ORGANIC WASTE DIVERSION IN CANADA

by

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Bachelor of Arts, Simon Fraser University, 2005

PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF PUBLIC POLICY

In the
Faculty
of
Arts and Social Sciences

SIMON FRASER UNIVERSITY

Spring 2009

APPROVAL

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Degree: **M.P.P.**

Title of Capstone: **Organic Waste Diversion in Canada**

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Abstract

Solid waste management is becoming an increasingly pressing issue with the rise of land constraints, concern over environmental degradation, and pressures to recover resources. Cities across Canada are turning to organics as an important waste component to target for diversion. This study investigates the nature of current comprehensive organic waste programs in mid-sized Canadian cities. A case study analysis highlights the three forms of centralized composting used in Canada: source-separated, mixed waste, and hybrid systems. These case studies illustrate the common elements for a successful organics program as well as their constraints and risks. A policy analysis of the organic diversion systems points out the key criteria and factors a municipality needs to determine and discuss in the process of selecting an organics strategy.

Keywords: organic waste; solid waste; waste management; waste diversion; composting

Subject Terms: Organic wastes – Recycling; Recycling (Waste, etc.) – Canada; Waste minimization – Canada – Case studies; Compost; Refuse and refuse disposal

Executive Summary

Across Canada, solid waste management is becoming an increasingly pressing issue with the rise of land constraints, concern over environmental degradation, and pressures to recover resources. Canada relies on landfills as the primary tool for dealing with solid waste; however, landfills are not environmentally sustainable and face increasing public opposition. A global effort to reduce greenhouse gases includes solid waste as part of the strategy. This study focuses on organic waste as one material category that can be reduced in the waste stream and thereby ameliorate negative environmental impacts, avoid public criticism towards new landfills, and create a more desirable end product from waste. While organic waste diversion has many benefits, the majority of Canadian cities have limited if any organics programs in place. The national waste diversion rate in Canada is 24%, while the success yardstick for most jurisdictions around the world is 50% or higher. The policy problem addressed in this study is a low waste diversion rate and a corresponding lack of comprehensive organic waste diversion programs in Canada. With incineration still an expensive and contentious issue, organic waste diversion is a logical step for many Canadian cities. This study considers policy alternatives that mid-sized Canadian cities can explore to introduce centralized composting. In particular, this study uses the lens of policy, rather than engineering, to analyze organic waste diversion programs.

The municipalities of Halifax, Edmonton, Niagara, and Hamilton are used to explore the different technologies and diversion strategies available for cities to implement. Successful program elements common to most of the cases are the existence of diversion goals (municipal and/or provincial), achievement of economies of scale, public consultation and engagement, and the inclusion of the industrial, commercial, and institutional sector. Cities adopt program elements to different degrees, and this indicates the trade-offs inherent in these decisions, in terms

of cost, public acceptability, and administrative burden. For a city to implement all the possibilities, it would require a high degree of commitment, innovation, and public cooperation.

Based on the cases, four policy options are developed: the status quo, a mixed waste composting system (based on the Edmonton model), a source separated composting system (based on Hamilton and Niagara), and a hybrid system of both source-separated and mixed composting (based on Halifax). While I model these options on the Canadian cases, they are broadly representative of the approaches used in the United States and Europe. I evaluate these policies based on the following criteria: (a) Effectiveness: diversion potential, environmental impacts (b) Cost: capital and operating costs (c) Public acceptability.

While the proposed policy alternatives are mutually exclusive and are thus discrete policy directions, a range of program elements are discussed that can increase diversion intensity within any technology choice made by the city. The goal of this study is to provide municipalities with information regarding their organic waste diversion program choices, rather than making a specific policy recommendation for a given city. Therefore, part of the analysis provides a decision tree that takes into account variables such as density, diversion goal, and financial commitment in suggesting the most appropriate organics policy to pursue. Municipalities need to take into consideration the unique circumstances of their city when adopting an organics program. Recommendations for all cities in terms of a successful organic diversion program include:

- Strengthening the regulatory framework
- Creating incentives for participation (including market-based)
- Increasing the accessibility and convenience of the program
- Running a pilot project and using broad public consultation
- Careful facility siting to avoid odour issues
- Striving for economies of scale (e.g. through regional partnerships, waste importing, acceptable materials expansion)
- Considering the flexibility of the technology adapted

To my parents for teaching me the importance of education

Acknowledgements

I offer my gratitude to my capstone supervisor, Nancy Olewiler, for her guidance, encouragement, and critical eye. I appreciate the many ways she has helped me throughout my time with the MPP program. I would also like to thank Doug McArthur for his careful examination of my work during my defence, as well Kennedy Stewart for his insight and support in the early stages of my work.

Thank you to my capstone group members, Kate Trethewey, Caitlin Cooper, Colin Ward, Jillian Pringle, and Anson Wong, for their feedback during the writing and defence process. A special thank you to my classmates, Jennifer Balcom and Heather Lynch, for their empathy, support, and friendship.

I am grateful for the generous funding of this research by the SSHRC Joseph-Armand Bombardier Canada Graduate Scholarships Program as well as the SFU Graduate Fellowship Program.

I could not have written this capstone without the love and support of my family and friends. I want to express the deep gratitude I have for my husband. His unwavering support and unconditional love give me the courage to pursue my dreams.

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Glossary

AB	**Alberta**
BC	British Columbia
CCME	Canadian Council of Ministers of the Environment
CSR	Corporations Supporting Recycling
EWCM	Edmonton Waste Management Centre
FCM	Federation of Canadian Municipalities
GAP	Generally Accepted Principles
GHG	Greenhouse Gas
HRM	Halifax Regional Municipality
IC&I	Industrial, Commercial, and Institutional
LYW	Leaf and Yard Waste
MBT	Mechanical Biological Treatment
MFB	Multi-family Buildings
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
NIMBY	Not-in-my-backyard
NS	Nova Scotia
NSEL	Nova Scotia Department of the Environment and Labour
OECD	Organization for Economic Co-operation and Development
ON	Ontario
OW	Organic Waste
PAYT	Pay-as-you-throw
SWM	Solid Waste Management
WARM	Waste Reduction Model
WTE	Waste-to-Energy

Definitions

Biosolids: Organic product obtained from the physico-chemical and/or biological treatment of wastewater. Biosolids result from primary wastewater treatment (primary biosolids), or from secondary wastewater treatment (secondary biosolids), and these two types of biosolids are often combined (mixed biosolids). These biosolids can be derived from the treatment of either municipal wastewater or industrial wastewater.
Source: Canadian Council of Ministers of the Environment

Composting Composting is an aerobic biological treatment process used most frequently in Canada at this time for management of biodegradable residential waste such as leaf and yard waste or food wastes. Another method of composting organic materials is anaerobic digestion. In Canada, this method is in its developmental stages yet a few facilities that employ this process have either been recently constructed or will be built in the near future.
Source: Statistics Canada

Incineration Incineration, in the context of waste, refers to the burning of waste. Most jurisdictions in Canada consider incineration to be disposal.
Source: Statistics Canada

Landfill A site, on land, that is used primarily for the disposal of waste materials. The contents of landfills can include garbage which is not processed, and also residual material from processing operations (MRF residues, incinerator ash, compost residues, etc).
Source: Statistics Canada

Organic Waste The organic fraction of the waste stream, consisting of material that is biodegradable, typically food, yard waste, and paper.
Source: Federation of Canadian Municipalities

Waste Disposal Landfills and incinerators as well as facilities designed to contain hazardous wastes.
Source: Statistics Canada

Waste Diversion — Any physical transformation of materials in preparation for recycling or reuse. Such activities include sorting, cleaning, and volume reduction as well as composting.
Source: Statistics Canada

Waste Management — Waste management is the collection, transport, processing, recycling, or disposal of solid, liquid, and gaseous wastes in ways that reduce their effect on human health and the environment.
Source: Environment Canada

1: Introduction

Across Canada, municipalities decide how to manage the garbage produced by their residents. Solid waste management is becoming an increasingly pressing issue with the rise of land constraints, concern over environmental degradation, and pressures to recover resources. Canada relies on landfills as the primary tool for dealing with solid waste; however, landfills are not environmentally sustainable and face increasing public opposition. A global effort to reduce greenhouse gases includes solid waste as part of the strategy. This study focuses on organic waste as one material category that can be reduced in the waste stream and thereby ameliorate negative environmental impacts, avoid public criticism towards new landfills, and create a more desirable end product from waste. While organic waste diversion has many benefits, the majority of Canadian cities have limited if any organics programs in place. The national waste diversion rate in Canada is 24%, while the success yardstick for most jurisdictions around the world is 50% or higher (Federation of Canadian Municipalities, 2004a). **The policy problem addressed in this study is a low waste diversion rate and a corresponding lack of comprehensive organic waste diversion programs in Canada.** With incineration still an expensive and contentious issue, organic waste diversion is the next logical step for many Canadian cities. It is therefore instructive to consider the strengths, weaknesses, challenges and opportunities that exist in current organics programs. It is also important to outline the policies that will meet diversion, cost, environmental impact, and public acceptability objectives.

2: Background

2.1 Defining Waste

In 2004, every Canadian generated, on average, over 1,037 kg of non-hazardous solid waste, an increase of 6% from 2002 (Statistics Canada, 2008). This waste is a result of extraction, production, distribution, and consumption processes. The waste comes from household, industrial, commercial and institutional sources. Statistics Canada (2005) has categorized waste according to form, hazard, composition, and source. Table 2.1 illustrates these categories and denotes (in italics) the kind of waste this study will be investigating: organics within the solid, non-hazardous waste stream. The waste under consideration is predominantly from residential sources, but also includes some commercial, institutional, and industrial sources. Each waste material is unique in its properties, its impact on the environment, and its life cycle.

Table 2.1 Waste Characteristics
Source: Statistics Canada, 2005

Form	Hazard	Composition	Source
Solid	*Non-Hazardous*	*Organic*	*Residential*
Liquid	Hazardous	Paper	*Commercial*
Gaseous		Glass	*Institutional*
		Metal	*Industrial*
		Plastic	
		Other	

While consideration of the larger waste picture is desirable, there is value in analyzing specific material categories within the waste stream. Success in diverting organics may be attributable to an integrated solid waste management strategy but an in-depth understanding of each material category is useful prior to undertaking an integrated approach.

2.2 Waste Process and Material Categories

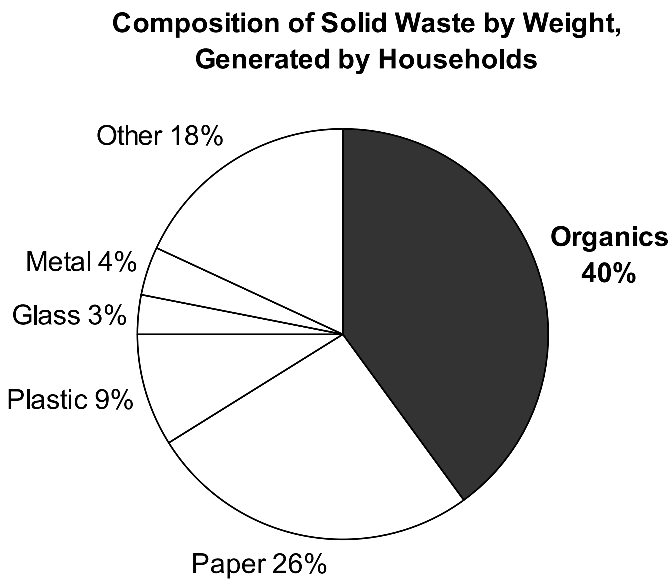
Policies can target various stages of the waste process including extraction, manufacturing, materials management and ultimate disposal. Extended producer responsibility, for example, shifts the burden of dealing with waste from government to the producer of the good. This shift simultaneously provides an incentive for producers to design products that are easier to dispose of or that require less packaging. There are also policies aimed at reducing overall consumption and wastefulness. Once a product has reached the end of its useful and intended life, there is an additional set of policies dealing with its disposal. Goods can be recycled, composted, landfilled, or have their energy partially recovered through waste-to-energy facilities.

Organic waste will continue to be generated as long as people garden, cut grass, cook, and eat food. The focus thus is on policies for diverting organic waste already generated by households rather than the production and generation end of the waste cycle. Organic waste includes kitchen waste, yard waste, agricultural waste, and biosolids. While there are many opportunities for organic diversion and composting programs for the primary production waste coming from the agricultural, forestry, fisheries, mining, and quarrying sectors, these are outside the scope of this study. These industries usually manage their waste on-site or through contracts with private waste firms. This study is thus limited to organics in the municipal waste stream.

2.3 Why Study Organic Waste?

Recycling of materials such as plastics, aluminium, paper, glass, and tin has received widespread attention and support by both politicians and citizens. Ninety-three percent of households across Canada have access to a recycling program, with ninety-seven percent of those households making use of such a program (Statistics Canada, 2006). There have also been various initiatives and legislation passed by provincial governments in Canada towards the recycling and proper handling of hazardous waste, electronic waste, pharmaceuticals, and other materials. An area with comparatively less attention has been the management of organic waste, a responsibility under municipal jurisdiction.

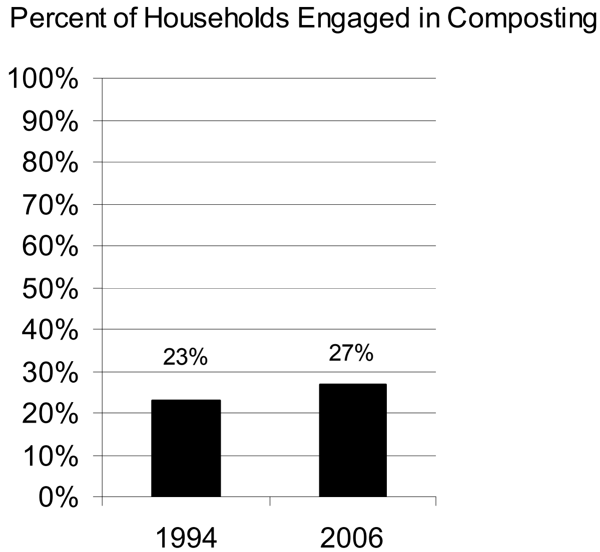
Figure 2.1 *Composition of Solid Waste by Weight, Generated by Households*
Adapted from: Statistics Canada, 2005



Organic material forms a large proportion of the residential waste stream (see Figure 2.1) and thus provides potential for large-scale diversion. However, less than one third of Canadians engage in some form of composting (through backyard or municipal collection), a figure that has seen little improvement over the years (see Figure 2.2). Even for those that do compost, the capture rate is significantly below one hundred percent as backyard composters are limited in the organics they can take (e.g. no fat, meat, or dairy) and the majority of municipalities restrict their programs to leaf and yard waste collection.

Figure 2.2 Percent of Households Engaged in Composting

Adapted from: Statistics Canada, 2006



Currently Canada sends the majority of organic waste to landfills; seventy-nine percent compared to fifty-eight percent for other OECD countries (OECD, 2004). Canada has a greater reliance on landfills likely because of the high availability of land. While some regions in Canada may continue to have space for landfills, it is becoming more common for urban centres to transport waste outside of the local area and even outside of national borders in some cases (e.g. Ontario). For regions that do have adequate landfill space there may still be severe public opposition in the form of "NIMBYism" (Not-in-my-backyard), which can block potential landfill developments. Fewer Canadian cities are finding landfilling a viable option.

2.4 Environmental Impacts

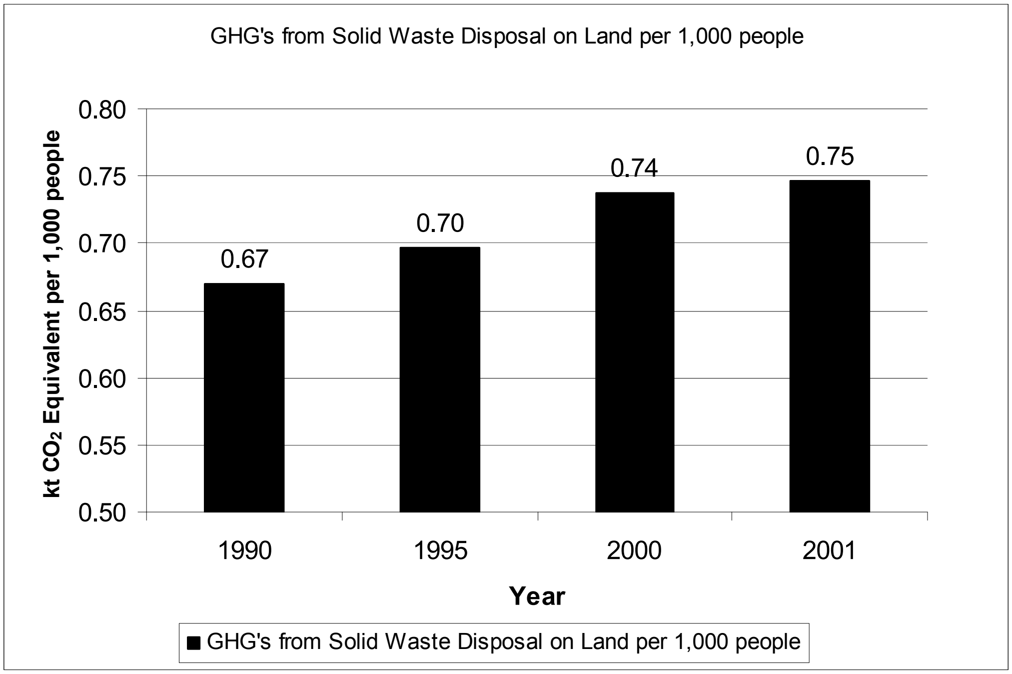
One of the strongest arguments against landfills is their negative environmental impact. Toxic effects can occur when municipalities combine organics with other waste materials without proper management. Landfills emit methane (CH_4) and carbon dioxide (CO_2) into the atmosphere due to the anaerobic decomposition of organic wastes (Environment Canada, 2003). While the majority of these emissions occur within the first twenty years of landfill disposal, smaller amounts can continue to occur for over one hundred years. In 2001, solid waste disposal on land resulted in 23,100 kt of CO_2 being released into the atmosphere (see Table 2.2) (Environment Canada, 2003). Dealing with organic waste separately from other materials would have a significant impact on the greenhouse gases produced from landfills (see Section 6 for a more thorough discussion on this).

Table 2.2 Canada's GHG Emissions by Gas and Sector, 2001
Adapted from: Environment Canada, 2003

Canada's GHG Emissions by Gas and Sector, 2001	
Greenhouse Gas Source	Total GHG's Unit: kt CO_2 eq
Solid Waste Disposal on Land	*23,100*
Waste Incineration	*350*
Wastewater Handling	1,370
ALL	24,800

A worrying trend is the increase of emissions from waste sources per capita over the last twenty years (see Figure 2.3). Weak waste regulations, both from the producer and consumer end, have made it possible for consumption and waste generation to out-pace population growth.

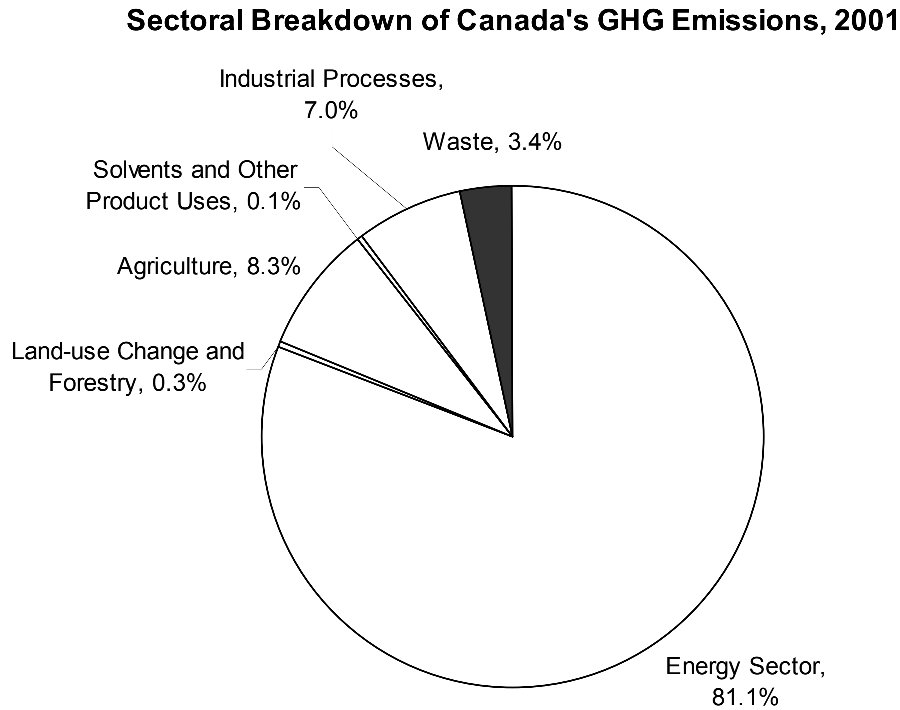
Figure 2.3 Canada's GHG Emissions from Solid Waste Disposal on Land, 1990-2001
Adapted from: Environment Canada, 2003



When compared with all possible sources for greenhouse gases in Canada, waste plays a small but significant role. Environment Canada (2003) calculated that in 2001, the waste sector contributed 3.4% of total Canadian greenhouse gas emissions (see Figure 2.4). The waste sector includes solid waste disposal on land, waste incineration, and wastewater handling. This figure does not include the emissions associated with the transportation required for garbage collection. A more startling figure is that solid waste disposal on land accounts for approximately 25% of the national total for methane, the second largest source category (Environment Canada, 2003). Methane is about twenty-one times more powerful than carbon dioxide at warming the atmosphere and has a shorter chemical lifetime making it a strong candidate for mitigating climate change within the next twenty-five years (U.S. Environment Protection Agency, 2006). These figures would be larger if not for the advances made in methane recovery from landfills and diversion initiatives across Canada.

Figure 2.4 Canada's GHG Emissions by Sector, 2001

Adapted from: Environment Canada, 2003



Our current waste management practices have many negative environmental impacts. In order to provide a more holistic assessment of waste diversion, there has been some research looking at the cost-benefit analysis of landfilling versus alternative methods. For example, the GPI Atlantic (a non-profit research and education organization) conducted a major research study that used a full cost accounting of Nova Scotia's transition in waste management systems in 1998. The report argues that the new system has more than paid for itself while also having a positive effect on job creation and environmental preservation (GPI Atlantic, 2004). This report considers the full breadth of impacts from waste management systems including the economic, social, and environmental.

Another study, conducted by the Tellus Institute (2000), calculates the benefits resulting from diversion in Iowa. The researchers found that for every percentage point in diversion achieved, there was a $2 million benefit to society, exclusive of environmental benefits and energy conservation. The benefits were based on recycled material and compost commodity value; reduced purchase costs for finished goods resulting from more efficient material use (source reduction); and direct and indirect employment related to recycling and remanufacturing industries (Tellus Institute, 2000).

2.5 Managing Organic Waste

Organic waste management is a complex material category that allows for various recovery and disposal methods. These methods vary in terms of diversion potential, cost, convenience, environmental impact, as well as administrative and political feasibility. I summarize the options for organic waste management in Table 2.3. The categories of waste management are broken down into disposal and diversion, with the latter divided according to its diversion potential.

Options with lower diversion potential include backyard composting, vermicomposting, garburating, grass-cycling, mulching, and direct soil incorporation. Residents at the household level use these methods and there is no realistic method for enforcement by government. Another reason for the lower diversion is the restrictions on what materials are included, with most of these methods excluding bulky yard waste, oils, dairy, and meat. The GAP method estimates that a backyard composter will divert 100 kg/year of organics with about 25-30% of single-family households participating in a moderately promoted program, and 55% in an intensely promoted program (FCM, 2004b).

Table 2.3 Diversion and Disposal Strategies for Organic Waste

	Type of System	Definition	Suitable for	Acceptable Materials	Unacceptable Materials
Lower Diversion Rate Potential	*Backyard Composting*	Compost bin placed in backyard	Residences with yards	Yard Waste Food Scraps	Meat, Dairy, Oil
	Vermicomposting	Compost bin that uses some species of earthworm to breakdown organic matter	Apartment building units or other residences	Yard Waste Food Scraps	Meat, Dairy, Oil
	Garburating	A device under a kitchen sink that shreds food scraps into small enough pieces to pass through plumbing.	Residences equipped with garburators	Food Scraps	Bulky Waste, Yard Waste
	Grass-cycling	Practice of leaving grass clippings on lawn after mowing	Residences with yards	Yard Waste	Food Scraps
	Mulching	Practice of spreading yard waste over soil to improve its condition	Residences with yards	Yard Waste	Food Scraps
	Direct Soil Incorporation	Practice of burying organics under soil	Residences with yards	Yard Waste Food Scraps (limited amounts)	Meat, Dairy, Oil, Bulky Waste
Higher Diversion Rate Potential	*Centralized Composting*	Collection of organic waste to be composted in a centralized facility – can be mixed or source-separated.	Cities or private companies	Most organics: food scraps, yard waste, contaminated paper, etc	Varies with program – can include all organics
	Onsite Composting	Composting operated by producers of waste in certain sectors	Agricultural, forestry, fisheries, mining, and quarrying sectors	Depends on the sector	Depends on the sector
Disposal	*Landfilling*	Disposal of waste through burial	Cities	All	-
	Incinerating	Disposal of waste through burning (may include energy recovery)	Cities	All	-

Yard waste is the most common organic material composted. Yard waste can include some or all of the following: grass, leaves, weeds, garden materials, household plants, shrubbery, branches and tree stumps. Residents can manage yard waste through backyard composting, vermicomposting, mulching, grass cycling, and direct soil incorporation. When municipalities run an organics collection program they usually start with yard waste as it is the least hazardous organic material to handle.

Food waste can include all or some of the following: fruit and vegetables, meat, shellfish, fish products, pasta, bread, cereal, dairy products, eggshells, coffee grounds, candies, cookies, cake, baking ingredients, herbs, spices, pet food, coffee filters, and tea bags. When municipalities expand their organic waste collection service, the next material to include is food waste. Food waste is acceptable for backyard composting and vermicomposting with the exception of meat, dairy, and oils as they attract animals and are more prone to creating foul odours.

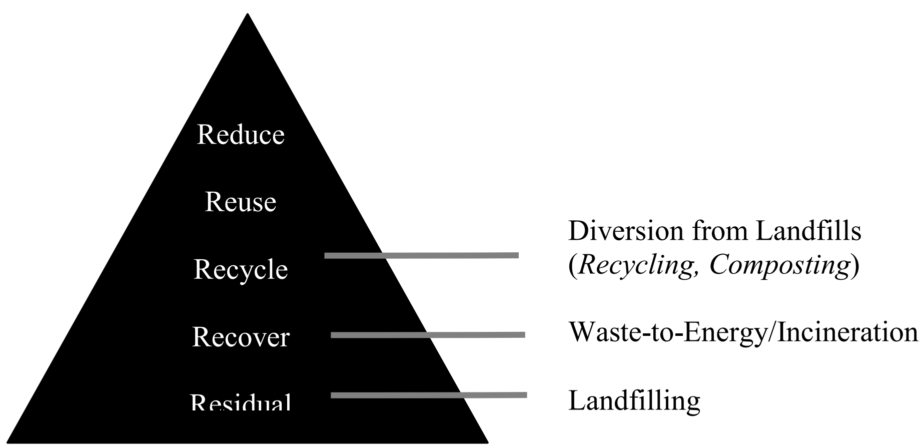
It is difficult to categorize the remaining organic materials which include: soiled paper towels, tissues, soiled paper food packaging, paper plates, diapers, sanitary products, animal waste, hair, bedding (e.g. from hamster cages), kitty litter, land-clearing debris, and wood. Cities advise against disposing these materials into backyard composters. Centralized composting programs differ on which of these materials they accept.

Producers can self-manage waste (on-site composting, backyard composting, and vermicomposting) or service-providers can collect the waste. When waste materials are collected, they can either be sorted at source (households separating recyclables, organics, and garbage) or they can be sorted at the waste facility. The former methods is referred to as source separation and it has implications for compliance (source separation requires user cooperation), while the latter has implications for cost (more work on the part of the city to separate all incoming waste), and compost quality (mixed-waste sorting leads to more contamination).

In this study, I only consider strategies that have a high waste diversion potential in order to suggest programs that will have a large impact on diversion rates for Canadian cities. Since municipalities have limited control over onsite composting, this study is limited to centralized composting. Section 2.6 discusses the various technologies that cities can use within centralized composting programs.

As cities across North America have struggled to cope with their solid waste in a way that is responsible to its citizens and the environment, they have historically followed the waste management hierarchy (see Figure 2.5) (Environment Canada, 1998). The waste hierarchy model is well established for prioritizing strategies for waste management that promote avoidance ahead of recycling, and recycling ahead of disposal. This study uses the assumption that cities will follow this hierarchy in order to fulfill commitments to diversion goals and environmental and human health protection.

Figure 2.5 Waste Management Hierarchy



I do not consider incineration as part of a comprehensive organic waste strategy due to several factors. First, incineration requires a steady flow of highly combustible materials such as paper and plastics. These materials provide sufficient heating value and make it possible to avoid using additional fuel to facilitate incineration (Statistics Canada, 2005). In order for companies to build and service facilities, local governments sign contracts that guarantee a minimum threshold of incoming waste materials. This commitment creates disincentives for current and future diversion efforts (especially for plastics and paper), since incineration requires these materials.

Second, incineration produces pollutants that can have negative impacts on human health and the environment. Some of the by-products of incineration include particulate matter, sulphur oxide, nitrogen oxide, volatile organic compounds, and carbon monoxide (Statistics Canada, 2005). These emissions can contribute to smog, acid rain, and poor air quality.

Finally, incineration is an extremely expensive alternative, especially if a full cost accounting method is used. A recent report for the region of Niagara, Ontario looked at various disposal methods for organic waste and estimated their cost based on not only the operations cost but also the economic environmental benefits they created (Regional Municipality of Niagara, 2007). The study looked at GHGs; particulates, toxics, and carcinogens that affect human health; acidification; and ecosystem toxicity to evaluate the environmental benefit or cost of each given option. The findings indicate that composting (of both yard and food waste) is less expensive than landfills or waste to energy facilities (incineration) when considering the full social and environmental cost. By considering the full scope of incineration, I have decided to exclude incineration from consideration in a comprehensive organic waste management strategy.

2.6 Centralized Composting Technologies

There are many kinds of centralized composting facilities in North America. There is no clearly identifiable best choice as they all require trade-offs in regards to cost, public health/nuisance factors, and quality of compost product. This study uses the lens of policy, rather than engineering, to analyze organic waste diversion programs. Many technical elements need careful consideration in the process of deciding on an organics program but these deliberations are outside the qualifications of the researcher and outside the scope of this study. Instead, I offer a general overview of the structural approaches that municipalities can take for diverting waste. According to the Federation of Canadian Municipalities (2004, p.194), there are four basic types of centralized composting methods:

- *Turned-windrow composting*: waste is formed into long piles called "windrows" and regularly mixed and manipulated to achieve a number of purposes.

- *Aerated static pile composting*: similar to windrow composting waste is not moved and is aerated either actively or passively while remaining in place.

- *Enclosed channel composting*: waste is contained, usually between parallel walls of some type, and regularly moved and turned by some form of suspended machinery.

- *In-vessel composting*: any technology where the waste is sealed into a chamber, where the environment is closely controlled, and facility personnel do not normally enter. In-vessel systems include vessels that are fixed, portable, and even non-rigid. In-vessel systems may or may not include internal systems for agitation or maceration while in process, and commonly include internal systems for monitoring and addition of oxygen.

2.7 Benefits of Composting

Composting, whether performed on a small or large scale, reduces the amount of waste and thus increases the lifespan of landfills. Fewer organics in landfills yields a reduction in leachate, emissions and odour. Compost is a valuable end product used to improve soil's organic matter content, water-holding capacity, and fertility (Statistics Canada, 2005). Composting also increases carbon storage in soils and through improving plant growth, it expands carbon sequestration (Platt, Ciplet, Bailey, Lombardi, 2008).

The benefits of compost, in land application, are smaller when mixed waste contamination compromises the quality. In 1996, the Canadian Council of Ministers of the Environment (CCME) created compost quality guidelines to protect public health and the environment. The composting industry benefits from these guidelines because they frame compost as a beneficial soil amendment and a valuable resource (CCME, 2005). Levels of foreign matter, maturity, pathogens, and trace elements determine the grade of material.

Category A is, “compost that can be used in any application, such as agricultural lands, residential gardens, horticultural operations, the nursery industry, and other businesses” whereas Category B is, “compost that has a restricted use because of the presence of sharp foreign matter or higher trace element content. Category B compost may require additional control when deemed necessary by a province or territory” (CCME, 2005, p. 11). The CCME has determined that generally only source-separated organics lead to Category A classification. As I will discuss in later parts of this study, the structure of an organics program affects the quality and therefore usefulness of compost.

2.8 Risks associated with a Comprehensive Organics Program

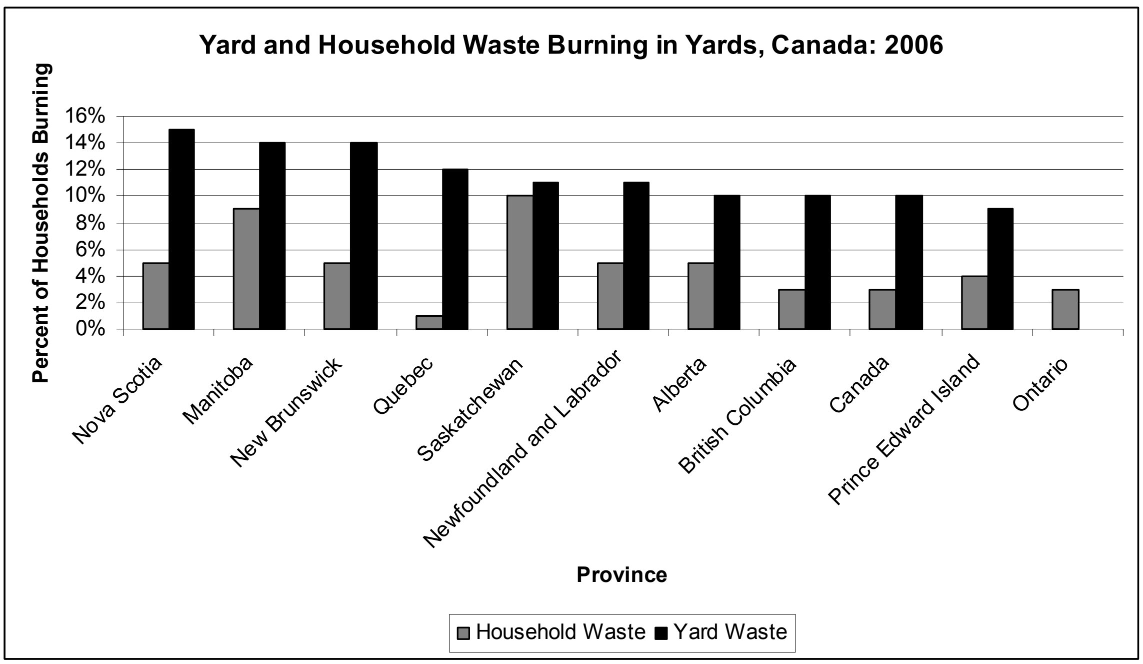
2.8.1 Costs

Cities with available landfill space may see little incentive to adopt a comprehensive organics program. A local landfill with many years of capacity is a less expensive option than embarking on a new curbside program or the construction of a new facility. For example, London, Ontario has made limited progress on diversion initiatives due to the long life span of its landfill (fifteen years currently remaining). Despite Ontario’s 60% diversion goal by 2008, the city has only recently started seriously considering available organic diversion options (Pedro, 2008). This is in contrast to Toronto, which does not have a local landfill and has to transport its waste to Michigan where increasingly stringent regulations limit the types of material for export and high costs make this option very unattractive. In general, cities will consider composting a competitive option once disposal costs go beyond $65/ton (Spencer and Yepsen, 2008).

2.8.2 Non-Compliance

If a city implements overly strict regulations or requires too much effort to divert materials, households may instead turn to the illegal dumping or burning of their waste. Burning contributes to green house gas emissions as well as increased levels of particulate matter. Figure 2.6 shows that in almost all provinces some households burn waste despite regulations against such activity.

Figure 2.6 Waste Burning Activity in Canada, 2006
Adapted from: Statistics Canada, 2006



In Nova Scotia, where regulations on organics are the strictest in the country, the percentage of households burning yard waste is also the highest. This may be due to long-standing rural practices, or a residue of previous policies (Nova Scotia was historically reliant on burning as a waste disposal method). Illegal dumping and burning are more likely to occur in rural areas; however, the prevalence of these actions points to possible non-compliance issues worth considering by municipalities.

2.8.3 Public Nuisance

Compost operations, especially ones that process materials beyond leaf and yard waste, require the right balance of feedstock and close monitoring of moisture, oxygen, and temperatures to avoid odour problems. Odour problems in a compost facility near residential communities can create a strong and negative public reaction and lead to future NIMBYism in regards to facility siting. Some Canadian cities have shut down compost facilities due to odour issues. While these incidences are the minority, they feed into the fears surrounding the risk of composting.

2.9 Summary

Waste is a complex and multi-faceted issue that researchers and policy analysts can investigate from a number of different perspectives. This study looks at organic solid waste and the role that centralized composting can play in diversion. Organic waste diversion presents an opportunity for reducing negative environmental impacts from waste management in Canada, which in turn can have positive impacts on public health and the economy. Many cities in Canada are interested in looking at centralized composting as a way to increase their waste diversion rate. This study helps in assessing the organics diversion programs currently in place in Canada and understanding why these programs yield varying diversion rates. The following section outlines the methodology used in researching this question.

3: Methodology

3.1 Research Design

There is no municipal solid waste data set in Canada. Statistics Canada collects provincial-level data on solid waste generation and diversion, but this level of analysis does not account for demographic and program differences of municipalities within a province. Solid waste management is within municipal jurisdiction and thus I undertake the analysis at this level. Due to the lack of a comprehensive municipal data set, I am conducting a case study analysis on municipalities in Canada.

3.2 Case Selection

To determine the cases for this analysis, I considered all cities with a population over 100,000 that have a comprehensive organic waste program. I define a comprehensive organic waste program as one that collects leaf and yard waste as well as other organics (most commonly kitchen scraps) and treats this waste stream through a composting process. My research question focuses on why cities with comprehensive organics programs have different diversion rates and thus I have not included any cities that do not have such a program.

I only looked at mid- and large-sized cities because small cities or towns face very different problems and issues when implementing such a program. Prosperous rural cities with low population densities have the most success with high diversion rates while major urban areas have, on average, much lower diversion rates (Seymour, 2004). The larger cohesion of the citizenry, the smaller facilities and operations, and the housing make-up of small cities can partly explain this difference. I chose the 100,000-population figure to approximate the start of a mid-sized city. Based on my research, there are nine cities that fit the initial case selection criteria (see Table 3.1).

Table 3.1 Case Selection Criteria

	Government Structure	Prov	Waste Diversion Rate	Population	Density	Year of Full Implementation
1. Edmonton	City	AB	60%	730,372	1067	2000
2. Halifax	Regional Municipality	NS	56%	372,679	68	1998
3. Hamilton	City	ON	42%	504,559	452	2006
4. Toronto	City	ON	42%	2,503,281	3972	2004
5. Peel	Regional Municipality	ON	45%	1,159,405	933	2006
6. York	Regional Municipality	ON	40%	892,712	507	2007
7. Durham	Regional Municipality	ON	42%	561,258	222	2006
8. Niagara	Regional Municipality	ON	43%	427,421	231	2004
9. Guelph	City	ON	39%	114,943	1326	2004

In considering my case selection, I looked at the demographics, program type, year of implementation, and diversion rate to decide which cities to select as my case studies. Halifax and Edmonton are both considered pioneers in solid waste management with markedly different approaches. Due to their early adoption, there are many lessons to draw out from over eight years of operations. Edmonton and Halifax have many differences including local government structure, the degree of urbanization, geography, population, density, organics program and facility. Despite these differences the cities are the top two in terms of their waste diversion rate. With the exception of Edmonton and Halifax, the remainder of the cities are located in Ontario. The provincial 60% waste diversion goal and the increasing landfill pressures have spurred widespread action on organic waste in Ontario. Looking only at Ontario cities would miss some explanatory variables such as geography, provincial laws and policies, and municipal demographics. For this reason, I chose to look at Edmonton and Halifax as well as two Ontario cities.

In selecting the Ontario cities, I looked at Edmonton and Halifax to determine the best comparison. I did not want to choose a city that fully implemented organics collection in 2007 or later as this would give too little time for analyzing the program and its impacts on the diversion rate. I also did not want to choose cases with a disproportionately larger or smaller populations than Halifax or Edmonton since population is a control variable. The diversion rates for Ontario cities are all very similar, mostly hovering over 40%, so this was not a factor. Since Halifax and Edmonton have different local government structures (regional municipality versus a city), there was no need to keep this variable of government structure constant. I chose the City of Hamilton and the Niagara Regional Municipality because they both have populations and densities between that of Halifax and Edmonton. They fully implemented their programs in different years, which allows for a comparison of programs at different stages and they have different approaches in their program design. Finally, the outcomes of the two cities programs are markedly different.

3.3 Dependent Variable

This paper considers why Edmonton, Halifax, Hamilton, and Niagara have varying successes with their comprehensive organic waste diversion programs. I use the overall objective of waste diversion as the indicator for success. The dependent variable is a relative measure of diversion expressed as the percentage of the waste stream going towards recycling and composting. While the diversion rates do vary enough for a comparative analysis, it is worth noting that these cities are all above the Canadian average for diversion (see Figure 3.1).

Figure 3.1 2007 Waste Diversion Rates of Cases

Data Sources:

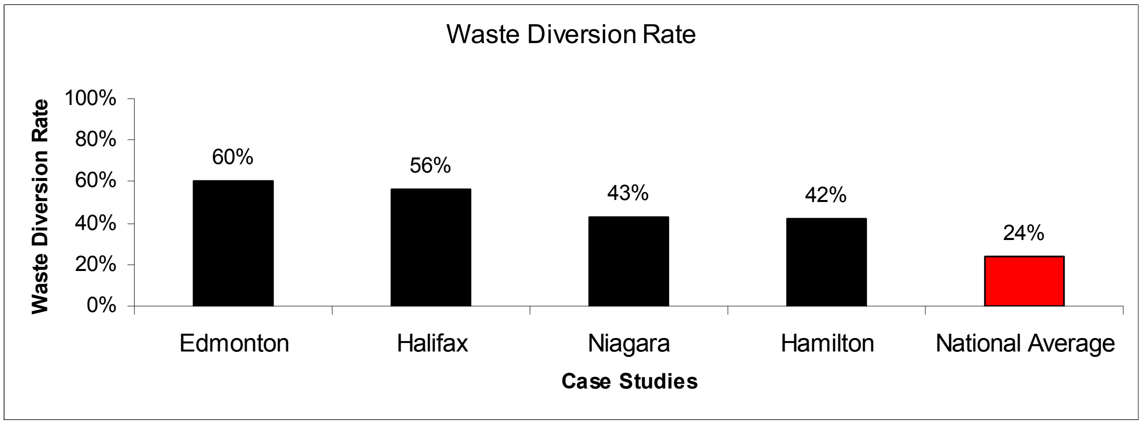
Edmonton – City of Edmonton, 2007

Halifax – Halifax Regional Council, 2007

Niagara –Regional Municipality of Niagara, 2008a

Hamilton – City of Hamilton, 2008

National Average – Statistics Canada, 2008



Researchers can look at other measures such as specific data on organics diversion, disposal per capita, and diversion per capita. However, there are issues around the comparability of municipal waste flow data in these more specific forms. In 2000, an organization called Corporations Supporting Recycling (CSR) led a Canada-wide team to look at municipal waste flow and diversion in order to establish standardized principles and practices for measuring waste flow. Out of this group, a GAP protocol was established:

> "“GAP” refers to generally accepted principles (GAP) for measuring municipal waste flow. It is the term used to identify the process that allows municipalities to identify what should and should not be included and excluded in records of waste generation and diversion in any municipality or jurisdiction, and to report waste flow and diversion in a consistent manner across Canada." (Corporations Supporting Recycling, 2006, Introduction, para. 1)

The GAP protocol remains a work in progress and while some municipalities in Canada have adopted the protocol (Ontario has implemented this for all of its municipalities), others have not (e.g. Edmonton). This measurement asymmetry complicates comparisons and has led me to use the more general diversion rate. Furthermore, municipalities and provinces have customarily adopted goals for the overall diversion rate, as opposed to the other measures mentioned, which makes it more suitable as a reference for analysis.

3.4 Research Limitations

Many factors affect a city's waste diversion rate. Organics play a large role in diversion but this kind of research cannot determine its exact effects. Variables affecting diversion are both inherent in the waste management strategy (e.g. recycling program changes) as well and extraneous to it (e.g. population fluctuations, land use changes, climate changes, and economic development). This study looks at one significant aspect of diversion and considers the factors that may lead to lower or higher rates. The goal of this study is to identify important elements to consider in waste policy design, mistakes to avoid, and best practices to follow for mid-sized Canadian cities exploring comprehensive organic waste programs. Each city will have to make decisions that are suited to local needs and characteristics but the general principles derived from this study can shed light onto their decision making process.

The case study methodology used in my study provides a more in-depth look at cities that have adopted a centralized composting program. While these cases provide insight, readers must exercise caution in treating the findings as generalizable. Research that draws on a larger sample, using quantitative analysis, would yield findings that are more robust. Although I have chosen my cases carefully, I have limited my investigation to four cities due to time constraints and that most of the additional cases would come from Ontario, and hence not be significantly different from the two Ontario cases examined. However, the possibility remains that I may have omitted variables from this study.

3.5 Independent Variables

A considerable amount of research investigates factors that influence household waste practices, particularly recycling. The literature on waste diversion largely ignores the unique role of organics within diversion. The ubiquity of recycling programs compared to organic programs can explain this difference. Even within research that examines organics, the scope of the study is usually limited to leaf and yard waste collection, which still does not address the particular challenges of a comprehensive organic waste diversion program. Due to these limitations, the use of research on recycling in general serves as a proxy for more specific research on organics. I also derive some variables based on principles of economics as well as information from the cases.

3.5.1 Demographics

Researchers have shown relationships between demographic variables and diversion behaviour. Most of this research focuses on recycling, rather than composting, as it is a far more common diversion practice. Research has often looked at household level behaviour rather than aggregate behaviour. I have drawn on the existing literature, despite these limitations, in order to derive demographic variables relevant for city diversion programs. Demographics are important to consider in any city planning exercise due to the constraints they can place on implementation and success rates.

Jenkins et. al (2000) use national household-level data to analyze the effects of demographic and waste policy factors on recycling intensities within households. They found that age had a small but positive impact on intensity of recycling effort. Ferrara and Missios (2005) conducted research that looked at the effect of recycling policies on recycling behaviour. The researchers held 18 structured interviews from single-family households in 12 municipalities across Ontario. Ferrara and Missios (2005) found that recycling intensity was positively correlated with age. Kipperberg (2006) found that age had a significant positive effect specifically on paper, glass and metal recycling. While these studies found positive relationships with age, the usefulness of the findings in relation to this study are limited due to constricted age ranges, and the use of university students (an unrepresentative sample) in the research. The cities I consider in my original case selection have a median age range from 38 to 42, and thus the value in comparisons is limited. These findings are more applicable for explaining differences within groups rather than between groups.

The demographic variable that consistently arose in the literature is density. Kipperberg (2007) found few socio-economic and demographic variables with significant impacts on recycling behaviour; however, density was a variable with a significant negative impact on food waste recycling specifically as compared to other material categories. Jenkins, Martinez, Palmer, and Podolsky (2000) also found a negative relationship with density. Low-density areas allow for more space to deal with diversion materials such as organics.

Households allocate space for the collection of recyclables in between curbside pick-up dates. This same principle applies to organics. The possession of adequate space increases the convenience of diversion activities. Maximizing recycling intensities requires the lowering of the opportunity cost of the activity (Scott, 1997). The more effort that is required to recycle, the less desirable it becomes as an allocation of time. In order to estimate the relationship between storage space and diversion behaviour, Derksen and Gartrell (1993) use the proxy of housing type to identify a strong and positive relationship between residence in a single-family dwelling and recycling participation. Residents in high-density areas living in multi-household buildings have greater challenges in finding space for organics. In addition, many multi-household buildings contract-out their waste collection to private companies and thus local government has less control over how this waste is collected and managed.

Using observation points derived from the nine pre-selection cases, I plotted a graph for density and applied trend lines. The trend line supports research findings showing a negative relationship. This is consistent with the literature, as researchers consider density one of the most important variables determining diversion behaviours. However, due to the limitation of the small number of observations, I could not make conclusions based on the trend lines. Instead, I have relied on the literature to support this inverse relationship between density and diversion.

3.5.2 Program Elements

The following section outlines the program elements of a waste management program that researchers and practitioners have identified as increasing diversion. All program elements are hypothesized to have a positive relationship with diversion; therefore, it is predicted that a waste management system that incorporates more of these program elements will have higher a diversion rate than a city with fewer of these program elements.

3.5.2.1 Regulatory Framework

Kipperberg (2007) compared household level data on material specific recycling behaviours in Norway and the United States, including yard waste (US) and food waste (Norway). The results from this econometric study show that a policy of mandatory recycling is positively related to food waste recycling intensities, though not for other material categories. Ferrara and Missios (2005) also found that mandatory participation increases recycling efforts in Canada. Cities may be reluctant to apply mandatory measures due to fears of monitoring and enforcement costs as well as perceptions of paternalism. Examples derived from my cases include municipal bans on organics, provincial bans on organics, municipal diversion goals, provincial diversion goals, and the degree of enforcement activity.

3.5.2.2 Participation Incentives

Pricing is a variable that researchers have found has a significant and positive relationship with recycling intensities (Kipperberg, 2007; Callan and Thomas, 1997). The association created between waste and household expense can explain these results. An example of a pricing policy is a pay-as-you-throw (PAYT) system wherein cities impose a bag limit and require residents to pay a fee for additional bags. Researchers have found that PAYT systems increase waste diversion in many cities in North America (Enviros RIS, 2001). Cities may be cautious in formulating pricing policies due to the potential for illegal dumping or waste burning.

Barr and Gilg (2005) show that recycling is positively correlated with local knowledge of waste services including the types of materials acceptable for recycling. They explain this by saying that a lack of knowledge leads to a decline in perceptions of self-efficacy and thus lower participation and willingness to participate. I apply this research to extend to general levels of knowledge on recycling and composting. I measure this by looking at the general outreach and education efforts on the part of the city. Through my cases, I have identified practitioners that have found a positive relationship between diversion intensity and the use of incentives such as bi-weekly garbage pick-up scheduling as a way to reduce the convenience of disposal over diversion, using clear garbage bags to increase neighbourly accountability, and designing a program that encourages a culture of diversion.

3.5.2.3 Accessibility and Convenience of Program

Jenkins, Martinez, Palmer, Podolsky (2000) contrasted the responses of respondents that had access to curbside recycling programs versus those that were required to drop-off their recycling at a local facility. This convenience factor accounted for a twenty percent difference in recycling frequencies. Kipperberg (2006) found that access to a curbside recycling program had a positive effect on paper and plastic recycling intensities. Derksen and Gartrell (1993) found that access to a recycling program was the single most important determinant of recycling behaviour. Finally, Barr and Gilg (2005) show that recycling is positively correlated with access to curbside recycling program.

I apply this research to a similar element, the overall level of convenience associated with the diversion program. Examples of accessibility derived from my cases include the extent to which the program services the general public as well as specifically multi-residential buildings and the industrial, commercial, and institutional sector. Another measure of accessibility I found includes the use of free distribution of green carts to households, rather than requiring households to purchase and pick-up their carts.

3.5.2.4 Summary of Program Elements

Table 3.2 shows the specific examples of what cities can implement under the heading of each program element. For example, as part of the regulatory framework, a city can be operating with a municipal diversion goal, a provincial organics ban, and a high level of enforcement. The categorizations of these program elements blur, and I use them for illustrative purposes. While I identify the general principles through the literature, I derive the specifics of the examples from my cases.

Table 3.2 Program Elements to Increase Diversion

Program Elements to Increase Diversion		
Regulatory Framework	**Participation Incentives**	**Access to Program**
- Municipal Diversion Goal - Provincial Diversion Goal - Municipal Organics Ban - Provincial Organics Ban - Level of Enforcement	- Clear garbage bags - Program encourages culture of diversion - Outreach and education - Garbage bag limits - Bi-weekly garbage pick-up	- Inclusion of all households - Inclusion of IC&I sector - Accessible to multi-residential dwellings - Free green bins

4: Case Studies

This section outlines key descriptive information on all of the case studies. I compare and analyze elements of the cases in section 5. These elements include:

- Demographics of the city
- Background of the organics program and city initiatives
- Financing and costs of the system
- Public engagement strategies
- Economic benefits derived from a change in the waste system
- The economies of scale achieved in the waste operations
- Regulations in place to facilitate diversion (local and provincial)

4.1 Edmonton

4.1.1 Demographics

Table 4.1 summarizes key demographics of the city.

Table 4.1 Edmonton Demographic Data
Data: Statistics Canada, 2006 – Census Community Profiles

Edmonton Demographics	
Population	730,372
Land Area	684 sq km
Density	1067
Median Age	36
Single-detached houses (as a % of total occupied private dwellings)	50%

4.1.2 Background

In the late 1980s, Edmonton's landfill was nearing capacity and the city faced a waste crisis. Public opposition to the search for a new landfill resulted in Edmonton adopting a new strategy and developing a world-leading waste facility (Lin, 2007). In 1994, Edmonton approved a thirty-year Waste Management Strategic Plan, which serves as a framework for the city's waste management. In 2004, Edmonton released a ten-year update of the Strategic Plan with extensive input from the community.

Prior to building the waste management facility, Edmonton had a 14% diversion rate; it now boasts the highest diversion rate in Canada at 60% (City of Edmonton, 2007). In 2000, the city introduced the composting operations of the facility, designed to maximize participation by requiring no additional effort from citizens in their waste disposal behaviours. In addition to the public opposition, Edmonton cites the following reasons for shifting away from landfilling and towards centralized composting (City of Edmonton, 2003):

- Compost is better for the environment (decrease in methane and leachate) and is more economical in the long term
- Compost provides a valuable soil supplement that improves the quality of top soil
- Landfills are unpopular, expensive, and environmentally risky
- Landfill takes up valuable land space
- Focusing on composting extends the life of the landfill for residuals

4.1.3 Costs and Incentives

The city finances its waste management programs through property taxes (31%), user fees (56%), and revenues (13%) (FCM, 2007a). The city and a private company share waste collection responsibilities. This is a partnership that has been successful and keeps both sides honest according to the Manager of Waste Management, Asset Management and Public Works (FCM, 2007a).

Edmonton is the only city in Canada to establish a separate utility fund for waste, which is charged monthly according to type of dwelling (see Table 4.2). The Director of Communications has said that this fee has not been an issue with residents (Bowerman, 2005). Since the utility fund is a flat fee, there are no incentives for decreased waste generation (Enviros RIS, 2001). Edmonton also has a waste volume limit dependent on the type of residence (see Table 4.3).

Table 4.2 Edmonton Waste Service Fees

Source: City of Edmonton, 2008b

Bylaw 13777, SCHEDULE A – Waste service fees and rates

Type of Dwelling	Monthly Waste Service Fee
Single Family Residential	$26.59 per unit per month
Multi-Family Residential	$17.29 per unit per month
Rooming House	$26.59 per site per month
Plus City contract waste fees for additional waste volumes where applicable.	

Table 4.3 Edmonton Waste Volume Limits

Source: City of Edmonton, 2008b

Bylaw 13777, Part II - HOUSEHOLD REFUSE AND RECYCLING SERVICES

Waste Volume Limits
11) The City will remove household waste to an annual average amount of four (4) 100-litre receptacles per week per single family residence or rooming house and two (2) 100-litre receptacles per week per multi-family residence.

4.1.4 Public Engagement

The Manager of Waste Management, Asset Management and Public Works attributes the success of the solid waste programs to the engagement and participation of the city's residents (FCM, 2007a). The ICLEI – Local Governments for Sustainability (2002) documents this assessment, in which Edmonton writes the following:

> Public consultation and education are critical to the success of such initiatives. By listening to citizens' concerns and suggestions and keeping them informed of developments, Edmonton fostered a high level of community acceptance and pride in the project. In addition, networking with peers in other municipalities, the private sector, and other waste management specialists enabled Edmonton to learn from others and avoid any major pitfalls or resistance.

There is also $1.5 million worth of education and outreach efforts that the city engages in, including (FCM, 2007a):

- Every three years the city surveys its residents to determine their needs and to assess the city's progress on waste management initiatives.
- Ten city staff members who intervene directly at the classroom level
- In-school presentations, resources and facility tours to more than 15,000 students, parents, and teachers each year (City of Edmonton, 2008)

- Grade 4 curriculum called “Waste in Our World”
- Tours of the EWMC facilities to 10,000 students every year
- E-learning program, “Sort It Out”, available to school boards
- Attendance at community shows and events
- A hotline, a service centre, tours, open houses and workshops for residents
- An average of 230 residents contact the City each day with questions about waste (City of Edmonton, 2008)
- Recruitment of 1,000 volunteers for waste outreach efforts
- A Master Composter/Recycler Program where 30-35 residents are trained per year in a 3 week course to educate people at the community level about composting/recycling (City of Edmonton, 2008)

Edmonton has adopted the waste management hierarchy through an integrated approach. Edmonton encourages waste reduction through promotion of household composting and grasscycling. These methods can reduce household waste by up to 65% if used consistently (City of Edmonton, 2008). Edmonton is also one of the first Canadian cities to have offered a comprehensive curbside recycling program. Calgary, as compared to Edmonton, has neither a curbside recycling nor organics program, and disposes 80% of its waste into landfills (Bowerman, 2005).

4.1.5 Collection Services

The City of Edmonton collects waste from individual homes, apartments, condominiums, and depots. It also collects waste from small businesses on a direct cost-recovery basis. (FCM, 2007a). This waste is transferred to the Edmonton Waste Management Centre (EWMC). Within this facility, there are composting and recycling operations as well as a landfill gas-recovery plant. The EWMC is also a waste management Centre of Excellence for applied research, demonstration, and training (ICLEI – Local Governments for Sustainability, 2002).

The Edmonton Composting Facility is a co-composter because it processes residential solid waste together with biosolids from municipal wastewater treatment plants. Edmonton residents do not need to source separate their organics from their waste. Instead, organics are separated from the waste stream once they have arrived at the EWMC. Compost is cured, screened, and prepared for agricultural, reclamation, turf management, and horticultural markets. It takes around two to three months to produce finished compost. The facility generated 50,000 tonnes of compost products in 2007 (FCM, 2007a).

In order to achieve a diversion rate of greater than 60%, the city is planning on building a gasification plant to be completed in 2012 (Lin, 2007). Edmonton officials are hoping that the plant, at a cost of eighty-seven million dollars, will help the city reach a 90% diversion rate.

4.1.6 Economic Benefits

The City of Edmonton has garnered international attention with its high diversion rate. Local business benefit from visitors including 10,000 students and several hundred national and international visitors every year (City of Edmonton, 2008). The city sells compost generated by the facility and this contributes to the revenues of the facility operations. Edmonton avoided the high costs of siting a new landfill after extensive consultation found that this was not an acceptable option to the public. The local landfill now has many years remaining before it reaches its capacity.

4.1.7 Economies of Scale

Edmonton has a unique waste management system in that it has a co-composter, which enables the processing of organic waste as well as biosolids. This ensures a large dual flow of waste to the facility. While some cities import waste from surrounding areas, Edmonton is able to rely on its own waste generation for processing. It is the largest co-composter in North America. The facility sits on a 550-acre site that can process up to 180,000 tonnes of residential solid waste and 100,000 tonnes of biosolids per year (City of Edmonton, 2008).

The province of Alberta has also achieved economies of scale. In the 1970s, Alberta began a process of regionalizing its municipal landfills to consolidate waste and to increase cost-effectiveness (Alberta Environment, 2007). This regionalization saw the transition from small municipal dumps to regional landfills with transfer stations.

4.1.8 Regulatory Framework

Among Canadian provinces, Alberta has the highest per capita municipal solid waste disposal rate (Alberta Environment, 2007). Alberta has traditionally relied on landfills for waste management. It has admitted that innovative waste reduction initiatives tend to develop only when waste disposal options become more limited and when waste disposal fees reflect the true social and environmental costs of waste (Alberta Environment, 2007). Alberta has a network of regional and private landfills that compete with each other, resulting in low tipping fees and little incentive for diversion. The province has also invested little in diversion, with spending less than 15% of the amount going towards disposal (Alberta Environment, 2007).

While Alberta does not have a diversion goal, it does have a 500 kg per capita goal for municipal solid waste going to landfills by 2010. However, the province says it likely will not reach this goal due to the lack of financial incentives (low tipping fees) and the current voluntary nature of diversion initiatives. The province has generally not taken assertive action on solid waste diversion though it supports diversion programs in principle. It also does not require its municipalities to implement certain diversion programs or reach diversion goals as Ontario and Nova Scotia have done.

Alberta supports using the waste management hierarchy and states that their challenge is to, "work towards reversing the current waste profile and ultimately work towards a Zero Waste Society" (Alberta Environment, 2007, p.6). On the municipal level, Alberta has a disposal rate of

80% and hopes to reduce this to 20% in the future. However, the province has not set a date for when they hope to reach this goal.

Alberta, in consultation with its Waste Management Stakeholder Group, has identified three broad outcomes for waste management (Alberta Environment, 2007, p.9):

> 1. Albertans take responsibility for resource conservation and waste minimization
> 2. Waste management systems are integrated to provide the capacity for processing and/or recovery of materials that would otherwise be disposed of as wastes.
> 3. Facilities ad practices to manage secondary materials and wastes are protective of air, land, water and human health.

4.2 Halifax

4.2.1 Demographics

Table 4.4 summarizes key demographics of the city.

Table 4.4 Halifax Demographic Data

Data: Statistics Canada, 2007c – Census Community Profiles

Halifax Demographics	
Population	372,679
Land Area	5,490 sq km
Density	68
Median Age	39
Single-detached houses (as a % of total occupied private dwellings)	52%

4.2.2 Background

In the early 1990s Nova Scotia's waste management mainly consisted of landfills, incineration, and open burning (Wagner and Arnold, 2008)[1]. In 1989, Nova Scotia's largest landfill, the Highway 101 landfill, received media attention for the inadequate environmental protections it had in place. There were reports of leachate discharging into the Sackville River. The negative press resulted in considerable opposition from potential host communities for the siting of a new landfill as well as attention on problem landfills across the province. The media attention, along with the rejection of a proposed replacement landfill and the rejection of a proposed waste-to-energy incinerator, resulted in public support for a waste strategy based on pollution prevention. Halifax was the first municipality in Canada to implement an aggressive waste management campaign. One year after the implementation (1999), Halifax achieved a 44% diversion rate and a 50% diversion rate by 2000 (Friesen, 2000).

[1] Unless otherwise noted, information in the Halifax section is referenced from Wagner and Arnold, 2008.

4.2.3 Financing and Cost

The Halifax Regional Municipality has financed the majority of the waste management capital costs through twenty year municipal debentures. The overall strategy is financed through capital debt financing, private partnerships, tipping fees, and property taxes (Tools of Change, n.d.). Halifax contracts with private haulers for weekly waste collection.

The HRM is the only city in the cases to collect garbage on a bi-weekly, rather than the more common weekly, basis. This is a program choice designed to encourage residents to divert into both the blue bin and green bin, before looking towards the garbage bin as the latter has limited capacity. The HRM also has limits on the size of garbage containers, as follows:

- Single unit/Semi-Detached/Rowhouse/Townhouse : Up to 6 bags or containers per household
- Apartment buildings up to 6 units: Up to 5 bags or containers per unit

4.2.4 Public Engagement

Nova Scotia held town hall meetings in 1994 and 1995 to garner feedback on potential waste management strategies at the local level. While the implementation of the waste strategy was top-down with the province dictating the terms to its cities, there was public consultation with local communities which resulted in a satisfaction rate for the waste system at over 85% (Halaprin, 2007). The level of involvement of residents in designing the program has been credited for its strong endorsement. The organics program appears to be a source of pride for Halifax Regional Municipality (HRM) residents. According to the HRM, 90% of residents feel that the program is an easy way to manage organic waste (HRM, 2008).

4.2.5 Collection Services

Halifax has two private in-vessel composting facilities. Each has a capacity of 25,000 tonnes per year of source separated organic waste from 110,000 households. The Miller Compost

Facility is located in Dartmouth and it processes half of the waste from the green bin program. Compost generated from the facility is Class A according to CCME guidelines, which means it has unrestricted use. This facility sells compost at around $30 per cubic yard and HRM receives a share of these revenues. The compost is primarily sold to large landscaping businesses.

The Otter Lake facility, which began operations in 1999, includes a front end mechanical processing, biological stabilization unit (aerobic composting), and a landfill. The primary purpose of the mechanical and biological treatment system was to reduce the amount of moisture and readily degradable organic matter in the waste before going to landfill (Lee, 2004). A secondary benefit is that this facility contributes around 10% to the diversion of recyclables and organics. This is a significant contribution to diversion, one that is rarely discussed in the literature as the high diversion rate is typically attributed to provincial legislation.

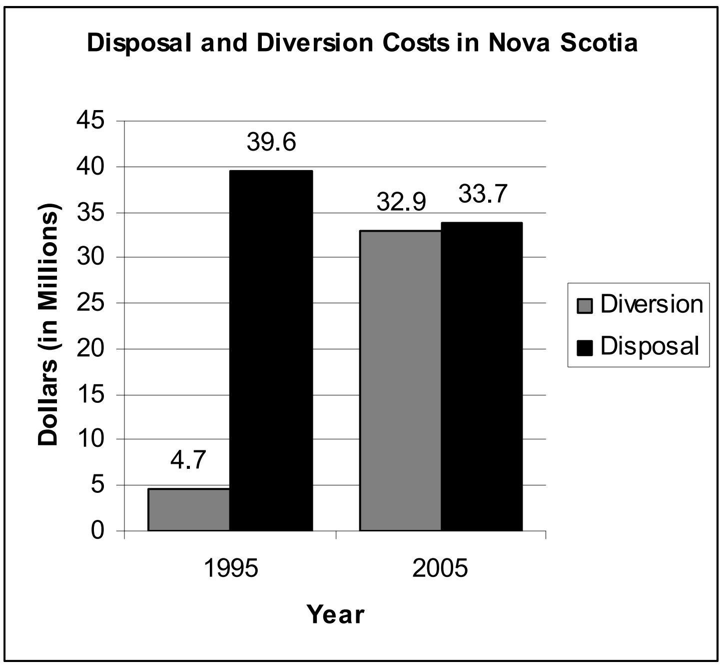
4.2.6 Economic Benefits

Halifax has focused on a paradigm shift from waste management to resource recovery, "A key element of the new model was, therefore, to reframe waste as possessing a positive economic potential rather than negative residual liability" (Wagner and Arnold, 2008, p.412). The Nova Scotia Solid-Waste Resource Management Strategy cited this focus as one of the four primary goals. The GPI Atlantic has supported this framing. The non-profit research and education organization is creating a genuine progress index for Nova Scotia. In 2004, they released a major research study that conducted a full cost accounting of Nova Scotia's transition to their new waste management system in 1998. The GPI Atlantic estimates that the solid waste system in the 2000-01 fiscal year,

> "produced net savings of between $31.2 million and $167.7 million, when compared to the system in place in the fiscal year 1996-97 … This translates into savings of $33 to $178 for each Nova Scotian, rather than a net additional cost of $24 as suggested when comparing strictly the operating and amortized capital costs of the two systems" (GPI Atlantic, 2004, p.4).

The report argues that the new system has more than paid for itself while also having a positive effect on job creation and environmental preservation. From 1995 to 2000, Nova Scotia saw an increase from 80 to 340 jobs in composting, recycling, and source reduction (Province of Nova Scotia, 2009). Using traditional accounting methods, the province has increased diversion costs significantly, but it has also saved money in their disposal process (see Figure 4.1).

Figure 4.1 Disposal and Diversion Costs in Nova Scotia
Adapted from: Province of Nova Scotia, 2009



4.2.7 Economies of Scale

The Nova Scotia Department of the Environment commissioned a series of studies in the development of its MSW strategy (Wagner & Arnold, 2008). One such study emphasized the efficiencies and economies of scale achievable through regional or inter-municipal collaboration. Regional cooperation became one of the four primary goals of the Nova Scotia Solid-Waste Resource Management Strategy. Implementation of this part of the strategy occurred with the creation of seven waste-resource management regions across the province. The province worked closely with each region to provide options for reaching the 50% diversion goal and in developing a long-term regional plan.

4.2.8 Regulatory Framework

In 1993, Nova Scotia initiated a process to develop an integrated provincial waste management strategy for its municipalities. The province commissioned various studies to determine the feasibility of waste management options. In 1995, the Nova Scotia legislature passed the Environment Act which adopted a 50% diversion goal by 2000. This Act also mandated the creation of a solid-waste-resource management strategy for the province. The strategy was created with the following foundations: planning and implementation, restricting disposal, system funding, increasing the recovery of material, and increasing the use of diverted materials. Highlights of the strategy include a provincial ban on the disposal of organic and recyclable materials, as well as the coordination of three-stream collection systems across the province. Nova Scotia is considered to be a strong provincial leader in terms of waste management in Canada.

Halifax has outlined the duties of the public in the source-separation of organics under Bylaw S-600 (see Table 4.5). Source-separation applies to all commercial properties as well as all residents in the HRM, including those in apartment buildings with six or more units. This is a requirement under provincial law. Halifax has enforcement mechanisms for ensuring compliance with regulations that ban the disposal of organics, the dumping of garbage, etc. In the first year of operation, the municipality took the following enforcement actions: 238 verbal warnings, 10 education sessions, 7 letters, and 30 tickets issued ($50 fine payable within 14 days) (HRM, 1999). The city focuses on public outreach and education, but has the means to enforce its regulations.

Table 4.5 Halifax By-Law on Source Separation of Organics

Source: Halifax Regional Municipality, 2003

HRM Solid Waste Resource Collection and Disposal By-Law No. S-600
4. The Public 4.1 The owner or occupier of an eligible premises shall: (i) source-separate all collectible waste generated from eligible premises at the point of generation so as to comply with the provincial disposal bans and to facilitate their recycling, composting or disposal in accordance with the Municipality's waste resource management system.

4.3 Hamilton

4.3.1 Demographics

Table 4.6 summarizes key demographics of the city.

Table 4.6 Hamilton Demographic Data

Data: Statistics Canada, 2007d – Census Community Profiles

Hamilton Demographics	
Population	504,559
Land Area	5,490 sq km
Density	452
Median Age	40
Single-detached houses (as a % of total occupied private dwellings)	58%

4.3.2 Background

In 2001, the Transportation, Operations, and Environment Department made recommendations for the creation of a 25 year Solid Waste Management Master Plan. It was reported that federal air emission guidelines, to take in effect by 2006, would impact the ability of the city's energy to waste facility to operate (Goodger, 2001). The committee investigated various options and recommended the implementation of a Green Cart system.

In April 2006, Hamilton launched the Green Cart Program to all residents receiving curbside waste collection. The Green Cart included the distribution of carts, mini bins, and communication materials between April and June of 2006. One hundred fifty thousand carts were delivered in addition to the five thousand carts from the pilot project (undertaken from 2002 to 2005). The introduction of the Green Cart program significantly increased the number of tonnes of waste diverted from landfill (City of Hamilton, 2007c) (See Figure 4.2 and 4.3 and note the introduction of the green cart program). In 2007, leaf and yard waste collection combined with the green bin program represented over 25% of the tonnes of waste going to landfill.

Figure 4.2 Waste Diversion Rates, Hamilton: 2000-2007
Adapted from: City of Hamilton, 2007b

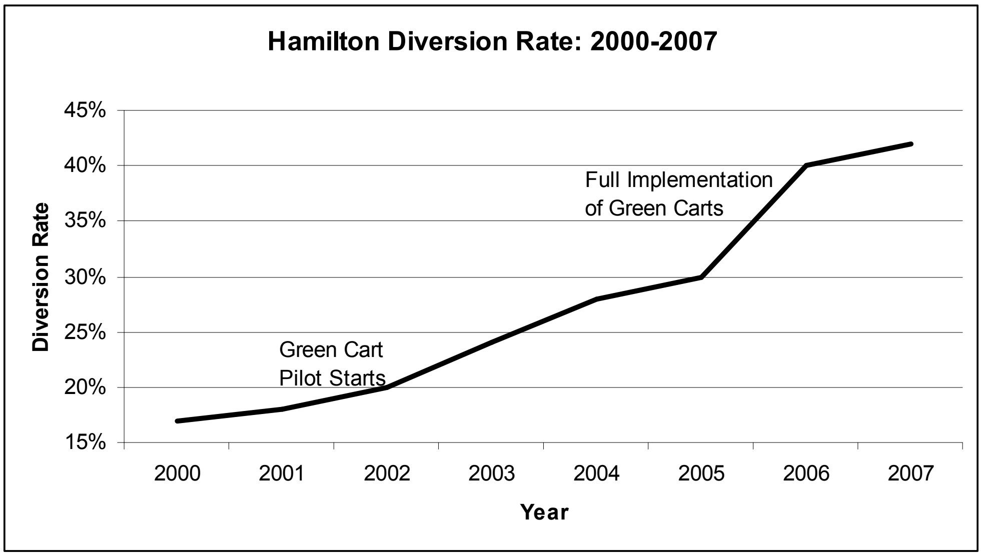
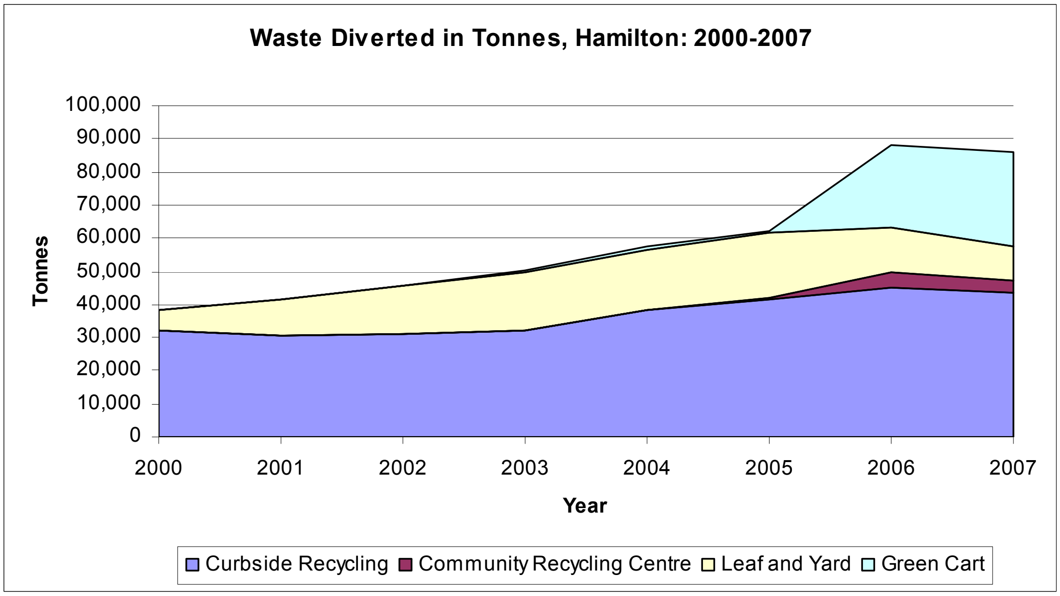


Figure 4.3 *Waste Diversion in Tonnes, Hamilton: 2000-2007*

Adapted from: City of Hamilton, 2007b



4.3.3 Financing and Cost

The City of Hamilton is considering a pay-as-you-throw scheme for funding their waste management operations (FCM, 2007b). Currently the city allows residents to set out up to two garbage containers per week. Households can set out additional bags if they pay a per bag fee. There is a voluntary one-container limit for garbage. Hamilton has adopted a system of increasingly stricter restrictions on bag limits:

- 2007: 3 Container Limit (50lbs/23kg)
- 2008: 2 Container Limit (1 Clear Bag)
- 2010: Proposed 1 Container Limit

General city revenues fund waste management. Federal Gas Tax Funds funded 55% of the capital cost of the composting facility (Association of Municipalities of Ontario, 2008). Researchers estimate that the operative cost of composting in Hamilton is 25-35% less than landfilling, which simultaneously offsets the cost of bio-remediation[2] (Belanger, 2007).

[2] Bioremediation is the use of living organisms to clean up contaminated soil or water. Bioremediation usually refers specifically to the use of microorganisms.

4.3.4 Public Engagement

Hamilton put together a Public Advisory Committee to recommend a new waste management plan. This committee was comprised of various members including representatives from government, environmental groups, the school board, academia, the chamber of commerce, (Goodger, 2001). The committee operated on a consensus approach rather than majority rule to ensure every member was on board. Between 2002 and 2004, the City of Hamilton conducted pilot projects to identify problems and best applications of programs. This allowed residents to be a part of the decision process by providing feedback to the city.

Since the introduction of the Green Cart system, there have been various public outreach and education efforts. One such effort has been the creation of a citizen's advisory committee called the Waste Reduction Task Force, which monitors the implementation of the waste plan (McGuinness, 2007). Other efforts include (City of Hamilton, 2007a):

- 180 tours and presentations held in 2006
- 214 Green Cart promotional newspaper advertisements in 2006
- Television and radio advertisements for Green Cart
- Over 5,000 phone calls answered regarding the Green Cart
- Green Cart communications package prepared and distributed to all single-family homes

Public engagement is entrenched in the Solid Waste Management Master Plan. Recommendation 10 of the plan states:

> "The City of Hamilton must implement, sustain and support a comprehensive public education, awareness and marketing program in all areas of the city outlining the benefits and encouraging participation in waste reduction, re-use and recycling programs" (City of Hamilton, 2001, p. 4).

The discussion further states that,

> "The City needs to allocate financial resources and staffing to ensure the success of the program. The public education program must overcome social and communication barriers in order to reach out to the City's diverse population. The awareness program should provide frequent reminders to motivate the public to participate in the programs" (City of Hamilton, 2001, p. 4).

4.3.5 Collection Services

Residents in Hamilton receive weekly collection of waste and organics with a separate weekly collection of recyclables. The organics are processed at a central composting facility, using an aerobic process and operated by National Waste Services Inc. The Federation of Canadian Municipalities (2007b) has partly attributed the success of the program to the private-sector role in the composting facility. The City of Hamilton made an important decision to build the facility on a brownfield in an industrial area. The Hamilton facility has created a minimal impact on the surrounding community (FCM, 2007b). There are 150,000 households in the organics program (City of London, 2007) out of a possible 194,455 (Statistics Canada, 2006), meaning that 77% of households are covered.

The program has started to cover multi-family dwellings despite the traditional difficulty of offering waste services to this group (Elliott, 2007). Compliance with source separation has been high as demonstrated by a residue rate of less than 2% for incoming waste material (in contrast to, for example, the York region's 50% residue rate). This low residue rate is facilitated by the fact that Hamilton does not allow plastic bag liners for its green bins nor does it allow materials that lead to high contamination (e.g. diapers, sanitary products, pet waste). The end product meets the guidelines for unrestricted Class A compost (City of Hamilton, 2007c).

4.3.6 Economic Benefits

The City of Hamilton avoided the expense of creating another landfill, which the city estimates to be at around $100 million (City of Hamilton, 2006). Hamilton chose a focus on diversion as the lower cost option. However, the city based this decision on a diversion goal of 65%, by 2008, which they have been unable to meet.

4.3.7 Economies of Scale

Hamilton’s compost plant is operating at capacity with waste flows coming in from Halton Region (20,000 tonnes per year) and Barrie-area communities in Simcoe County (10,000 tonnes) in addition to its local organic waste (38,000 tonnes). The city recently turned down Waterloo’s request for processing its organic waste due to the full capacity (Hamilton Spectator, 2008). By processing waste from surrounding areas, Hamilton has greater assurance of meeting waste flow agreements and was able to establish a larger facility than if it was only serving its own community.

4.3.8 Regulatory Framework

The Waste Diversion Act was created in Ontario to promote the reduction, reuse and recycling of waste. In 2002, this act created Waste Diversion Ontario (WDO) as a permanent, non-share non-government corporation. WDO develops, implements, and operates waste diversion programs for designated materials under the Waste Diversion Act. While Ontario has shown some leadership in encouraging diversion, a large impetus for organics programs in Ontario cities appears to be the shrinking landfill capacity and the moves by Michigan to limit the import of Canadian waste (Luxmore, 2008). In addition to setting a provincial 60% diversion goal, Ontario also implemented compost regulations that outline requirements for municipalities (see Table 4.7).

Table 4.7 Ontario Compost Regulations

Source: Ministry of Environment and Energy, Ontario, 1994

Ontario Compost Regulations
- All local municipalities with populations over 5,000 must provide home composters to residents along with information on their use. - Local municipalities with populations of 5,000 or more that collect or accept leaf and yard waste, separated from other garbage at the source, must implement a Leaf and Yard Waste System. - Municipalities with populations of 50,000 or more must implement a Leaf Yard Waste System whether these materials are currently collected separately or not.

4.4 Niagara

4.4.1 Demographics

Table 4.8 summarizes key demographics of the city.

Table 4.8 Niagara Demographic Data
Data: Statistics Canada, 2007d – Census Community Profiles

Niagara Demographics	
Population	427,421
Land Area	1,854 sq km
Density	231
Median Age	42
Single-detached houses (as a % of total occupied private dwellings)	68%

4.4.2 Background

Niagara was the first Ontario municipality to collect organics from a curb-side green bin program on a weekly basis (Luxmore, 2008)[3]. The region's diversion rate jumped quickly to 46% in a year and a half after implementation. The diversion goal for the region is 65% by the year 2012. In 2004, one of the Niagara composting facilities, run by private contractors, encountered odour issues with subsequent complaints by nearby residents. The Ontario Ministry of the Environment investigated the claims and laid charges on the region for discharging a contaminant into the natural environment. Since Niagara owns the facility, it was responsible for the $25,000 fine. The Region has since spent over $1.4 million to reduce odours but the incident created a lasting negative impression on residents. Participation rates in the organics program decreased significantly. According to a recent visual curbside audit, 78% of residences are putting their blue and grey boxes to the curb, while only 32% are putting out the green bin (Niagara Region Public

[3] Unless otherwise noted, information in the Background section is referenced from Luxmore (2008).

Works Department, 2007). Table 4.9 provides an overview of the history of organic waste management changes in Niagara since 2001.

Table 4.9 Overview of Waste Service Changes in the Niagara Region
Source: Regional Municipality of Niagara, 2008a

Year	Waste Services in Niagara Region
2001	Uniform waste services across the Region
2003	Grimsby, Lincoln, and Pelham receive new organic collection services
2004	Full implementation of organic collection services Odour problems begin at the Elm Street landfill composting facilities Charges laid against Niagara by the Ministry of Environment
2009	Changes considered by the city to increase diversion – planned implementation in 2009 or later (Region of Niagara, 2006): - Re-launch source-separated organics (SSO) program and green bin distribution - Ban use of plastic bags for SSO and leaf and yard waste - Implement SSO program for the remainder of municipalities in the region - Include kitty litter and pet waste in the SSO program - Reduce frequency of residential waste collection to every 2 weeks - Reduce residential container limit from 2 containers per week to 1 container per week - Introduce disposal bans and use of clear bags for waste collection - Extend recycling, leaf and yard waste collection and SSO program to multi-residential sectors - Extend full SSO program to IC&I sector

The Director of Waste Management Services for the Niagara Region argues that the odour issues are mostly to blame for the failure of the program. Other factors affecting low diversion are the initial rollout of the program (discussed under public engagement), weekly rather than bi-weekly pick up of garbage, and the use of plastic green bin liners, which contaminate the waste flow and result in more non-compostable waste. Niagara has decided to overhaul the whole system with a new composting facility and a re-launch of the green bin program in April 2009. Niagara's first facility used outdoor windrow composting. In the new facility, Gore-Tex fabric will cover the windrows and waste will aerate for four weeks prior to being moved outside. The city hopes the new system will be free of odour issues.

4.4.3 Financing and Cost

The Niagara Region is one of the largest Regional Municipalities in Ontario in terms of total land base and it therefore has significant direct haul distances, which add to the cost of collection (Regional Municipality of Niagara, 2008a). In 2004, the region cut the weekly waste container limit from three to two to encourage diversion. Residents can purchase garbage tags, for additional waste, at $1 each. In the spring of 2009, Niagara plans on reducing the frequency of waste collection to every other week, and will further limit waste container limit to two containers for every other week (Regional Municipality of Niagara, 2007).

The Niagara Region funds its waste management system through municipal requisitions (49%) and uniform disposal rate (UDR) tipping fees (21%). The sale of recyclables, residential and commercial tipping fees, and the sale of containers and garbage tags funds the remaining 30 percent (Regional Municipality of Niagara, 2007).

4.4.4 Public Engagement

The Region has a backyard composting program which includes subsidized composter sales and promotion (Regional Municipality of Niagara, 2008a). The Region of Niagara has acknowledged the important role of social marketing in the success of diversion programs. Some of the outreach highlights include (Regional Municipality of Niagara, 2008):

- Reached over 257,650 people through presentations, events and festivals, door-to-door visits, the Waste Information Line and public education material.
- Received over 85,000 and 5,700 page views of the Waste Management web pages and Smart Gardening website, respectively.
- Received over 925 entries for various contests.

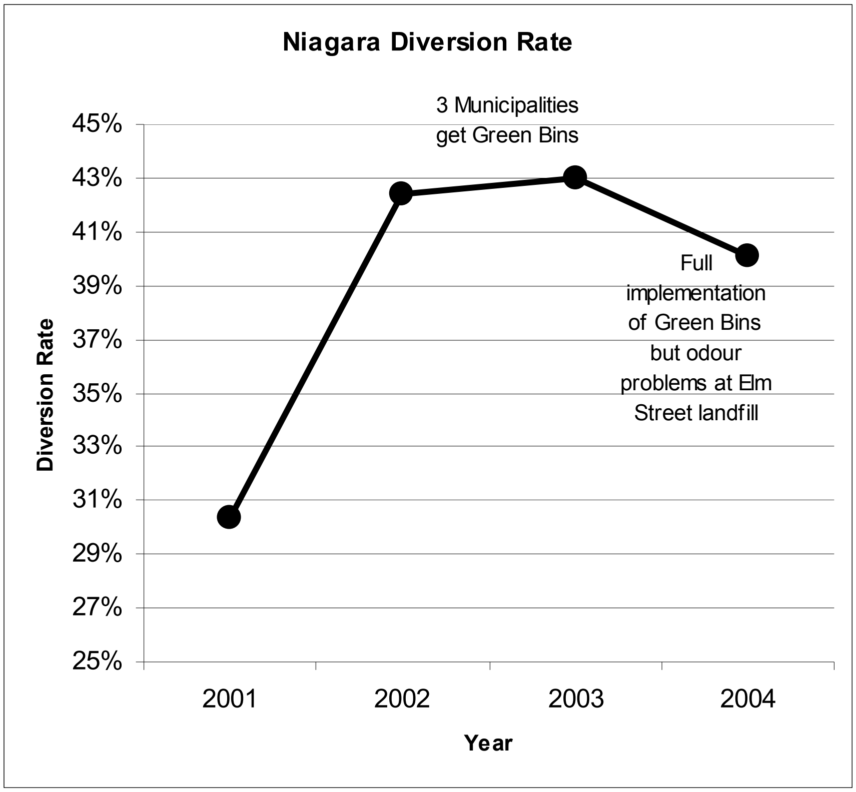
In the early stages of the green bin program, the Niagara Region admits that it did not do enough to engage citizens and ensure high participation levels. The Niagara Director of Waste Management Services says that the initial distribution system for household green bins was flawed because it put the onus on households to both pay for and collect the green bins (Luxmore, 2008). This is in contrast to the other cases where cities distributed bins directly to households at no cost. While participation rates were relatively high and public perception was positive during the first couple of years of the program, the mood grew decidedly sour once odour became a major issue.

4.4.5 Collection Services

Niagara has contracted with a private sector firm with a facility in Thorold to process source separated organics. Niagara also has an open windrow composting facility using an aerobic process located at the Elm Street Landfill in Port Colborne. This facility, originally established in 1990 as a leaf-composting site, has grown from processing 300 to 25,000 tonnes of organic waste. All operations currently take place outdoors. A private sector contractor operates the facility, which is within close proximity to a local trucking firm as well as a residential neighbourhood (FCM, 2004b). As previously mentioned, odour issues have required the re-launch of the program. Figure 4.4 illustrates the recent reduction in the diversion rate, possibly due to the negative public reaction towards the composting problems. Another indicator of this unrest is the increase in public complaints received concerning the waste system (2.5% of households in 2003 compared with 4.1% of households in 2007) which is now above the Ontario average (41%) (Regional Municipality of Niagara, 2008a).

Figure 4.4 Niagara Diversion Rate: 2001-2004

Adapted from: Regional Municipality of Niagara, 2007



All towns in the Niagara Region, except for Wainfleet and West Lincoln, have the source-separated green bin program. Single-family households and multi-residential buildings with five units or less are part of the Green Bin program. In the two excluded towns, there is collection of source-separated leaf and yard waste only. The Region's Solid Waste Management By-Law 95-2008, does not permit organics or recyclables in the waste stream.

The Region provides weekly waste and weekly organics collection services to all twelve of the area municipalities using contracted services (Regional Municipality of Niagara, 2008a). In 2007, Niagara Region operated five landfills, three composting operations, and maintained nine closed landfill sites (Regional Municipality of Niagara, 2008a). The Region is considering moving towards waste collection every other week to encourage diversion (Regional Municipality of Niagara, 2008b).

To increase resident participation in organic diversion, the Region is re-launching the Green Bin program. Part of the re-launch includes broadening the acceptable organics to include pet waste and kitty litter. In addition, plastic bag liners are no longer accepted in the green bins. The region is hoping these changes will divert an additional 3,500 tonnes annually by 2010.

4.4.6 Economic Benefits

Due to the instability of the program, and decisions to re-launch the green bin distribution as well as to create a new composting facility, there are few direct economic benefits. One economic benefit that was achieved, as with all diversion programs, is the extension of landfill capacity.

4.4.7 Economies of Scale

Materials processed at the Niagara composting facility include yard wastes, food wastes from restaurants and major food processing industries, and paper mill sludge. Most of the organic waste originates outside of the Niagara region and is from the industrial, commercial and institutional (IC&I) sector, which allows for an offset of some of the operational costs (FCM, 2004b).

4.4.8 Regulatory Framework

Ontario has set diversion goals as well as legislation that sets out requirements for municipal waste programs[4]. The Niagara Region has also implemented a by-law that prohibits the disposal of green bin material into the waste stream (see Table 4.10).

[4] Please refer to section 4.3.8 for an overview of the regulatory framework for Ontario.

Table 4.10 Niagara By-Law on Ban of Organics in Waste Stream

Source: Regional Municipality of Niagara, 2008b

Solid Waste Management By-Law No. 95-2008
PART II – CURBSIDE COLLECTION 12. Garbage 12.1 Material not included in the other Classes of Collectible Material of this By-law shall be set out for collection as Garbage: (e) containing no other Classes of Curbside Collectible Material including but not limited to Leaf and Yard Material, Green Bin Material, Blue Box Material and Grey Box Material.

5: Comparison and Analysis of the Cases

In this section, I compare and analyze density and the program elements in each of the four case studies. The analysis here helps formulate the policy analysis and scenario analysis sections.

5.1 Density

Cities with high density levels may need to look at a mixed waste system such as Edmonton's in order to deal with the challenges associated with high density (constrained space for collecting divertible materials, multi-dwelling buildings). Alternately, cities can use a green bin program and aggressively adopt diversion strategies such as targeting multi-dwelling units for source separation. Hamilton and Niagara are both actively considering options for expanding their program to large apartment buildings in order to generate additional diversion levels. These efforts are costly, as they require liaison work with building managers as well as enforcement mechanisms to ensure compliance. Finally, a high-density city can manage with a green bin program if there is provincial legislation in place that essentially forces the private sector (including apartment buildings) to institute a source-separated system. Regulation needs to make failure to comply illegal and impose fines to ensure compliance.

5.2 Program Elements

Within the general structure of the diversion programs, there is a range of program elements that cities can implement. The combination of these program choices can significantly affect the diversion rate. The following section highlights the policy suite developed by each of the case studies. I have listed the program elements and have identified whether each case study makes use of them. The list highlights the trade-offs inherent in these decisions, in terms of cost, public acceptability, and administrative burden. For a city to implement all the possibilities, it would require a high degree of commitment, innovation, and public cooperation.

The range of available program choices is dependent on the type of diversion system adopted by a city. In order to compare the diversion capacities of the cities, I divide the analysis into program elements that are exclusive to a source-separated program (Table 5.1), and program elements that are applicable to both a source separated and mixed waste program (Table 5.2). The diversion strategies are listed rather than tallied because it is difficult to determine the weight that should be applied to each program element.

Table 5.1 Overview of Program Choices in Source-Separation Programs

	Halifax	Hamilton	Niagara
Bi-weekly garbage collection	✓	-	-
Organics ban at municipal level	✓	-	✓
Organics ban at provincial level	✓	-	-
Free and easy to obtain green bin	✓	✓	-
Strong enforcement strategy	✓	-	-
Clear garbage bags	-	-	-

In the comparison between source-separated programs, it is clear that Halifax has adopted more diversion strategies than Hamilton and Niagara. While all the cities have adopted a limit on garbage containers, only Halifax has restricted garbage collection to once every two weeks. This represents some of the more contentious decisions Halifax has made to ensure high levels of diversion. Halifax also has a strong regulatory framework coupled with enforcement mechanisms to ensure compliance. One strategy Halifax is exploring is the use of clear garbage bags to act as an easy enforcement mechanism for non-compliance and as a general deterrent in the form of public exposure. All of these strategies restrict household behaviour in some way, and subsequently can elicit negative public reaction. It is for this reason that municipalities must weigh each of these options seriously and carefully as well as adopting a marketing strategy for their implementation. Municipalities in Ontario are actively considering adopting more of these strategies to increase their stagnating diversion rates.

Table 5.2 Overview of Program Choices in Diversion Programs

	Halifax	Hamilton	Niagara	Edmonton
Limit on garbage containers	✓	✓	✓	✓
Economies of scale	✓	✓	✓	✓
Municipal Diversion Goal	✓	✓	✓	✓
Provincial Diversion Goal	✓	✓	✓	-
Program encourages culture of diversion	✓	✓	✓	-
Inclusion of IC&I sector	✓	-	✓	✓
Inclusion of all households in program	✓	-	-	✓
High level of public consultation and engagement	✓	✓	-	✓
Low household effort requirement	-	-	-	✓
High accessibility for multi-residential buildings	-	-	-	✓

When looking at all four of the case studies, the strategies that set Edmonton apart from the others is the low household effort requirement and the high multi-residential building accessibility. These are the defining features of the mixed waste composting program that lead to high diversion. Edmonton has been able to overcome the challenges of having a high-density population through these features. One of the downsides is that Edmonton's program does not encourage a culture of diversion and conservation. Studies have shown that there is a positive relationship between access to diversion programs and diversion intensity for each material category (Sterner and Barterling, 1999). For example, after the implementation of the Green Cart program in Hamilton, there was also an increase in Blue Bin recycling (City of Hamilton, 2007a). Elements common to most of the case studies are the existence of diversion goals (municipal and/or provincial), achievement of economies of scale, public consultation and engagement, and the inclusion of the IC&I sector.

Policy Options

In this section, I consider the policy options available to Canadian municipalities that are considering organic waste diversion as a significant component of a medium to high waste diversion goal. Waste management outcomes are a complex aggregation of policies, program choices, and demographics. I conduct my policy analysis by choosing policy tools that already exist in Canadian organics diversion programs, as provided by my municipal cases. While I model these options on the Canadian cases, they are broadly representative of the approaches used in the United States and Europe. The policy options include the status quo, a mixed waste composting system (based on the Edmonton model), a source separated composting system (based on Hamilton and Niagara), and a hybrid system (based on Halifax). I provide more detail on each of these options in the following sections.

5.3 Status Quo

The majority of Canadian cities rely on landfills as their primary waste management strategy. Landfills are becoming less viable due to land constraints, environmental concerns, and public opposition. Major cities such as Vancouver, Quebec City, London, Ottawa, and Montreal are actively exploring centralized composting. For some cities, it is because their landfills are reaching capacity or because public pressure has compelled them to introduce diversion goals. Other cities are unable to meet existing diversion goals and are looking to boost their diversion rate through organics. The status quo option assumes a mid-sized city that generally relies on its landfill but has some diversion programs such as backyard composting, single dwelling curbside recycling, and recycling depots.

5.4 Mixed Waste Composting Program

In this option, garbage is collected in its usual method and is delivered to a composting facility for intensive pre-processing and post-processing. Mixed waste composting can come in two forms: composting of the entire municipal waste stream or composting of the municipal waste stream with source separation of recyclables (Edmonton's method). Once the facility receives the garbage, it sorts and "cleans" the waste to yield a useable compost product and to recover marketable recyclables. The main strengths of this program are that it provides high accessibility to multi-residential dwellings and requires no additional effort for households. One of the drawbacks of this system is that there is a lower quality compost product due to higher levels of visible contaminants such as glass and plastic as well as higher levels of heavy metals. The Edmonton facility may also have reduced marketability of its compost product due to public distaste at the use of biosolids. However, it is able to produce compost that passes the compost guidelines for restricted use (Class B). This policy option, while primarily based on the Edmonton facility, is similar to mixed waste composting systems in Europe (most common in the United Kingdom and Germany).

5.5 Source Separated Composting Program

A source-separated program entails curbside pick-up of organics from bins or carts. This is a process similar to the blue bin system, which collects recyclables at the curb. Green bins are a form of waste source-separation, which has a higher percentage of recovery and a higher quality final product than mixed waste systems (FCM, 2004b).

Cities use green bins as the collection method for organics, but there is no uniform facility for the delivery and processing of the organics. Centralized composting facilities can come in different forms as described in Section 2.6. In brief, possible technologies include turned windrow composting, aerated static pile composting, enclosed channel composting, and in-vessel composting. Enclosed facilities tend to be more capital-intensive and have higher operating costs, but they tend to have a better track record on odour management (FCM, 2004b).

5.6 Hybrid: Source Separated and Mixed Waste Composting

The Halifax model is a combination of source separated composting through green bins and mixed waste composting. This model focuses on source separation as the main diversion activity and uses mixed waste processing as an additional treatment for garbage. Its mixed waste processing includes a front-end processing facility as well as a waste stabilization facility. These facilities capture the organics and recyclables that households do not source separate. Organics stabilize for 21 days in an in-vessel composting system. While this hybrid model increases the diversion potential and reaps the benefits of both composting approaches, it also has higher operating costs.

6: Criteria and Measures

6.1 Criteria and Measures

In this section, I describe the criteria relevant for evaluating the four policy options. I have summarized these criteria and measures in Table 6.1. I use my cases, the literature, and subjective evaluation from my research in order to assess each policy option according to the following criteria:

Table 6.1 Criteria and Measures used for Policy Analysis

Criteria		Measures
Effectiveness	Diversion Potential	Diversion achievements from the case study
	Environmental Impacts	Climate change indicators from research studies
Cost	Capital Costs	Costs per household from cases and from research in Canada
	Operating Costs	
Feasibility	Public Acceptability	Predicted public response from cases and subjective evaluation based on research

6.1.1 Effectiveness

6.1.1.1 Diversion Potential

I measure the effectiveness of the policy alternatives in terms of the diversion rates that they can achieve. The main reason a municipality embarks on an organics program is to increase their diversion rate. While municipalities usually consider diversion as the primary goal, higher diversion rates are associated with increasing costs and larger efforts by both the government and the public. There are inherent trade-offs in the effectiveness of the policies and the other criteria. Diversion potential is estimated using information from the cases.

6.1.1.2 Environmental Impacts

A second reason municipalities strive towards higher diversion rates is to decrease the environmental degradation caused by traditional waste management strategies (landfills). Because data on environmental effects in the specific cases is propriety, I use data from studies in other jurisdictions that consider the spectrum of environmental impacts resulting from different waste management technologies.

6.1.2 Cost

Cost is a fundamental criterion that cities consider when developing their waste management plans. I consider the capital and operating costs of each policy option. There is considerable variability in the costs that a mid-sized city can incur for each of the policy options Approximations of capital and operating costs as provided based on the cases and research from the Canadian Federation of Municipalities.

6.1.3 Feasibility

6.1.3.1 Public Acceptability

Governments must consider the reaction of the public in any major policy or program decision. Municipalities can influence public reaction to waste policies through consultations and outreach. In fact, some organic programs that require high levels of household cooperation and effort have also achieved high levels of public acceptance through strong engagement initiatives. The acceptability levels are relative to each other to highlight the marginal difficulties of the programs. An important consideration given to the ranking of acceptability is the level of effort required of households in the use of each organics program. Public acceptability is assessed using evidence from the cases as well as a subjective evaluation.

6.2 Policy Analysis

6.2.1 Diversion Potential

Generally, a city needs to have a comprehensive organics program in order to reach the 50% diversion goal (FCM, 2004a). An average city with a modest set of diversion programs will be unable to divert more than around 30%. An effective comparison is between Calgary and Edmonton. While these cities are similar, they have drastically different diversion rates: 20% for Calgary and 60% for Edmonton. While Edmonton has advanced diversion strategies, Calgary opted for a depot rather than curbside system, primarily to cut costs (Bowerman, 2005). Waste management decisions are often subject to path dependency. For example, since Calgary has chosen a depot system, an overhaul of the system is now required to transition to curbside services.

The status quo will have the lowest diversion potential of all the options, while mixed waste composting and a hybrid option will have the highest. A mixed waste system requires no additional effort from households while a hybrid system combines the best of both worlds: high capture rate from source separation, and a second screening process for materials in the waste stream. Opting for source separation on its own will achieve higher diversion than the status quo, but looking at the many cities and regional municipalities in Ontario that have adopted this system, it is clear that there are difficulties going beyond a 45% diversion rate. Based on the cases, the following is a ranking of diversion potential from most to least:

1. Hybrid OR Mixed Waste Composting
2. Source Separated Organics
3. Status Quo

6.2.2 Environmental Impacts

The waste hierarchy, as previously mentioned (Section 2.5), is a broadly accepted concept in waste management. It ranks waste management methods according to their desirability in terms of environmental impact. The hierarchy from least to most environmentally damaging goes as follows:

1. Reduce
2. Reuse
3. Recycle or Compost
4. Recover (Waste to Energy)
5. Landfill

While the hierarchy makes intuitive sense, researchers have also tested this empirically. Major research studies have examined waste technologies similar to those found in Canada. In this section, I review two such studies, one from the European Union and the other from the United States Environmental Protection Agency.

6.2.2.1 European Union

A major research report by the European Commission Environment Directorate General assesses the climate change impacts in terms of net fluxes of greenhouse gases from different municipal solid waste technologies (Smith et al., 2001). The study covers the fifteen member states of the European Union from 2000 to a projected 2020. The report uses a model with a thorough account of climate change impacts, both negative impacts as well as ameliorated impacts. The model does not include non-greenhouse gas impacts of waste management options or emissions from plant construction. The analysis is conducted on all steps of the waste process: mobilisation, process, disposal, and displaced emissions. The following aspects are included (Smith et. al., 2001, p.11-12):

- Direct emissions from waste treatment processes
- Energy used (and hence greenhouse gas emissions arising) in the treatment and disposal of waste including transport

- Energy (and emissions) saved from reduced production of feedstock when feedstock is replaced by recycled materials (including replacement of peat or fertiliser use by compost)
- Energy (and emissions) saved from avoided transport of raw feedstock to the factory when recycled materials are used
- Energy process savings through the use of recycled feedstock
- Energy generation emissions avoided through energy recovery
- An estimate of emissions saved through the storage of carbon in landfill sites or in the soil following the application of compost.

All composting options considered in the study (open-, closed-, home-, and anaerobic digestion- composting) yielded net negative greenhouse gas fluxes, meaning there were more positive environmental impacts than negative. Mechanical biological treatment (MBT) significantly reduces methane emissions from waste as compared to untreated waste. The model shows that MBT has a lower greenhouse gas flux than the European Union standard for landfills. Other benefits include, "more effective use of landfill void space, greater stabilisation of the waste, reducing the threat from leachate escape and the consequent reduction in environmental management costs at the landfill" (Smith et. al., 2001, p.36). There is also the value of recovered recyclables in the process. Overall, the study finds that source-separation of waste, followed by recycling or composting or anaerobic digestion offers the lowest net flux of greenhouse gases. It also points to the environmental superiority of MBT over landfills.

6.2.2.2 U.S. Environmental Protection Agency

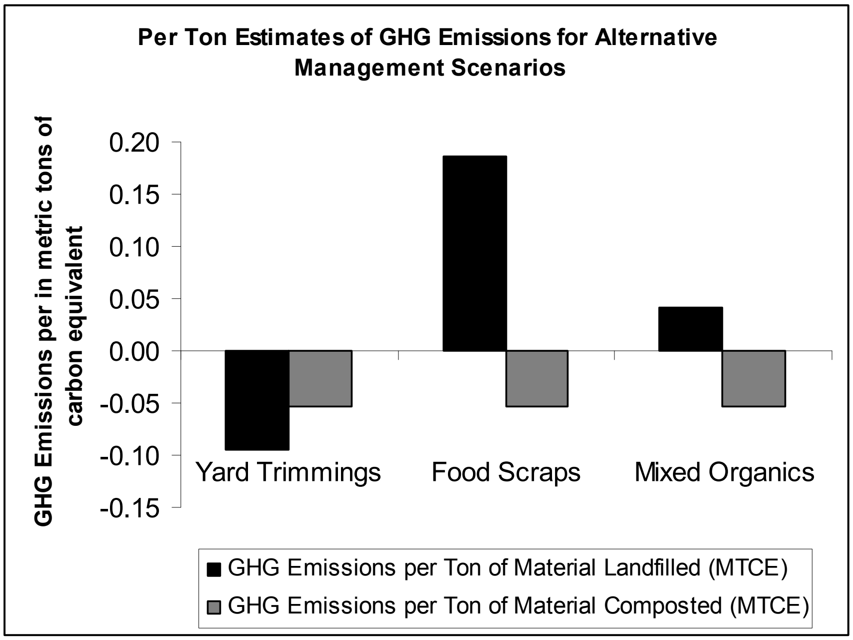
The U.S. Environmental Protection Agency has developed the Waste Reduction Model (WARM) to calculate the greenhouse gas (GHG) emissions from different waste management practices (U.S. Environmental Protection Agency, 2008). I have used the model to look at the comparison between composting and landfilling of yard waste, food scraps, and mixed organic waste. When given the option, I chose national averages for transportation distances as well as the national average level of emissions from landfills with gas recovery systems.

For composting, the model considers the increase in soil carbon storage (GHG sink), compost machinery emissions, and transportation emissions. For landfilling, the model considers, "baseline process and transportation emissions due to manufacture from the current mix of virgin and recycled inputs" as well as, "CH_4 emissions, long-term carbon storage, avoided utility emissions, and transportation emissions" (U.S. Environmental Protection Agency, 2008).

Figure 6.1 shows that both landfilling and composting have GHG emission reduction impacts for yard trimmings, a relatively stable material. When food scraps or mixed organics are considered, the model shows the contribution of landfills to GHG emissions as opposed to the carbon sink that composting provides for these materials. The waste reduction model shows the disparity between environmental impacts from landfilling and composting, especially for the most volatile material, food scraps.

Figure 6.1 US EPA Waste Reduction Model Estimates of GHG Emissions for Waste Management Scenarios in metric tons of carbon equivalent.

Adapted from: U.S. Environmental Protection Agency, 2008



6.2.2.3 Summary

These two major research studies support the waste hierarchy empirically. Landfilling is clearly the least environmentally friendly method, while source-separated composting is the best. The hybrid model uses both source separation and MBT processes. However, unlike Edmonton, Halifax relies predominantly on source separation for diversion and screens the remaining waste as a back-up method. Edmonton uses no source separation and the MBT process is therefore far more intensive than in Halifax. For these reasons, I have ranked the hybrid process as more environmentally friendly than the mixed waste composting due to the level of significance that each technology has. I have developed a more specific waste management hierarchy to rank my policy options based on their relative climate change impacts. I rank these options from best (#1) to worst (#4) as follows:

1. Source Separated Composting
2. Hybrid
3. Mixed Waste Composting
4. Landfill

6.2.3 Cost

Municipalities generally present their costs as price per tonne of waste. However, cities consider the cost of a waste system in terms of the general operational scheme (pickup frequency, number of workers, number of transfer stations, etc) rather than a set flow of waste (Favoino & Ricci, 2006). In order to evaluate the cost-competitiveness of each technology, I look at both capital and operating costs per capita in each of the case studies (see Table 6.2). Due to the instability of the Niagara program, the disruptions in service as well as construction of a new facility, I have excluded its costs from the comparison. Since Hamilton and Niagara both have a source-separated program, Hamilton is able to represent the approximations of the costs for this kind of program.

Table 6.2 Capital and Operating Costs of Case Study Diversion Programs

	Composting Capital Cost		**Waste Operating Cost**
Edmonton	$100 Million	$137/person	$202/person/year
Halifax	$50.5 Million	$135/person	$86/person/year
Hamilton	$52.7 Million	$104/person	$30/person/year

Edmonton's waste management system is overwhelmingly the most convenient for households. There is no additional effort necessary to separate organic waste as it is disposed of together with regular garbage. However, Edmonton residents pay the price for this convenience. A mixed waste system requires resource-intensive separation at the facility. The capital costs for the Edmonton facility is significantly higher than the other options. Due to Edmonton's large population, the cost per capita for the facility is equivalent to Halifax. If a city has external pressures such as a landfill reaching capacity or constraints of waste exporting, then the cost to maintain the status quo can be very high. Based on the cases, the approximate cost of siting a new landfill is $100 Million plus the costs of public consultation and managing public opposition to siting. In all the cases, an external pressure existed, which created a policy window to choose an alternative to landfilling. Some cities chose the alternative simply from an economic perspective due to the high costs of a new landfill. Since the status quo can have two scenarios depending on whether the city needs to find a new landfill, I have identified the capital costs of each option as low, medium, or high rather than ranking them:

- Status Quo - Mixed
    - External Pressures require a new landfill – High: $100 Million
    - No External pressures – Low: $0
- Source Separated Composting – Medium: $50 Million
- Hybrid: Source Separated and Mixed Waste Composting – Medium: $50 Million
- Mixed Waste Composting – High: $100 Million

According to the Federation of Canadian Municipalities (2004), the majority of comprehensive household organics collection programs, “operate at a net cost (collection and processing, less revenue from compost sold) that is higher than conventional collection and landfill disposal of waste” (p.185). The high net operating cost is one reason why these projects are not more common in North America and the UK. The Federation of Canadian Municipalities (2004) provides a rough estimate for collection and processing costs for garbage, source separated composting, and mixed waste composting, as shown in Tables 6.3 to 6.5.

Table 6.3 Collection Costs for Garbage and Organics

Adapted from: Federation of Canadian Municipalities, 2004

Collection Costs for Garbage and Organics	
Garbage Collection	**Source Separated Organics Collection**
$50/tonne $35/household	$80-100/tonne $20-25/household

Table 6.4 Processing Costs for Organics

Adapted from: Federation of Canadian Municipalities, 2004

Processing Costs for Composting Facilities		
In-Vessel	**Enclosed channel facilities**	**Open windrow composting**
$60-80/tonne	$45-60/tonne	$20-30/tonne
Source Separated Compost Processing Average: $10-20/household/year		

Table 6.5 Processing and Collection Costs for Organics

Adapted from: Federation of Canadian Municipalities, 2004

Total Cost Comparison of Composting Facilities – Collection and Processing	
Source Separated Composting **Mixed Waste Composting**	$30-45/household/year $70-120/household/year

These estimates show the following hierarchy in terms of collection and processing costs, from lowest to highest: 1) Garbage 2) Source Separated Composting 3) Mixed Waste Composting. By comparing these estimates to the case study costs, I can also conclude that the hybrid model is more expensive than source-separated composting and less expensive than a fully mixed waste composting system. In order to provide approximate operating costs, I use the FCM estimates since they cover more cities than my cases. I use the average operating cost within the range that they provide. For the hybrid model, I calculated the average of the range between a source-separated and mixed waste composting facility in order to provide a rough estimate. The ranking from least to highest operating cost is as follows:

1. Status Quo: $35/household
2. Source Separated Composting: $38/household
3. Hybrid: Source Separated and Mixed Waste Composting: $75/household
4. Mixed Waste Composting: $95/household

6.2.4 Public Acceptability

It is a large undertaking for a city to implement a comprehensive organic waste program. The support of the public is both beneficial and in some cases required in order for the program to succeed. All of the cities studied highlight the important role of public support in the outcome of their programs. Halifax and Hamilton both cited citizen engagement and pride as key to success. Even Edmonton has pointed to its consultation processes and community participation as instrumental to success, despite the system's ease of use and lack of burden on households. Niagara has decided to re-launch their program due to negative public reaction to the composting facility. This highlights a potential fatal flaw in all of the scenarios. All waste management facility siting (e.g. landfills, centralized composting, and incinerators) is replete with public scrutiny and requires strong consultation efforts to win public support.

As previously mentioned, a green bin system requires much higher levels of effort from households than a mixed waste system. The hybrid system includes source separation, which has an equivalent effort requirement from households as a standalone green bin system. Source separation requires complementing program tools such as material bans, pricing schemes, enforcement, and public education. While these tools are necessary to address compliance issues, they can elicit resistance from residents.

In 2008, the Region of Niagara held consultations to determine public support for activities aimed at increasing diversion (Regional Municipality of Niagara, 2008c). The region held 12 public open houses with feedback surveys and conducted 800 telephone surveys of its residents. As Table 6.6 shows, almost every respondent supported the 65% diversion goal, but were significantly less receptive to changes that facilitate high diversion levels (garbage container limits, bi-weekly garbage collection, and clear bags for garbage). The only activity that received high levels of support was an education campaign, which generally has a more limited impact on behaviour than other strategies. This illustrates the challenges of building public acceptance towards strategies used to achieve a diversion goal.

Table 6.6 Niagara Diversion Survey of Residents

Adapted from: Regional Municipality of Niagara, 2008c

Feedback	**Percent of Respondents Expressing Support**	
	Telephone Survey	**Feedback Survey**
65% Diversion Goal	94%	97%
Weekly garbage collection, 1 container limit	53%	58%
Every other week collection, 3 container limit	30%	42%
Every other week collection, 2 container limit	23%	33%
Test clear bag system	52%	53%
Increased education for diversion programs	92%	89%

Public acceptance for the status quo can vary greatly depending on the city's situation. In the four cases I looked at, the cities were partially motivated to adopt an organics program due to the public's rejection of or aversion to a new landfill, incinerator, or the exporting of waste. If a city is considering an organics program, this likely means there are some external pressures such as a landfill reaching capacity, complications from exporting waste, high tipping fees, or a provincial regulation for diversion. A city that has no external pressures and a landfill with a long life span will experience a different public reaction to its solid waste management decisions. There are two scenarios within the status quo as follows:

Table 6.7 Public Acceptability for Status Quo

Scenario	**Public Acceptability for Status Quo**
City A: External pressures to change diversion rate: NO Long term landfill capacity: HIGH	**High** This situation yields little appetite by residents to change the solid waste management strategy. Major changes in dealing with organic waste would be more expensive than the status quo. The only motivating factor for residents would be environmental, and this would not be enough for the majority of residents to want increased waste expenses.
City B: External pressures to change diversion rate: YES *OR* Long term landfill capacity: LOW	**Low** The viability of building new landfills is decreasing due to public perceptions of negative environmental impacts, odour and health concerns, and general NIMBYism. Landfill siting is very difficult whereas composting is generally looked upon more favourably.

6.2.5 Policy Matrix

The following policy matrix (Table 6.8) summarizes the policy analysis discussion. The matrix allows for a comparison of the tradeoffs in the criteria selected for each policy option. My policy analysis does not lead to a recommendation of a specific policy, as this would ignore the unique needs and constraints of a municipality. Rather, I have created a scenario analysis (Section 7), which considers the main goals and constraints experienced by a city wishing to undertake a comprehensive organics diversion program. The scenario analysis is in the form of a decision tree, which is part of a policy decision tool that uses information from my cases, literature, and policy analysis.

Table 6.8 Policy Matrix

		Policies			
Criteria	**Measure**	**Status Quo: Landfills and Minimal Diversion Programs**	**Mixed Waste Composting**	**Hybrid: Source Separated and Mixed Waste Composting**	**Source Separated Composting**
Effectiveness	Diversion Potential	**0-30%** An average city with landfill reliance and a few diversion programs (some recycling, backyard composting, etc) will have trouble going above 30% diversion.	**50-60%** A large diversion capture rate is possible due to the reliance on mechanical and biological separation as opposed to household effort.	**50-60%** A centralized composting system coupled with a small-scale MBT system brings the best of both systems (source separation and a second screening for waste)	**30-40%** A typical green bin program will yield a medium diversion rate. Cities can increase this rate through regulations, pricing schemes, and pick-up schedules.
	Environmental Impacts	**4 (Worst)** Landfills consistently rank lowest in environmental protection. Gas recovery can reduce the negative impact but it is still the worst environmentally.	**3** Mixed waste composting is superior to landfilling but has greater negative environmental impacts than source separation.	**2** Composting of source-separated waste is most environmentally friendly, but the addition of mixed waste composting reduces this rank.	**1 (Best)** Composting of source-separated waste is most environmentally friendly option for waste management of organics.
Cost	Capital Cost	**High**: New landfill: ~ $100 Million **Low**: No new landfill: ~ $0	**High** ~ $100 Million	**Medium** ~ $50 Million	**Medium** ~ $50 Million
	Annual Operating Cost	**1 (Lowest)** ~$35/household	**4 (Highest)** ~$95/household	**3** ~$75/household	**2** ~$38/household

Criteria	Measure	Status Quo: Landfills and Minimal Diversion Programs	Mixed Waste Composting	Hybrid: Source Separated and Mixed Waste Composting	Source Separated Composting
Feasibility	Public Acceptability	Mixed **High**: If the city has no external pressures to divert waste and has no constraints on their landfill's lifespan. **Low**: If the city needs a new landfill.	Mixed **High**: In terms of household effort **Low**: If high capital and operating costs are not distributed over a large enough tax base.	Mixed **High**: Generally seen as an environmentally sustainable system with moderate capital and operating costs. **Low**: In terms of household effort	Mixed **High**: Generally seen as an environmentally sustainable system with moderate capital and operating costs. **Low**: In terms of household effort

7: Scenario Analysis

Cities make solid waste management decisions within given constraints. Constraints can be political, demographic, financial, cultural, and environmental. To facilitate decision-making, I have made a decision-tree for cities contemplating an increase in waste diversion through an organics program. This decision tree takes into account the most important constraints, as have been identified through the literature, as well as through my examination of the Canadian municipal cases. The decision tree is a tool that municipalities can enhance and populate with more detail as fits their local needs. It provides a general guide for cities to explore their options. The following sections describe the factors included in the decision tree.

7.1 Density

Researchers have shown that density is one of the most important demographic variables to consider when evaluating diversion policies. Density is also the only variable that I identified as having a relationship with diversion on an aggregate level in my case study analysis. As previously discussed (see Section 3.5.1), density has an inverse relationship with diversion due to the challenges of diversion for multi-dwelling buildings, and the space constraints presented by a high density city.

This criterion is important because the policy options may rely on the municipal demographics to be successful. For example, if a city has chosen an organics program based on its diversion goal and financial resources, but it has not considered the local conditions, then it may be designing the program for failure. While cities can influence density, it is unlikely they will do so simply for the sake of a new waste management strategy. Given this, I consider density a locked physical constraint for a municipality and place it as the first option in the decision tree.

Defining measures of density, let alone deciding what constitutes “low” and “high” density cities, is subject to debate (FCM, 2005). Due to the lack of a common definition, for the purpose of this study, a high-density city is one with 500 people per square kilometre or greater, and a low-density city is one with less than 500 people per square kilometre. This serves as a rough guideline based on my cases for determining density requirements for an organics program.

7.2 Diversion Goal

In the nine original cases, all the municipalities identified diversion targets. The diversion goal is a reflection of the city’s desire to innovate, public support levels, and external constraints. A city may set a high diversion goal of fifty to sixty percent for a number of reasons:

- The province institutes a diversion goal with regulatory instruments to force municipal compliance (organics ban, organic program requirement, etc)
- The city is forced to increase diversion due to waste management constraints (landfill reaching capacity, increasing restrictions on waste exports, etc)

In other cases, cities may have less ambitious goals for diversion due to lack of resources, lack of public support, or lack of institutional capacity. I have defined a medium diversion goal as forty percent, which is above the national average (23%) but below the high end of the diversion spectrum (60%). Almost all of the Ontario cities that have adopted a basic green bin program have been able to reach this level. While it may be commendable for a city to make a high diversion goal, these commitments tend to be overly optimistic and often fall short of the goal by the adopted timeframe. I have included the medium diversion goal as a more realistic option for cities.

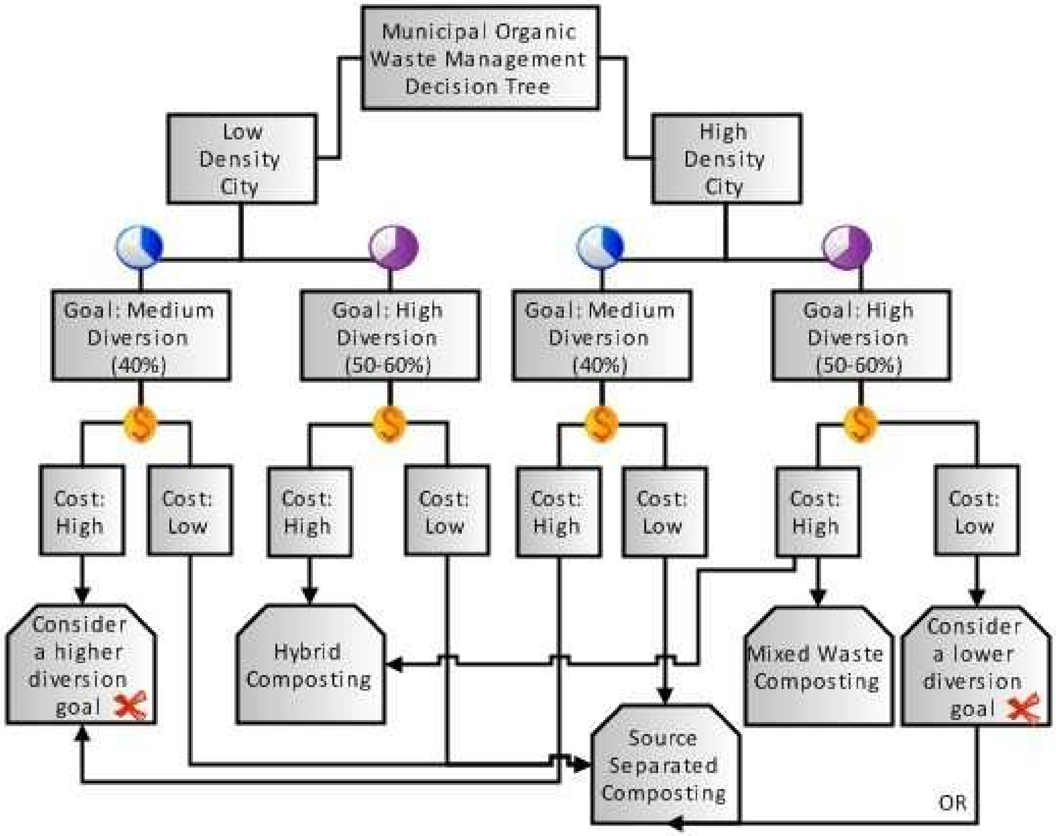
7.3 Cost

Despite high levels of motivation and commitment by both municipalities and its residents, cost is a heavy constraint on the possible policy options. In the decision tree, I have categorized these costs very roughly as “high” and “low”. A mixed waste facility such as the one in Edmonton, requires high capital costs (roughly $100 million), while a facility that processes source separated materials (such as Halifax and the Ontario cities) has much lower capital costs (roughly $50 million). The operating costs for a city relying on a mixed waste facility are much higher than one with a source separated program. However, the addition of policy tools such as strict enforcement, public education campaigns, and the subsidization of green bins can also add significantly to costs. The high/low distinction in the decision tree is a relative choice and refers to what the city has available and is willing to spend on the capital and operating needs of the organics program.

7.4 Organic Waste Management Decision Tree

This section presents the decision tree for comprehensive organic waste management (Figure 7.1). In order to explain how this decision tree works, I will go through the decision tree using Metro Vancouver, British Columbia as an example. Metro Vancouver is actively considering an organics program to increase their diversion rate. With a population density of 736 people per square kilometre in the Vancouver Census metropolitan area (Statistics Canada, 2007b), the area falls into the category of “high density”. The region has an aggressive diversion goal and is in the “high diversion” category (50-60%). While Metro Vancouver has expressed interest in an organics program, it is concurrently interested in the construction of waste-to-energy facilities, which the city estimates to cost between 1.1 and 1.7 billion dollars (Nenninger, 2008). This expense suggests little investment commitment to an organics program and I therefore categorize it as “low cost”.

Figure 7.1 Comprehensive Organic Waste Management Decision Tree



The first result of this decision tree for the Vancouver example is a re-consideration of the diversion goal. Since Vancouver collects leaf and yard waste, the introduction of a comprehensive organics program with low financial commitment will likely yield in little additional diversion. Vancouver may want to re-assess the projected diversion from this kind of program. If Vancouver decides to go ahead with an organics program, the most suitable choice would be a source-separated program with a low technology composting facility to reduce costs. Vancouver could supplement this with low-cost policies such as organics bans, bi-weekly garbage scheduling, clear garbage bags, and a stricter pricing scheme for garbage. While these options are low cost, their effectiveness decreases without enforcement (an additional cost). Alternatively, if Vancouver worked backwards in the decision tree, and if it wanted to have facilities such as the one in Halifax or Edmonton, then its financial commitment would need to be higher. In this scenario, Vancouver could maintain its diversion commitments but re-consider the decision to invest so heavily in waste-to-energy facilities.

The Vancouver example illustrates some of the considerations necessary in making decisions about an organics program. It also highlights the contradiction many cities experience between high diversion goals and low financial commitments. There are nuanced considerations a city must have prior to decisions on an organics program, but this decision tree provides preliminary guidance for a city to assess its expectations and outcomes.

A second example I will use as a guide through the decision tree is Abbotsford, British Columbia. This city has limited waste diversion programs. The main program available for organics is a leaf and yard waste depot system with fees associated with the volume of dropped-off materials. This city has a density of 345 people per square kilometre (Statistics Canada, 2007b) and is therefore "low density". Considering the nature of the city and the limited diversion programs in place, a moderate diversion goal of 40% would likely be reasonable. If the city was fully invested in an organics strategy and willing to commit substantial financing for it, then the city could re-consider a higher diversion goal. A more likely outcome would be a moderate investment in a source-separated composting system. To increase participation and diversion, the city could adopt the previously discussed strategies summarized in Table 7.1, which are applicable for any city considering a source-separated composting program.

Table 7.1 Strategies for a Successful Source-Separated Organics Program

Strategies for a successful source-separated composting program
Strengthening the regulatory framework
• Introducing a municipal ban on organics • Lobbying the province to introduce a provincial ban on organics • Adopting and committing finances to a clear enforcement strategy • Adopting a reasonable municipal diversion goal

Creating incentives for participation
• Requiring the use of clear garbage bags to identify transgressors • Adopting bi-weekly garbage pick-up • Instituting stricter garbage bag/container limits • Conducting consistent outreach and education
Increasing accessibility and convenience of the program
• Adopting strategies to target multi-residential dwellings and the IC&I sector • Distributing green bins to households and requiring no fee
General strategies for ensuring a successful program
• Running a pilot project and using broad public consultation • Careful facility siting to avoid odour issues • Striving for economies of scale (e.g. through regional partnerships, waste importing, acceptable materials expansion)

8: Further Considerations

In addition to the choice of waste technologies and diversion strategies, there are also some general lessons on managing an organics diversion program from the case studies in this report. In this final section, I explain the importance of developing economies of scale, an effective pilot project, careful siting of the facility, the use of data, and adapting to change.

"Economies of scale" is an economic term used to refer to a situation whereby the cost of producing an additional unit of output decreases as the volume of output increases. In waste management, cities can achieve economies of scale by collaborating with a neighbouring region for a larger facility, accepting waste materials from other jurisdictions, or expanding the types of materials accepted at the facility. Waste facilities are most efficient and cost effective when they run at capacity but municipalities do not always achieve this. Larger economies of scale lead to a more efficient system overall and give cities the ability to commit funds towards areas such as education and enforcement. All of the cities in the case studies used some method to achieve economies of scale. For centralized facilities:

> By pooling resources, several municipalities can capitalize on economies of scale. With the fixed costs for specific aspects of the design-build process, it makes more sense for smaller communities to commit to one large facility. By doing so, funds are available to ensure the facility has excellent odor controls, that expert staff are well-trained, and equipment produces a quality product. (Nicholson, 2008, p.2)

When designing an organics program, the use of pilot projects is important in identifying local characteristics and needs. All of the source-separated programs in this study used a pilot project in their initial phases. This process can take years to run, but it is essential in developing an organics program that will be both viable and acceptable to the public. Cities can make program decisions such as the use of green carts or bins, the use of a plastic or paper container liners, and route scheduling during this pilot process.

Cities must carefully choose the placement of a solid waste facility, whether it is a landfill, incinerator, or composting plant. Planners have to exercise even greater caution when they place such a facility near a residential area. As illustrated by Niagara, odour issues affecting residents can be a fatal flaw for an organics program.

Cities need to exercise caution in the data they use to compare their city to others as well as in maintaining high standards for measuring baselines and outcomes. While GAP will allow for better comparisons, data issues will continue to exist since municipalities only have information on the waste for which they are responsible. For example, municipalities will vary in terms of whether they cover small industries and the services sector. Municipalities may also lack information on onsite waste management as well as illegally dumped or burned waste. Another issue is the quality of the data that is collected. One way to examine the quality of municipal waste data collection would be the use of external data audits.

I situate this study within current technology and resource constraints. Waste management and diversion potential will change as these constraints adjust over time. For example, while waste-to-energy technology remains a contentious issue, with both strong opponents and proponents, there may come a time when the technology has improved to an extent where health and air quality impacts become negligible. Since public acceptance of technologies is a significant factor in the viability of new programs, contentious technologies may require a longer time span to reassure the public of positive or neutral long-term impacts. If waste-to-energy becomes a generally acceptable form of diversion, this could change the landscape of waste management in Canada.

Adaptation is also possible in the way that multi-residential dwellings handle diversion. As previously discussed, there are currently many challenges and barriers in achieving high rates of diversion from these dwellings; however, there is the potential for innovation to change this. Many cities in Canada, particularly in Ontario, are exploring ways of achieving high diversion rates in apartment buildings.

Given these and other possible changes, it is worthwhile for a city to consider the adaptability and commitment requirement of a given technology and facility. Source-separated centralized composting, using the most basic technology, is the least expensive and most amenable to change. As can be seen with the Niagara example, the city is able to re-launch the program and create a new facility without major setbacks. If Edmonton faces similar circumstances, adaptation would be far more difficult and the lost overhead would be substantial. Adaptability of the waste management plan can be an important consideration for a city, depending on its circumstances.

9: Conclusion

This study serves as a resource for mid-sized Canadian cities considering a comprehensive organic waste program. Through an in-depth description and analysis of four cities, I have presented the options, strategies, and risks in creating such a program. While I do not provide specific policy recommendations, I have generated a decision tree to both provide a general framework for cities and to illustrate an example of a model for waste management decision making.

A case study approach poses limitations on generalizability and data analysis capacity. While I have provided a qualitative assessment of the cases, the field would benefit from a quantitative approach. Further research could explore the reasons behind varying diversion rates through an aggregate model, allowing for more sophisticated data analysis such as regressions. This kind of a study would need to consider additional cities that do not have a comprehensive organic waste program, which would widen the scope of the research. Any future research within Canada will soon have the advantage of using standardized data from the GAP model. The GAP methodology will go a long way in allowing for an “apples to apples” comparison between cities that has been missing from waste management research. Research will also benefit from the trend in increasingly rigorous data collection techniques in the waste sector due to its rising prominence in managing climate change and environmental impacts.

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