as set out in Section 5.2 of this report. Appendix V provides details on the LCA modelling of emissions to water.

Note: the MSW-DST model includes direct emissions to water from landfill as well as indirect emissions to water associated with energy consumption (or generation).

Table 5.13 System 1 Annual Life Cycle Water Emissions

Parameter	LCA from Draft Report on the Evaluation of "Alternatives To" (IWM Model)	LCA based on Original Assumptions, (MSW-DST Model)	LCA based on Improved Assumptions (MSW-DST Model)
Lead (kg)	-1.7	14.5	14.45
Mercury (kg)	0.16	-0.00079	-0.00079
Cadmium (kg)	9.33	7.01	7.1
BOD (kg)	74,126	30,500	30,500

* Note, if high rate decomposition were undertaken using anaerobic digestion, there would be a small decrease in emissions as the system would generate energy to offset some of the energy consumed in the System.

Table 5.14 System 3b) Annual Life Cycle Water Emissions

Parameter	LCA from Draft Report on the Evaluation of "Alternatives To" (IWM Model)	LCA based on Original Assumptions, (MSW-DST Model)	LCA based on Improved Assumptions (MSW-DST Model)
Lead (kg)	8.54	0.00565	0.00565
Mercury (kg)	0.22	0.00014	0.00014
Cadmium (kg)	13.03	-0.26	-0.33
BOD (kg)	101,285	24,000	24,000

Table 5.15 System 2b) Annual Life Cycle Water Emissions

Parameter	LCA from Draft Report on the Evaluation of "Alternatives To" (IWM Model)	LCA based on Original Assumptions, (MSW-DST Model)	LCA based on Improved Assumptions (MSW-DST Model)
Lead (kg)	-10.63	-0.0031	-0.0044
Mercury (kg)	0.02	-0.0014	-0.0025
Cadmium (kg)	3.63	-8.79	-23.9
BOD (kg)	3,345	6,100	6,100

Table 5.16 System 2c) Annual Life Cycle Water Emissions

Parameter	LCA from Draft Report on the Evaluation of "Alternatives To" (IWM Model)	LCA based on Original Assumptions, (MSW-DST Model)	LCA based on Improved Assumptions (MSW-DST Model)
Lead (kg)	-11.12	17.5	17.5
Mercury (kg)	0.06	-0.0015	-0.0011
Cadmium (kg)	4.63	3.14	8.36
BOD (kg)	33,494	25,000	25,000

Relative Comparison of Emissions to Water

Figures 5-6 and 5-7 present a relative comparison of the emissions of Heavy Metals (total of the emissions of lead, mercury and cadmium to water on an annual basis) and Biological Oxygen Demand (BOD) based on both the original and improved system assumptions.

Figure 5-7 Life Cycle Water Annual Emissions of Heavy Metals (tonnes)

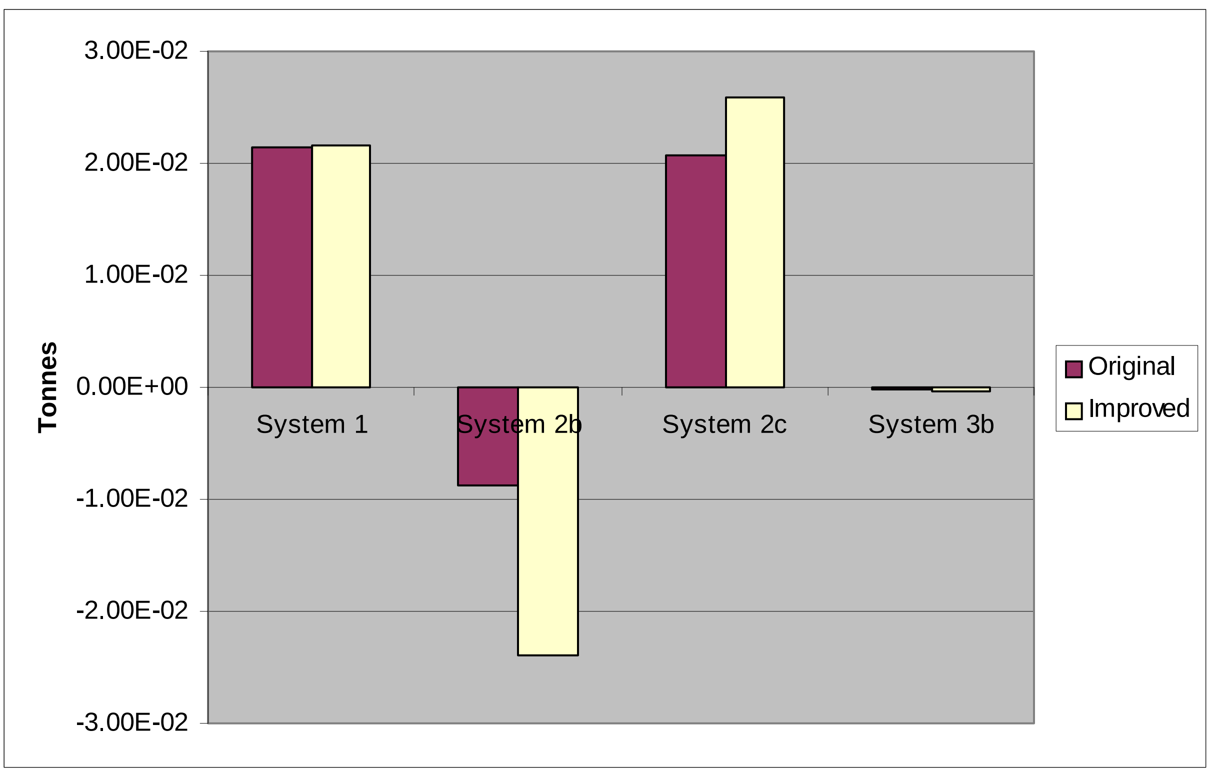
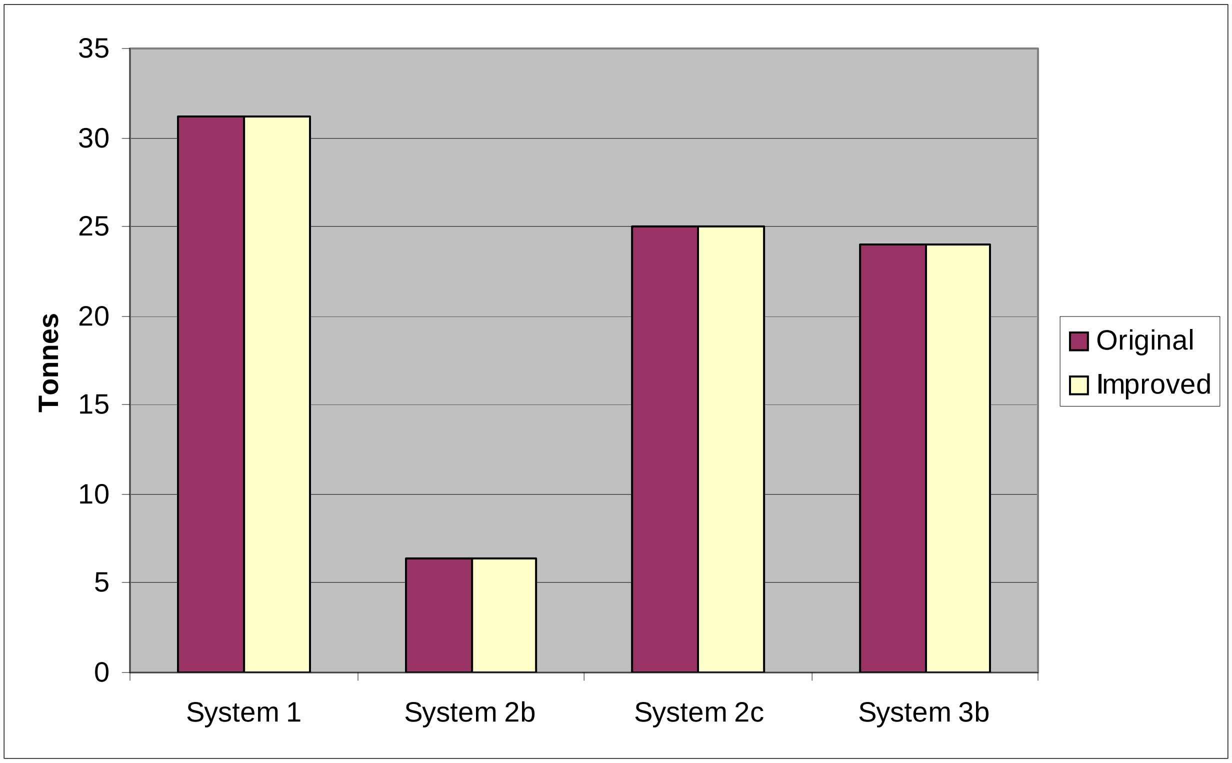


Figure 5-8 Life Cycle Annual Biochemical Oxygen Demand -BOD (tonnes)



Comparison of the systems based on the original assumptions: indicates that System 2b) has the overall lowest emissions of BOD and heavy metals to water. System 1 has the highest emissions of heavy metals to water, closely followed by System 2c). In terms of BOD, System 1 has the highest emissions of BOD, followed closely by System 2c) and 3b).

Comparison of the systems based on the improved assumptions: does not result in any change to relative ranking of the systems presented in the Draft Report. System 2b) has less net life cycle emissions of heavy metals and BOD to water, then Systems 1, 2c) and 3b) where a higher proportion of waste is landfilled, and where in the case of Systems 1a) and 2c) waste is treated biologically as part of the systems.

For System 1 and 2c), higher emissions of metals and BOD to water are associated with the indirect emissions related to the energy consumed during composting and during the remanufacturing process used to recycle recovered materials. Note: the direct emissions to water from the landfill component of Systems 1 and 2c) are lower than those for System 3b).

The MSW DST model also determines the emissions to water of other parameters of concern such as oil, iron, phosphate, chromium etc. These parameters are not reported in the tables provided above as only the four noted parameters were used in the Draft Report to determine the relative net effects of emissions to water.

The MSW DST model is consistent with the Study of Stabilized Landfill Final Report, as the direct emissions from the stabilized landfill in System 1 are lower for major parameters such as COD, BOD and Ammonia then the landfill in System 3b). It is not possible to compare the emissions to water of System 3b) with a conventional landfill that has been in operation for some time accepting mixed waste, as the waste that is landfilled in System 3b) is assumed to have a significant proportion of organics removed through source separated organics diversion programs that are in place and are being improved in Niagara and Hamilton.

5.3.3 Comparison of Net Energy Consumption/Generation

The following table presents the results of the net annual life cycle energy either generated (presented as a negative number) or consumed, that has been calculated for all four of the systems, including both the data generated in the preparation of the Draft Report and the data generated based on use of the MSW-DST for the original and improved assumptions set out in Section 5.2 of this report.

The net annual life cycle energy values represent the total energy balance of the systems including:

- energy used to run facilities (electrical, natural gas, diesel fuel etc.);
- energy used to transport materials within the system;
- energy generated by facilities (electrical, heat if captured) and the offsets associated with replacing electrical energy on the Ontario grid with that generated by the systems; and
- energy used to recycle materials and the virgin material displacement credits associated with replacing certain raw materials with the materials recovered by the systems.

The comparison of the information in the Draft Report and the analysis of the improved systems assumptions indicates:

- Less net energy is generated for System 1 as a result of the increased energy requirements for the high intensity composting approach. If however, anaerobic digestion were used for the high rate phase of decomposition, the net energy generated would be slightly more.
- A decrease in the net energy consumed for System 3b), as a result of assuming higher efficiency for landfill gas capture.
- An increase in the net energy generated for System 2b), associated with the slightly higher electrical energy efficiencies and the sale of heat in the form of hot water.
- An increase in the net energy generated for System 2c), associated with the higher efficiencies inherent in industrial use of RDF as a fuel in processes that utilize the heat generated from the combustion of the material (such as cement kilns).

Table 5.17 Net Annual Life Cycle Energy (GigaJoules)

LCA from Draft Report on the Evaluation of "Alternatives To" (IWM Model), GigaJoules (no transportation assumed)	LCA based on Original Assumptions, (MSW-DST Model), GigaJoules	LCA based on Improved Assumptions (MSW-DST Model), GigaJoules
System 1: -244,346	System 1: -254,200	System 1: -250,100 *
System 3b): -7,331	System 3b): 44,400	System 3b): 38,400

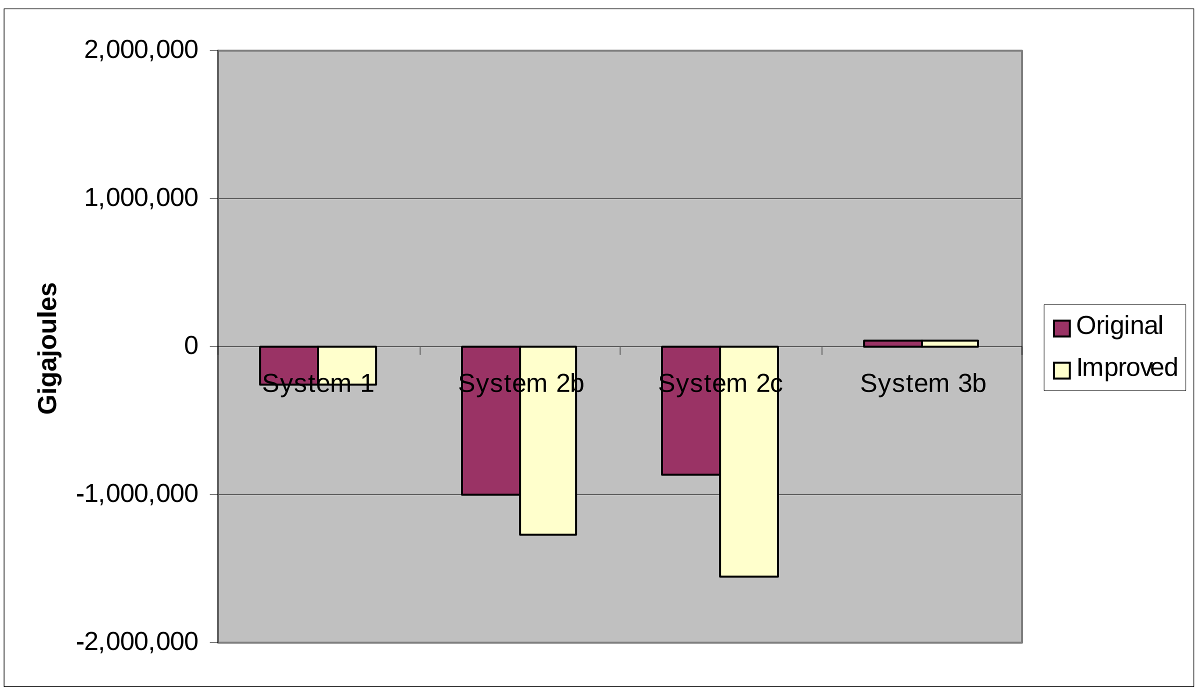
System 2b): -540,046	System 2b): -997,300	System 2b): -1,276,000
System 2c): -499,466	System 2c): -869,000	System 2c): -1,560,000

* Note if high rate decomposition were undertaken using anaerobic digestion, the relatively small quantity of energy produced would result in small improvements to the net life cycle energy assumptions.

Relative Comparison of Net Energy Generation/Consumption

Figure 5-9 presents a relative comparison of the net annual energy consumption based on the original and improved system assumptions.

Figure 5-9 Life Cycle (Annual) Energy Consumption (GJ)



Comparison of the systems based on the original assumptions: indicates that Thermal Systems 2b) and 2c) generate significantly more energy than the other Systems with 2b) generating the most energy. System 3b) is the only system that consumes more energy than it produces.

Comparison of the systems based on improved assumptions: has not changed the relative ranking of thermal Systems 2b) and 2c) as compared to Systems 1 and 3b) in the Draft Report. The systems with thermal treatment of the majority of the residual waste stream generate far greater net life cycle energy, than the systems where a higher proportion of waste is landfilled.

What has changed is the relationship between System 2b) and 2c), as the LCA indicates that the use of RDF as a direct substitute for fossil fuels like coal in industrial applications, results in an higher overall net life cycle generation of energy than the combustion of mixed residual waste in a dedicated thermal treatment facility even if both electricity and heat are marketed.

5.3.4 Comparison of Diversion Rates and Consumption of Landfill Space

The following table presents the results of the mass balance calculations for all four of the systems, including both the data generated in the preparation of the Draft Report and the data generated as a result of applying the improved assumptions set out in Section 5.2 of this report. These mass balance calculations are presented in Appendix VI.

For all Systems it is assumed that at-source diversion programs divert 65% of all waste from disposal at the beginning of the planning period, increasing to 70% at the end of the planning period.

The Draft Report compared the ability of the systems to:

- Divert additional materials from disposal (disposal being either the mass lost through thermal treatment and/or the mass disposed in landfill). Diversion of materials from disposal can be added to at-source diversion to determine the overall diversion rate of the systems; and
- Reduce the quantity of residual waste sent to landfill.

Table 5.18 Potential to Divert Residual Waste

Data Generated in Draft Report on the Evaluation of "Alternatives To"		Data generated from Improved Assumptions applied for Sensitivity Analysis	
Percent of total Waste Generated to Disposal	Percent of total Waste Generated to Landfill	Percent of total Waste Generated to Disposal	Percent of total Waste Generated to Landfill
System 1: 25%	System 1: 25%	System 1: 24% *	System 1: 24% *
System 3b: 35%	System 3b: 35%	System 3b: 35%	System 3b: 35%
System 2b: 34%	System 2b: 9%	System 2b: 28%	System 2b: 3%
System 2c: 28%	System 2c: 12%	System 2c: 28%	System 2c: 11%

* Note, the total quantity of residual waste that remains is the same regardless of whether high rate decomposition were undertaken using anaerobic digestion or aerobic composting.

For all systems except System 3b) where there is no processing component included in the system, the improved assumptions increase the potential to reduce the quantity of residual waste sent to landfill.

For System 1, improved assumptions increase overall diversion and reduce the quantity of materials sent to landfill, based on the longer retention time of the residual waste material within the biological portion of the MBT facility. Increased retention time allows for more complete decomposition of the volatile organics, some additional decomposition of the carbon based materials and additional moisture loss from the residual waste. The incremental difference between the results presented in the Draft Report that were based on a low to medium intensity composting approach to the high intensity approach used for the improved assumptions is not large, as the proportion of volatile organic materials in the residual waste stream is quite low (see section 5.2.1). If a class B compost material were recovered and marketed from the stabilized material in System 1, the percent of waste sent to disposal could decrease from 24% to 18%.

For System 2b) improved assumptions increase overall diversion and reduce the quantity of materials sent to landfill based on the assumed use of a large portion of the aged bottom ash from the thermal treatment facility as an aggregate substitute in permitted applications. Note: this improved assumption is based on experience in Europe regarding the use of material in such applications. Agreement by the province (MOE) for the use of this material for such applications would be required for this assumption to increase in probability during system implementation. Note: a portion of the bottom ash from the Algonquin EFW facility in Peel is diverted from landfill for use as aggregate used in asphalt.

For System 2c), there is a very small reduction in the materials sent to landfill due to the inclusion of any ash from the combustion of RDF in the product generated through industrial use of the RDF (such as in a cement kiln). Again, this is an improved assumption based on experience in Europe and the U.S.A. on the use of RDF in industrial applications.

Relative Comparison of Diversion from Disposal and Landfill

Based on the above noted results, the relative comparison of the systems based on improved assumptions does not result in any change to relative ranking of the systems presented in the Draft Report. System 1 continues to have the highest overall diversion from disposal, where disposal is defined as including both the mass loss through thermal treatment and/or landfill disposal of materials. Systems 2b) and 2c) result in the greatest reduction in the quantity of materials sent to landfill.

Note: that for all cases it is assumed that the supply of residual waste to the systems remains constant over the planning period (151,000 tonnes per year), assuming an increase in at-source diversion over the planning period from 65 to 70%. If higher at-source diversion rates were to be achieved, it would not affect the relative comparison of the ability of the systems to reduce the quantity of materials sent to landfill even if they were functioning at less then design capacity. If lower at-source diversion rates were to be achieved, all of the systems would require more capacity. This would result in a need for additional landfill airspace for Systems 1 and 3b). For System 2b), a thermal treatment facility expansion and/or additional landfill airspace would be required, and for System 2c) an MBT facility expansion and/or additional RDF markets, and/or additional landfill airspace would be required.

Landfill Airspace

While it was not discussed in the Draft Report, the consumption of landfill airspace was determined for all of the systems, and reflected the differences in the total tonnes and density of the material that required landfill disposal. The consumption of landfill space has also been determined based on the improved system assumptions.

The following table presents a comparison of the cubic metres of landfill space required for each of the systems. For all systems except System 3b), the consumption of landfill space decreases based on improved system assumptions.

Table 5.19 Total Volume of Landfill Space Required (over 25 years)

Data Generated in Draft Report on the Evaluation of "Alternatives To" (thousands m3)	Data generated from Improved Assumptions applied for sensitivity analysis (thousands m3)
System 1: 4,000,000	System 1: 3,570,000 *
System 3b): 5,900,000	System 3b): 5,900,000
System 2b): 900,000	System 2b): 251,000
System 2c): 1,200,000	System 2c): 1,031,000

* Note, the total quantity of residual waste and thus the landfill volume required, is the same regardless of whether high rate decomposition were undertaken using anaerobic digestion or aerobic composting.

With System 1, although the average density of the stabilized waste decreases from 750 kg/m3 to 700 kg/m3, less landfill space is required as more material is being diverted and as a portion of the stabilized material is being used to reduce overall landfill cover requirements. In System 1, the high intensity composting approach reduces the overall moisture content of the stabilized material, thus decreasing density. However, if the light fraction of the stabilized material is marketed as RDF, as is the case in System 2c), then the density of the stabilized material that remains for landfilling would increase to over 1,000 kg/m3. If class B compost were recovered, there would be some decrease in volume of landfill space required, however, additional soil materials would be required for landfill cover.

For System 2b), overall landfill space requirements decreases, as the total quantity of material disposed in landfill decreases with the use of a portion of the bottom ash as an aggregate substitute in approved applications.

With System 2c), overall landfill space requirements decreases slightly, as bottom ash from RDF combustion is no longer disposed in landfill but incorporated within the product generated through industrial use of the RDF material.

5.3.5 Comparison of Facility Land Area Requirements

The following table presents the results of the facility land area calculations for all four of the systems, including both the data generated in the preparation of the Draft Report and the results of applying improved system assumptions set out in Section 5.2 of this report.

The facility land area requirements represent the total quantity of land required for the development of the facilities in each system and are determined based on the calculated footprint of the facility and a minimum buffer of 100 metres between the facility footprint and the property line. The 100 metre buffer is assumed to exist between the footprint of any facility and the property line for all elements of the systems.

Table 5.20 Total Facility Land Area Requirements

Total Facility Land Area Requirements	
Data Generated in Draft Report on the Evaluation of "Alternatives To" (Ha)	**Data generated from Improved Assumptions applied for sensitivity analysis (Ha)**
System 1: 49 Ha for landfill plus 7Ha for the MBT	System 1: 47 Ha for landfill plus 12 Ha for the MBT *
System 3b: 62 Ha	System 3b: 44 Ha
System 2b: 5 Ha	System 2b: 5 Ha
System 2c: 6 Ha	System 2c: 5 Ha

* Note the total facility footprint is the same regardless of whether high rate decomposition was undertaken using anaerobic digestion or aerobic composting.

For System 1, the reduced landfill space requirements, result in a small reduction in land area requirements for the stabilized landfill component of the system, however, this is offset by the increased facility land area requirements for the expanded biological portion of the MBT system that is required for the high intensity composting approach. The land area requirements for System 1 could be reduced if it were possible within the site constraints to construct a deeper landfill however this could apply to the landfill component of any system. If some of the landfill requirements were addressed through disposal of the Niagara portion of the residual waste at the Niagara Waste Systems landfill then the area required for the landfill could be reduced by up to 40% to around 30 Ha, resulting in a total land area requirement of 42 Ha. If class B compost material were recovered, the total land area requirement could be reduced by a further 7 Ha to 35 Ha.

For System 3b), the land area requirements are reduced, as it is assumed that only the Hamilton portion of the residual waste stream would be disposed within new landfill capacity developed for this system. If the approved expansion area for Hamilton's Glanbrook landfill has sufficient capacity for some or all of Hamilton's residual waste over the planning period, the land area requirements would be further reduced. The Niagara portion of the residual waste stream would be disposed at the Niagara Waste Systems landfill.

For System 2b), the land area requirements remain unchanged, reflecting the siting of a new thermal treatment facility. The residual waste that remains is assumed to be disposed in existing approved landfills in Niagara or Hamilton or would be disposed in private sector landfills as only 251,000 cubic meters of landfill space is required.

With System 2c), the land area requirements are reduced slightly, as the improved assumptions no longer include the development of a new thermal treatment facility integrated with the MBT portion of the system. The residual waste that remains is assumed to be disposed in existing approved landfills in Niagara or Hamilton or would be disposed in private sector landfills as only just over 1 million cubic metres of landfill space is required.

Relative Comparison of Land Area Requirements

Based on the above noted results, the relative comparison of the systems based on improved system assumptions is a little different from the relative ranking of the systems in the Draft Report. What has not changed is that the systems with thermal treatment of the majority of the residual waste stream have a far smaller land area requirement then Systems 1 and 3b). What has changed is that the land area requirements for System 3b) are less than that for System 1, if it is assumed that a new Niagara/Hamilton stabilized landfill is developed for System 1 and a new landfill for Hamilton residual waste only would be required for System 3b).

However, if site characteristics permitted a deeper stabilized landfill as part of System 1 or the portion of stabilized material from Niagara were to be disposed in the Niagara Waste System landfill, then the land area requirements for System 1 would be relatively the same as System 3b). The land area requirements for System 1 could be less then System 3b) if class B compost were recovered and marketed from the stabilized materials.

5.3.6 Comparison of Net Cost per Tonne

The following table presents the results of the net cost per tonne calculations for all four of the systems, including both the data generated in the preparation of the Draft Report and the results of applying improved system assumptions set out in Section 5.2 of this report.

Annex E-4 of the Draft Report presented both low and high costs, based on application of different assumptions for system design and parameters such as interest rates. For this analysis reasonable costs per tonne were determined, based on the system design assumptions set out in Section 5.3 of this report.

The spreadsheets outlining the detailed cost calculations are included in Appendix VII of this report.

The real (excluding inflation) interest rate/cost of capital used in the calculations applied to all of the systems was 4%, the same as that used for the low cost estimates in the Draft Report.

Table 5.21 Net System Cost per Tonne Managed

Data Generated in Draft Report on the Evaluation of “Alternatives To” *Cost per tonne (low to high)*	**Data generated from Improved Assumptions applied for sensitivity analysis** *Reasonable Cost per tonne*
System 1: $127 to $180/tonne	System 1: $147 *

System 3b: $61 to $89/tonne	System 3b: $69
System 2b: $102 to $168/tonne	System 2b: $88
System 2c: $125 to $199/tonne	System 2c: $85

* Note the net cost of the system could be slightly higher if high rate decomposition were undertaken using anaerobic digestion.

The reasonable cost per tonne based on the improved assumptions for System 1 is higher than the low cost estimate in the Draft Report but lower than the high cost estimate. The reasonable cost estimates for System 1 are based on the use of urban/industrial land valued at $200,000 per hectare and the increased capital and operating costs for the high intensity composting component of the MBT. Note: the Draft Report assumed an urban/industrial land cost of $250,000 per hectare; however, more recent information on land values indicates that the average value of such property in Niagara and Hamilton may be lower than this. If Niagara's portion of stabilized residual waste were to be disposed in the Niagara Waste Systems landfill, the cost for System 1 would be slightly higher as there would be a slightly lower economy of scale to develop a Hamilton only stabilized landfill. If the stabilized landfill were sited in a rural area and the MBT in an urban area, the net cost of System 1 could be reduced to $142 per tonne, reflecting the lower cost of land associated with siting the stabilized landfill in a rural setting.

The reasonable cost per tonne determined for System 3b), is higher than the low cost estimate in the Draft Report but lower than the high cost estimate. The reasonable cost estimates reflect a slightly lower economy of scale for a landfill sited and designed to accept only Hamilton residual waste and the reported cost of $50/tonne noted in the Niagara Region report PWA 83-2007 for the disposal of Niagara's residual waste at the Niagara Waste Systems landfill.

The reasonable cost per tonne determined for System 2b), is lower than the low cost estimate in the Draft Report. The initial capital costs for System 2b) are higher to reflect the additional components for the APC and ash handling system in order to produce a granular product as well as the necessary on-site components to handle the hot water marketed for district heating. Annual operating costs are also slightly higher to reflect these additional activities. These increases are more than offset by the increased revenues associated with a slightly higher value for the electricity sold (reduces net cost by $6/tonne), the sale of the heat at 80% of the avoided natural gas price (reduces net cost by $21/tonne), and the reduced quantities of bottom ash requiring landfill disposal at an estimated cost of $65 per tonne at a private sector landfill (reduces net cost by $11/tonne). Note that the basic commodity spot price for electricity has increased from $0.06 to around $0.07 per kWh in the period of time since the Draft Report was issued. While this analysis assumes $ 0.07 for the sale of electrical energy, this value is likely to continue to increase over the next number of years. Note: the cost of using private sector landfill space for disposal of solid residues at a tip fee of $65 per tonne is assumed to cover all costs including long-term closure costs.

The reasonable cost per tonne determined for the System 2c), is significantly lower than the low cost estimate in the Draft Report. The capital and operating costs for the MBT portion of System 2c) remain unchanged, however the capital and operating costs for the thermal portion of the System have been eliminated as the improved system assumptions no longer include a dedicated thermal facility to combust the RDF. Instead, it is assumed that the RDF is shipped to an industrial facility for use as fuel at a cost of $10/tonne for shipping and handling. It is assumed that there would be no revenue from the sale of this material, as a market price has yet to be set in Ontario. Note: the cost of using private sector landfill space for disposal of solid residues at a tip fee of $65 per tonne is assumed to cover long-term closure costs.

5.4 Net Effects based on Improved Assumptions

Table 5.22 presents the overall net effects of applying improved system assumptions for all of the criteria used to evaluate the systems in the Draft Report as set out in Table 5.1. Systems with unique advantages and disadvantages are identified with an asterisk *.

Table 5.22 Summary of System Advantages and Disadvantages

ADVANTAGES	DISADVANTAGES
SYSTEM 1 *Mechanical Biological Treatment (MBT) and Landfilling of Stabilized Residuals)*	
Natural Environmental ✓ ***Lowest Net Emissions of Heavy Metals and Dioxins to Air **** ✓ ***Highest Potential for Diversion from Disposal**** ***Other Considerations*** No major unique social/cultural, technical, economic/financial, or legal advantages.	***Natural Environmental*** ✗ ***Greatest Net Electrical Energy Consumption **** ✗ ***Highest Net Emissions of BOD to water* (based on LCA of total system, not just landfill portion)*** ✗ ***Highest land requirements (59 hectares) for new MBT (12 hectares) and Stabilized Landfill (47 hectares). * However, reduced impacts to the Natural Environment through use of urban/industrial land. Assumes a new stabilized landfill is sited to manage the residual waste from both Niagara and Hamilton. Land requirements can be further reduced by use of NWS site for disposal of Niagara Residue making System 1 and 3b) equivalent as having highest land requirements. Recovery of class B compost could reduce land requirements by another 7 Ha.*** ***Social/ Cultural*** ✗ ***Highest Amount of New Landfill Capacity Required (if new Niagara/Hamilton Stabilized Landfill is sited and no class B compost recovered).*** ✗ ***Greatest land area required in urban/industrial setting, potential conflict with use of employment lands **** ***Economic/Financial*** ✗ ***Highest net cost per tonne **** No major or unique technical or legal disadvantages.

ADVANTAGES	DISADVANTAGES
SYSTEM 2B) *Thermal Treatment of Mixed Solid Waste with Recovery of Materials from Ash/Char)*	
Natural Environmental ✓ ***Lowest net emissions to water of heavy metals and BOD ***** ✓ ***Lowest Potential to Impact Land Resources*** ✓ ***Highest Net Electrical Energy Generation**** ✓ ***Lowest Land Requirements, Lowest Potential to Impact Sensitive Natural Habitats*** ✓ ***Greatest Reduction in materials sent to Landfill *(related to thermal treatment and marketing of granular materials)*** ***Social / Cultural*** ✓ ***Lowest Potential for Facility Siting Impacts*** ✓ ***Smallest amount of landfill capacity required, Avoid Need to Site Additional Approved Landfill Capacity**** ***Other Considerations*** No unique technical, economic/financial, or legal advantages.	***Natural Environmental*** ✗ ***Highest net emissions to Air of Heavy Metals and Dioxins. **** ✗ ***Need for Hazardous Residue Management **** ***Technical Considerations*** ✗ ***Least Flexible to Changes in Waste Stream Managed **** ***Legal Considerations*** ✗ ***Greatest Reliance on Partnerships/Contracts (sale of heat, marketing of granular materials).*** ***Other Considerations*** No unique social/cultural or economic/financial disadvantages.

ADVANTAGES	DISADVANTAGES
SYSTEM 2C) *Thermal Treatment of Alternative Fuel*	
Natural Environmental ✓ ***Lowest net emissions of GHG, Acid Gases, Smog Precursors to Air**** ***(depends on the marketing of RDF for industrial uses)*** ✓ ***Lowest Land Requirements, Lowest Potential to Impact Sensitive Natural Habitats*** ✓ ***Highest Net Energy Generation* (depends on the marketing of RDF for industrial uses)*** ✓ ***Greatest Potential to Conserve Non-renewable Resources* (depends on the marketing of RDF for industrial uses)*** ✓ ***Lowest Potential to Impact Land Resources*** ***Social / Cultural*** ✓ ***Lowest Potential for Facility Siting Impacts*** ✓ ***May Avoid Need to Site Additional Approved Landfill Capacity*** ***Legal Considerations*** ✓ ***Greatest Potential for a Successful Approval Process**** ***Other Considerations*** No unique technical or economic/financial advantages.	***Natural Environmental*** ✗ ***Highest net emissions of heavy metals to water**** ***Technical Considerations*** ✗ ***Lowest System Reliability* (depends on market for RDF)*** ***Economic/Financial Considerations*** ✗ ***Greatest Sensitivity of Costs to Influence of External Revenues * (depends on market for RDF)*** ***Legal Considerations*** ✗ ***Greatest Reliance on Partnerships/Contracts (sale of RDF)*** ***Other Considerations*** No unique social/cultural disadvantages.

ADVANTAGES	DISADVANTAGES
SYSTEM 3B) *Landfilling of Mixed Solid Waste with Utilization of Landfill Gas*	
Technical Considerations ✓ ***Highest System Reliability**** ***Economic / Financial*** ✓ ***Lowest Cost Per Tonne**** ***Other Considerations*** No unique natural environmental, social/cultural or legal advantages.	***Natural Environmental*** ✗ ***Highest net emissions of GHG, acid gases and smog precursors to air* (as lower overall recovery of resources and due to increased efficiency of energy recovery from Systems 2b) and c).*** ✗ ***Highest Potential to Impact Land Resources**** ✗ ***Highest Potential to Impact Sensitive Natural Habitats**** ✗ ***No Potential for Additional Diversion**** ***Social / Cultural*** ✗ ***Greatest land area required in rural/agricultural setting **** ✗ ***Greatest Potential for Land Use Conflicts**** ***Legal Considerations*** ✗ ***Lowest Potential for a Successful Approval Process**** ***Other Considerations*** No unique technical or economic/financial disadvantages.

The application of improved assumptions for Systems 1, 2b), 2c) and 3b) does result in some changes in the results of the overall net effects analysis compared to those documented in Table 7.1 of the Draft Report. These changes are reflected in the pair-wise comparison of the systems based on the improved assumptions as discussed below.

5.5 Pair-wise Comparison of Systems based on Improved Assumptions

5.5.1 Comparison of MBT/Stabilized Waste Landfill System 1 and MSW Landfill System3b)

In the Draft Report, the comparison of Systems 1 and 3b) concluded a preference for System 1. The comparison of Systems 1 and 3b) based on improved assumptions results in the same conclusion. Notable observations from this pair-wise comparison are as follows:

- System 1 is preferred under all natural environmental criteria, except for net emissions of BOD and the area of land required. The land area requirements for System 1 and 3b) would be relatively the same if the NWS landfill were used to dispose of Niagara's share of waste in both systems, and lower for System 1 if class B compost were recovered. Although System 1 has the potential for the highest electrical energy consumption of all systems considered (if aerobic biological component is implemented) the system is preferred when considering net lifecycle energy consumption/conservation.
- System 1 is one of the systems considered that offers the greatest potential for additional diversion from disposal (i.e. in addition to the targeted 65% at-source diversion rate) whereas System 3b) is one of the systems with the least potential for additional diversion.
- Siting impacts related to land resources, natural habitats and land use conflicts are predicted to be lower for System 1 based on the potential for siting on urban/industrial lands and the predicted reduction in nuisances due to the stabilized nature of the landfilled materials.
- System 3b) is one of the lowest cost systems considered in the evaluation and is considered more reliable than System 1 (although it should be noted that System 1 meets the screening criterion for reliability applied during development of the EA Terms of Reference).
- It is expected that an undertaking that proposed the direct landfilling of all residual MSW would present the greatest approvals challenge of all systems considered. The recovery of additional recyclables and the stabilization of remaining materials as an impact management measure in System 1 are expected to improve the likelihood of a landfill approval.

The natural environmental and social/cultural preferences for System 1, both of which would contribute to an enhanced likelihood of a successful approval process, are considered to outweigh the advantages of System 3b) related to cost and technical risk. The technical risks associated with System 1 are in the midrange of all systems considered in the evaluation.

5.5.2 Comparison of MSW Thermal Treatment System 2b) and Alternative Fuel Thermal Treatment System 2c)

In the Draft Report, the comparison of Systems 2b) and 2c) concluded a preference for System 2b). The comparison of Systems 2b) and 2c) based on improved assumptions indicates a preference for System 2c) as System 2c) has lower potential impacts. Notable observations from this pair-wise comparison are as follows:

- Overall, System 2c) is preferred under the natural environmental category of criteria considering the following:
  - The net emissions to air for System 2c) are lower for all parameters compared to System 2b), however, the net emissions to water for System 2c) are higher for all parameters then 2b).
  - With regards to the consideration of the residual waste stream as a resource, System 2c) provides greater potential for the preservation of non-renewable resources and, offers the greatest potential non-renewable resource preservation of all systems considered (by way of net energy conservation and electrical energy generation). System 2c) also provides greater potential for diversion from disposal.
- The systems are considered neutral under social/cultural and technical criteria as:
  - Siting impacts related to land resources, natural habitats and land use conflicts are predicted to be similar for both systems;
  - While System 2b) is assumed to have the lowest flexibility of all systems, System 2c) has the Lowest System Reliability as the environmental performance of the system depends on there being a secure market for RDF.
- System 2c) has slightly lower net costs per tonne however the net costs of System 2c) are sensitive to the ability to market the RDF. Net costs for System 2b) are higher, and while the revenues associated electricity sales are considered to be secure, those for the sale of heat (in the form of hot water) are contingent upon there being a user of the heat within close proximity to the thermal facility.
- System 2c) is considered more approvable based on historic observation of waste disposal approvals in Ontario and given that a new thermal treatment facility is not required and that there is greater emphasis on diversion from disposal.

Overall, based on the improved assumptions, System 2c) would be preferred over System 2b). However, if the improved assumptions for System 2c) on the ability to market RDF for use in industrial applications are determined as not being reasonable, either System 2b) under original or improved assumptions would be preferred.

5.5.3 Comparison of MBT/Stabilized Waste Landfill System 1 and Alternative Fuel Thermal Treatment System 2c)

In the Draft Report, the comparison of Systems 1 and 2b) concluded a preference for System 2b). The comparison of Systems 1 and 2c) based on improved assumptions indicates that if these assumptions are reasonable, System 2c) would be preferred. Notable observations from this pair-wise comparison are as follows:

- Overall, System 2c) is preferred under the natural environmental category of criteria considering the following:
  - The net emissions to air for System 2c) are lower for GHG, Smog Precursors and Acid Gases, while the net emissions to air for System 1 are lower for heavy metals and dioxins;

- System 1 has higher net emissions to water of BOD, while System 2c) has higher net emissions of heavy metals to water;
- The potential for destruction or disruption of sensitive terrestrial and/or aquatic habitats is predicted to be lower for System 2c) as the requirement for land resources for System 2c) is significantly lower then System 1.
- With regards to the consideration of the residual waste stream as a resource, System 2c) provides greater potential for the preservation of non-renewable resources and, offers the greatest potential non-renewable resource preservation of all systems considered (by way of net energy conservation and electrical energy generation). However, System 1 has greater potential for overall diversion from disposal.

- System 2c) is preferred under the social/cultural category of criteria considering:
  - The siting impacts related to land resources and land use conflicts are predicted to be lower for System 2c) as significantly less land for facility siting and less landfill site capacity is required; and
  - If urban/industrial lands were to be used for facility siting in System 1, there would be a negative social impact associated with consumption of employment lands for a landuse with relatively low employment per hectare of land consumed.
- System 1 would be preferred under the technical category of criteria, considering that System 2c) has the lowest system reliability as the environmental performance of the system depends on there being a secure market for the RDF.
- System 2c) would be preferred under the economic/financial category of criteria, considering that System 2c) has significantly lower net costs per tonne then System 1 notwithstanding that the net costs of System 2c) are sensitive to the ability to market the RDF.
- In regards to the legal category of criteria, both systems are relatively equivalent considering that:
  - System 2c) is considered more approvable based on historic observation of waste disposal approvals in Ontario, given that a new thermal treatment facility is not required and that overall requirements for landfill space are lower then System 1;
  - System 2c) has the greatest reliance on partnerships/contracts, IF the contract to market RDF under System 2c) is considered less secure then the contract to use the NWS landfill capacity for disposal of Niagara residues under System 1.

5.6 Results of Sensitivity Analysis

The results of applying improved system assumptions to address substantive issues and reflect additional study activities and other new information sources indicates that:

- The results of the evaluation of "Alternatives To" as documented in the Draft Report released in December 2005 are reasonable. While the application of improved system assumptions did result in some changes in the comparative advantages and disadvantages of the systems, based on application of the study criteria and consideration of study priorities, thermal treatment systems are more preferred.

- If the improved system assumptions have equal probability of occurring, that is if both a market for heat from a thermal facility were available in Niagara/Hamilton and there was a market for RDF in an industrial application, then System 2c) could be more preferred then System 2b). However, if a market for RDF is not available, then System 2b) would remain the preferred system.

6. Niagara Region's Review of Long-term Landfill Utilization

During March 2007, the Region of Niagara retained the services of Watson & Associates Economists Ltd. to undertake a financial analysis of the net cost associated with a number of waste disposal options that had previously been under review by the Region and that had recently become available related to approval of the Walker Industries Landfill expansion in Niagara Falls. The options all included a planning horizon to the year 2028.

6.1 Niagara Waste Systems Limited Landfill Approval & Availability

On November 16, 2006, the Province of Ontario issued approval under the Environmental Assessment Act (EAA) for expansion of the Niagara Waste Systems Limited (Walker Industries) landfill located in the City of Niagara Falls. The approval grants receipt of up to 850,000 tonnes per year of waste over an approximate 25 year period subject to the satisfaction of several EAA conditions of approval including approvals under the Province's Environmental Protection Act and Ontario Water Resources Act. Approvals in accordance with the Province's Planning Act and local official plans and zoning by-laws must also be addressed.

Of particular note to the Region of Niagara and its waste disposal needs was the provision in the approval that approximately 100,000 tonnes of capacity be reserved each year for use to address the Region's waste disposal requirements. A copy of the Province's Notice of Approval to Proceed with the Undertaking under the EAA is included in Appendix VIII of this report.

6.2 Niagara Region's Conclusion re: Long-term Landfill Utilization

Subsequent to the Niagara Waste Systems Ltd. Landfill EAA approval and after discussions between Niagara Region and Walker Industries Limited staff regarding potential use of the 100,000 tonne per year Regional reserve, the Region of Niagara in March 2007 commissioned a review of disposal options with capacity to the year 2028 and which included various combinations of potential capacity provided by existing Regional landfill sites, the expanded Niagara Waste Systems Limited landfill, and the draft recommended system that had been put forward by the WastePlan study in December 2005.

A Niagara Region Public Works staff report (PWA 83-2007) was prepared summarizing the financial analysis of 5 options undertaken by Watson & Associates Economists Ltd. and presented to the Region's Planning and Public Works Committee at their April 25, 2007 meeting. The financial analysis identified net present value costs to the Region in the range of $152.9 million to $184.9 million for the four options including existing Regional/expanded Niagara Waste System landfill capacity versus $273.4 million for the WastePlan option. At the April 25, 2007 meeting the Planning and Public Works committee approved the staff recommendation that Option 3 – Divert waste to Walker Landfill Site as Niagara Region landfill sites close and Niagara Road 12 Landfill Site continues to operate be selected as the preferred option at a net present value of $171.7 million. A copy of the staff report (PWA 83-2007), which also includes the Watson & Associates Economists Ltd. Financial analysis is included in Appendix IX of this report.

Part D – Conclusions & Recommendations

7. Conclusions

7.1 Integrity of Original Study Assumptions

As noted in Section 5.2 of this Addendum Report, during the evaluation of "Alternatives To", consistently conservative assumptions were applied to determine the potential effects for all major parameters. The analysis and evaluation of the systems as undertaken in the Draft Report was based on conservative assumptions as they represented circumstances that had a reasonable probability of occurring and holding true through completion of the EA Study and implementation of the preferred system.

Since the Draft Report was issued in December 2005, no new information has been received that brings into question the integrity of the original study assumptions or the results of the comparative evaluation of the systems.

Rather, new information has indicated that there are variables that could be considered to test the sensitivity around the assumptions used to determine the potential environmental effects of the Systems if the assumptions were to be varied.

For example as noted in Section 3.4 of this report, the results of the Study of Stabilized Landfill Final Report, indicates that a stabilized landfill operation may exist in proximity to a variety of land uses and that specific opportunities may exist within and outside the urban area for the siting of a landfill without impacts on surrounding land resources and population. Furthermore, Section 6 notes the results of Niagara Region's review of long-term landfill utilization indicate that pending the negotiation of a reasonable contract, the Region could secure some or all of its long-term landfill requirements using the private sector Niagara Waste Systems landfill.

In regards to thermal treatment, research undertaken since 2005 indicates that the environmental performance of thermal treatment alternatives may be better then originally assumed, and that overall environmental impacts can be reduced through the marketing of both electrical and heat energy or through the marketing of RDF.

These variables have been examined through the comparison of Systems based on improved assumptions that acknowledge key variables or 'what if' situations that would warrant a review of previous work completed in the study, and/or the terms of the joint study agreement.

The following variables would have to increase in probability to justify a change to the system analysis that was originally presented in the Draft Report:

- For System 1, sufficiently sized suitable lands located in more urban / industrial rather than agricultural / rural resource lands would have to be available within the Study Area. These lands would have to be free of other constraints that would prevent their use as stabilized landfill.
- The availability of an adjacent industrial user of heat (in the form of steam or hot water), or increased feasibility for a district heating system would decrease the net air emissions from a

thermal treatment plant and improve the economics or cost benefit of System 2b) reducing the most significant disadvantages of the system.

- To increase the potential for System 2c) to be preferred, industrial markets for RDF are required. Although the approvals process for RDF facilities has improved, it remains to be seen if over the next few years, industries such as the cement industry in Ontario seek and receive approval to use RDF in lieu of fossil fuels.
- The outcome of negotiations between Niagara Region and Niagara Waste Systems for use of private sector landfill space could increase the potential for System 1 or System 3b) to be preferred, but only if the priorities for the study were significantly altered such that costs are considered to be paramount over the evaluation criteria and priorities established through consultation in the EA process.

7.2 Preferred Niagara – Hamilton Long-term Disposal System

All of the waste disposal systems evaluated in the Niagara/Hamilton WastePlan:

- Have the ability to manage residual waste that remains after at-source diversion;
- Can meet the regulatory requirements in Ontario, that are intended to protect people and the environment; and
- Have equivalent representative facilities located in North America or Europe with commercial track record.

The selection of a preferred system was based on the application of Niagara/Hamilton WastePlan criteria and priorities confirmed through consultation early in the EA Study.

The Draft Report identified System 2b) *Thermal Treatment of MSW and Recovery of Materials from the Ash/Char*, as the preferred system based on broad consideration of potential impacts to the natural, social/cultural, technical, economic/financial and legal/jurisdictional environment.

The conclusion of the Draft Report has not changed as a result of the public consultation or additional study over the past 18 months, or as a result of the sensitivity analysis documented in this addendum. However, if future conditions should arise that increase the probability of the improved system assumptions, the results of system analysis and evaluation could change.

For example the results of the sensitivity analysis indicate that System 2c) may be more preferred to 2b) if RDF generated by System 2c) could be marketed to an industrial user such as a cement kiln, replacing fossil fuels (e.g. coal, petcoke) that would normally be used. In this situation there would be no need to develop a Niagara/Hamilton thermal treatment facility, only the MBT component of the system.

8. Recommendations

Since the issuance of the Draft Report in December 2005, some of the impetus to proceed with the Niagara/Hamilton WastePlan EA Study has decreased. Niagara Region now has the option to secure additional landfill capacity at the expanded Niagara Waste Systems landfill, thus reducing the need to develop new municipal disposal capacity to address the disposal short-fall when four of the five remaining operating landfills in Niagara close over the next few years. Niagara is also planning for additional diversion program improvements to further reduce the quantity of residual waste that requires disposal. The Glanbrook landfill in Hamilton has sufficient disposal capacity for approximately 20 to 30 years.

A decision by both municipalities to approve a preferred system and proceed with the next phase of the Niagara/Hamilton WastePlan EA including facility siting and procurement represents a significant commitment of financial resources, time and energy.

Niagara Region is no longer facing a major shortfall in disposal capacity over the next 10 or more years, such that the need for the Region to continue with the study at this time is less urgent.

In Hamilton’s case, the Solid Waste Management Master Plan was updated in December 2002 with the recommendation that the City explore the need for a new state-of-the-art Energy From Waste (EFW) facility to form part of the City of Hamilton's waste management system to optimize the disposal capacity at the Glanbrook landfill site immediately instead of in 2006.

Allowing for some additional time prior to proceeding with selection and approval of a preferred long-term disposal system would provide an opportunity for both municipalities to determine if:

- circumstances could support any of the improved assumptions for the disposal systems;
- a partnership approach is required to implement the system that best suits the needs of each municipality; and/or
- community priorities have changed to the extent that the criteria and priorities used in the evaluation of ‘Alternatives To’ for the WastePlan study are no longer applicable.

Based on the above, the following next steps are recommended for consideration by the Niagara/Hamilton Joint Working Group in the event that the municipalities are not ready to proceed with the selection of the preferred system and the next steps of the WastePlan EA Study:

Recommendation 1

That the “Evaluation of ”Alternatives To”, and Selection of a Preferred Disposal System” be concluded at this point in time, with the retention of Systems 1, 2b) and 2c) for consideration if and when the municipalities are ready to proceed with the WastePlan EA Study.

It is recommended that these three systems be retained as:

- under both the conservative assumptions applied in the Draft Report and under the improved assumptions assumed in Section 5 of this addendum, these systems have greater advantages than the landfill only System 3b); and

- the outcome of the comparative evaluation of Systems 1, 2b) and 2c) can change based on the application of conservative or improved assumptions.

Recommendation 2

If and when it is determined by Niagara Region and the City of Hamilton that the WastePlan Study should resume, a final determination of the preferred system would be undertaken to consider conditions or circumstances that may have changed to increase the probability for successful implementation of any of the Systems 1, 2b) and 2c) under the improved system assumptions.

Recommendation 3

If and when it is determined by Niagara Region and the City of Hamilton that the WastePlan Study should resume, an initial public consultation step be undertaken to determine if there have been any changes in community priorities prior to completing the selection of the preferred system.