Organic waste management in Manitoba, Canada: Barriers and opportunities to implement best-practices

By

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Abstract

Introduction

This thesis evaluates the waste management system in the province of Manitoba, Canada and other jurisdictions to identify best practices for, and barriers and opportunities to improving its impact on the environment. Multiple methods were used. First, a survey of expert stakeholders in the waste management sector in Manitoba was conducted, which was followed by an expert stakeholder meeting that further refined the results of the survey. All 102 communities in Manitoba with a population of at least 1,000 people were surveyed, achieving a census of data concerning residential tipping fees and organic waste management options for this population. Second, waste management systems of Manitoba, Canada, Nova Scotia, Canada, New South Wales, Australia, and Denmark were compared to determine which of the options already in use by other jurisdictions might be useful in Manitoba. Finally, an estimation of the amount of organic waste entering landfills in Manitoba was conducted, along with an estimation of the resulting methane emissions from landfills to determine their greenhouse gas emissions.

Census of communities and survey of expert stakeholders

The census of the communities with over 1000 people found that their weighted average tipping fee is approximately $38 per tonne. About 83% of the total population of the surveyed communities has access to some organic waste management options in 2010, but only the City of Winkler offered its residents the curb-side pickup of food waste, with Brandon implementing a pilot-project for the curb-side pickup of food waste

for 500 residents in July 2010. This means that less than one percent of the population in the surveyed communities had access to the curb-side pickup of food waste in 2010. This low rate of one percent is of concern since curb-side pickup is well documented to be far more effective at achieving waste diversion than any other voluntary option. An important finding from the analysis of tipping fees is that the majority of the waste generated in Manitoba is generated in the City of Winnipeg and the surrounding area; therefore, this area should, in the short term, be the focus for implementing waste diversion options.

The results of the survey and meeting of expert stakeholders indicated that the desire and knowledge among stakeholders exists for Manitoba to pursue a more sustainable waste management system. Indeed, the expert stakeholders were acutely aware of waste management options implemented by other jurisdictions and were eager to see many of those options implemented in Manitoba. The recommendations from the expert stakeholders included increased provincial government leadership in waste management, enhanced expert stakeholder involvement in decision-making, particularly regarding implementing programs in different regions of the province, developing regional cooperation to attain economies of scale, developing a provincial waste management strategy, implementing a landfill ban (e.g., for organic waste), and increasing landfill tipping fees. Interestingly, the expert stakeholders recommended options similar to those implemented by the Government of Nova Scotia.

Study of best-practices

An analysis was conducted of the effectiveness of the waste management systems in four jurisdictions: Manitoba, Canada; Nova Scotia, Canada; New South Wales, Australia; and Denmark. This comparison showed that Manitoba lags behind in terms of the sophistication of its waste management system. According to the waste management hierarchy, Manitoba is managing the vast majority of its waste in the least sustainable manner: that is, by landfilling it. The Government of Manitoba developed a waste management strategy in the early 1990s and set a target of 50% reduction in per capita waste disposal by the year 2000, but did not meet its goal, By 2006 Manitoba had reduced its per capita waste disposal by only about 13% and lagged behind most Canadian provinces in terms of its diversion of waste.

Some best practices in other jurisdictions that Manitoba can benefit from were identified. Nova Scotia split the province into several waste management regions, to achieve economies of scale in implementing waste management options, which would be beneficial in Manitoba with its low population density. For example, about 61% of the population of Manitoba lives in the Winnipeg Census Metropolitan Area, which could be a cost-effective waste management area. Second, all jurisdictions but Manitoba had an integrated waste management strategy and relevant waste diversion targets. Third, all the jurisdictions besides Manitoba maintained a cooperative approach to waste management among all levels of government, industry, and other stakeholders. Finally, other governments were able to raise the funds necessary to implement organic waste management options. Manitoba could do the same by imposing a new levy, like the beverage container levy that already exists, and use the funds generated by that levy to

pay for new waste management options, like large-scale, centralized composting facilities. In addition, the landfill levy could be increased over time to both encourage waste diversion and provide extra funds for diversion activities.

Organic waste and greenhouse gas emissions

The estimates of the amount of organic waste entering landfills and the methane emissions being emitted from landfills in Manitoba show that about two-thirds of the waste that is disposed of at landfills in Manitoba is organic waste and that Manitobans are contributing more per capita toward the generation of greenhouse gas emissions from waste management on land than the average Canadian. Since the decomposition of organic waste leads to the release of greenhouse gases from landfills, targeting organic waste for diversion would lead to a greater overall waste diversion rate and lower greenhouse gas emissions. Therefore, organic waste management options should be improved throughout Manitoba.

Opportunities and barriers

The following barriers and opportunities have been identified from the results of this study.

Issue No.	Barrier	Opportunity
1	Government of Canada lacks an integrated waste management strategy, which is unlike Australia and Denmark.	Nova Scotia has demonstrated that implementing a successful integrated waste management strategy in Canada is possible. The Canadian Council of Ministers of the Environment (CCME) also provides a forum for discussion among provinces concerning how to implement an integrated strategy.
2	Government of Manitoba lacks an integrated solid waste management strategy, unlike Nova Scotia, New South Wales, and Denmark.	Support for the development of an integrated waste management strategy exists, as demonstrated in Chapter 4. Nova Scotia presents an excellent example of how a strategy of this sort should be implemented. An integrated strategy is likely necessary if Manitoba is to realize significant waste diversion.

3	Lack of political will to implement an integrated waste management strategy or a more sophisticated organic waste management system.	The Government of Manitoba has legislated the target of meeting the Kyoto goal of 6% below 1990 levels by 2012. Ten percent of the difference between 2008 emissions and the Kyoto goal could be reduced through composting food, yard, and garden waste in Manitoba.
4	Manitoba lacks a formal system of regional cooperation.	Many municipalities in Manitoba collaborate to the extent that they share landfills. However, Chapter 2 identified waste management collaboration as difficult in Manitoba. The Government of Manitoba can build on regional cooperation by encouraging this cooperation and providing technical assistance to achieve greater economies of scale. The Government of Manitoba could also commission studies to determine the most cost-effective regional boundaries for cooperation.
5	Manitoba is a large province in terms of land area and has a low population density.	About 90% of Manitobans live within 200 km of the border, which is an area about 15% of the total land area in Manitoba. Also, about 60% of Manitobans live in Winnipeg's Capital Region. An integrated strategy could begin by focusing on waste management improvements in Winnipeg's Capital Region, since options in this area would make the most economic sense (due to the high population density).
6	Northern and remote communities cannot support programs that more densely populated communities can support.	By establishing waste regions, local characteristics come into play when determining how best to achieve waste diversion targets in those area. An integrated waste management strategy should allow northern and remote communities to implement unique waste management options, while having the technical support of the Government of Manitoba.
7	The public perception that Manitoba is so large that waste management options are unnecessary; lack of public support for waste management options.	By connecting waste management with climate change, public perception of waste may change over time. Chapter 6 demonstrated the extent to which waste management in Manitoba affects Manitoba's greenhouse gas emissions. In addition, Manitobans have been diverting recyclable waste for about 15 years, which suggests an acceptance of waste diversion activities.
8	The methane being release from landfills is from the decomposition of historic waste; organic waste diversion options will not stop these emissions.	The Brandon landfill will soon be flaring methane emitted from the landfill. This may prompt Winnipeg's Brady Road Landfill to flare its methane or, if feasible, collect the methane to be used to offset the use of natural gas. Brady Road Landfill is a huge point source of greenhouse gas emissions in Manitoba: this is motivation for the Government of Manitoba to implement landfill gas capture.
9	The huge number of landfills in Manitoba is a problem for achieving economies of scale, encouraging waste diversion, and environmental monitoring.	In reality, although more than 200 landfills are operational in Manitoba, the vast majority of waste produced by Manitobans ends up in one of the province's twelve Class 1 landfills (e.g., about 60% of Manitoba's waste goes to Winnipeg's Brady Road Landfill). In addition, in 2007, the Manitoba Auditor General provided recommendation on landfill permitting and operations concerning how to ensure environmental protection.
10	Most Manitobans have not source separated food waste before; voluntary drop-off programs have not proven to be successful.	Chapter 4 demonstrated that organic waste management options exist throughout Manitoba. These options should be built upon to educate Manitobans concerning the significance of organic waste. In addition, most Manitobans are already familiar with the Blue Box system for recyclables; therefore, getting people to separate organic waste into a "Green Box" may not be overly difficult.

11	The cost of operating a centralized composting facility is high: $30-$77 per tonne. In addition, the cost of picking up organic waste (three-steam system) was $6 more than a two-stream system (in 2002).	The levy system in Nova Scotia that funds waste management activities in the province is about 2.5 times greater than Manitoba's levy. Therefore, Manitoba would be justified in creating additional levies that could finance organic waste management options. In addition, the WRARS landfill levy could increase over time (currently at $10 per tonne) to pay for organic waste management options.
12	The usefulness of compost is not realized without standards for its production.	The CCME has a guide for the production of compost that the Government of Manitoba could use as a guideline for a compost quality regulation.
13	Residential waste accounts for only about 40% of the total waste stream in Manitoba.	Blue bin recycling for residents has existed for about 15 years. The success of this program suggests that the commercial, industrial, and institutional and construction and demolition sectors may be amenable to complying with waste diversion initiatives.
14	The commercial, industrial, and institutional and construction and demolition sectors may provide resistance to source separating its waste.	The implementation of scheduled landfill bans (and fines for non-compliance) after a certain amount of time has passed since the program was implemented, would give this sector time to adapt.
15	The City of Winnipeg recently decided that its organic waste management strategy will be to use an automated cart collection system to collect bagged yard waste in the North-West part of the city during the peak spring and fall period.	This is a step in the right direction. Extra funding (from increasing the levy on beverage containers or the landfill levy) from the Government of Manitoba or regulations, including a landfill ban on organics, might convince Winnipeg's City Council to implement a more sophisticated strategy, which could include the curb-side pickup of food waste for the entire city.

Recommendations

The following recommendations for Manitoba's waste management sector have been produced:

No.	Recommendation	Justification
1	Implement landfill gas capture at the Brady Road Landfill and other large landfills.	In 2008, the Brady Road Landfill was the third largest point source of GHG emissions in the province of Manitoba. Landfill gas, which is about 50% methane, can be captured and sold to displace the use of natural gas.
2	Develop waste management options in Winnipeg's Census Metropolitan Area (CMA), Brandon, and other large urban centres.	In 2009, nearly 61% of Manitoba's population resided in the CMA, which is the most densely populated area of the province. Implementing new waste management options in the CMA "picks the low-hanging fruit": new options would be most cost-effective in this area, but also reach a significant portion of Manitoba's population and act as a first step to implementing options in other areas of the province. Other large urban centres, like Brandon, would also benefit from the development of waste management options.

3	Create a publicly accessible waste management strategy.	The general public and businesses need to be aware of the implementation of new waste management options that will require them to change their behaviour. A publicly accessible strategy will indicate the schedule for the implementation of such options and offer advice to the public and businesses concerning how to adapt to these changes.
4	Public education, communication, and consultations are required.	On-going public education, communication, and consultations are required to keep the public informed concerning changes to the waste management system. The public should be made aware of a timeline for the implementation of new waste management options and strategies.
5	A portion of the WRARS landfill levy should be used to pay for new waste management options. In addition, scheduled increases to the levy should occur over time to encourage waste diversion and pay for new waste management options.	Manitoba's low landfill tipping fees can act as a barrier to implementing new waste management options, especially for large-scale, centralized composting, which can have tipping fees nearly twice as high as the tipping fee at the Brady Road Landfill and higher than many other landfills in Manitoba. Implementing scheduled increases in the landfill levy would allow residents and businesses to adapt to these new fees and provide the funds necessary to implement more expensive organic waste management options.
6	Create regulation for compost quality control.	The product produced by composting organic waste is called "compost". Compost can be sold as a soil conditioner and, to some extent, replace the use of synthetic fertilizers and pesticides. To increase consumer confidence in the quality of this product, a regulation concerning the production process and final product should be implemented.
7	Construct large-scale, centralized composting facilities.	Easily compostable organic waste (food, yard, and garden waste) constitutes about 35% of the total waste stream in Manitoba. To increase Manitoba's waste diversion rate, organic waste should be targeted for diversion. A large-scale composting facility would be necessary to manage organic waste from the CMA and other large urban centres.
8	Implement the curb-side pickup of food, yard, and garden waste from the residential sector in the CMA, Brandon, and other large urban centres.	The residential sector in the CMA and Brandon have been source-separating their waste for about 15 years (Blue Box program); therefore, the residential sector would be the most amenable to the source-separation of organic waste.
9	Implement the curb-side pickup of food, yard, and garden waste from the commercial sector in the CMA, Brandon, and other large urban centres.	The commercial sector will not be as familiar with source-separation as the residential sector; therefore, more time should be given to this sector to adapt to this change.
10	Implement landfill ban on organic waste in the CMA and other urban centres, with fees for non-compliance.	To achieve high levels of organic waste diversion, a ban on organic waste from landfills is likely required. This ban, however, should be implemented in a manner that allows residents and businesses time to adapt to this change.

Conclusion

This study has attempted to demonstrate the barriers and opportunities to improving Manitoba's waste management system. Although much change has been

identified as needed, Manitoba is in an excellent position to amend its waste management sector in a cost-effective manner and to increase its overall diversion rate, while decreasing its greenhouse gas emissions from waste management.

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C&D	Construction and Demolition
CAO	Chief Administrative Officer
CCME	Canadian Council of Ministers of the Environment
CEPA Act	*Canadian Environmental Protection Act*
CMA	Census Metropolitan Area
CO_2e	Carbon Dioxide Equivalent
DECCW	Department of Environment, Climate Change, and Water
DEWHA	Department of the Environment, Water, Heritage, and the Arts
EPR	Extended Producer Responsibility
ERA	Extended Regulated Area
EU	European Union
FCM	Federation of Canadian Municipalities
GDP	Gross Domestic Product
GHG	Greenhouse Gas
HHM	Household Hazardous Waste
ICI	Industrial, Commercial, and Institutional
IPCC	Intergovernmental Panel on Climate Change
LCA	Life Cycle Assessment
MARRC	Manitoba Association for Resource Recovery Corporation
MEST	Manitoba Energy, Science and Technology
MMSM	Multi-Material Stewardship Manitoba
MPSC	Manitoba Product Stewardship Corporation
MSTEM	Manitoba Science, Technology, Energy and Mines
MSW	Municipal Solid Waste
NEPC	National Environmental Protection Council
NRA	Non-Regulated Area
NSESD	National Strategy for Ecologically Sustainable Development
NSW	New South Wales
OAG	Office of the Auditor General
PEO	Parliamentary Education Office
POEO Act	*Protection of the Environment Operations Act*
RAC	Recycling Action Committee
RRFB	Resource Recovery Fund Board
SMA	Sydney Metropolitan Area
TNS	The Natural Step
US EPA	United States Environmental Protection Agency
WARR Act	*Waste Avoidance and Resource Recovery Act*
WEI	Wardrop Engineering Inc.
WRAP Act	*Waste Reduction and Prevention Act*
WRAPP	Waste Reduction and Pollution Prevention
WRARS	Waste Reduction and Recycling Support

CHAPTER 1: INTRODUCTION

1.0 Background

Sustainability is a development path that merges the needs of the social, economic, and environmental spheres in order to maximize human well-being within and between generations (Sathaye et al. 2007; Folke et al. 2002; Anand and Sen 2000; Division for Sustainable Development n.d.). The practical application of this process has changed over the years to incorporate new insights into its meaning (Sathaye et al. 2007), including the additions of intergenerational equity, the precautionary principle, and a more just distribution of wealth (Barrieu and Sinclair-Desgagné 2006; Gollier, Jullien, and Treich 2000; Anand and Sen 2000; Bishop 1993). Sustainability is an over-arching policy-making framework that can not only lead humanity away from the current environmental crisis, but, importantly, can do so while resolving social and economic injustice. Therefore, while the environmental crisis is without a doubt critical, we must remember to temper our mitigation policies with considerations of social and economic concerns.

For some time now, environmental issues have been at the forefront of much debate among policy-makers and much conversation within the Canadian media and by the general population. With the Kyoto Protocol largely failing to have much, if any, affect on Canadian policies, post-Kyoto strategies are emerging that will hopefully bring about more sustainable practices; however, it should be mentioned that Manitoba is the first jurisdiction in North America to legislate a greenhouse gas emissions target of 6% below 1990 by 2012, which is the Kyoto Protocol's target (Manitoba Science, Technology, Energy and Mines 2008). While the conversation concerning the current

environmental crisis is largely centered on greenhouse gas emissions resulting from the combustion of fossil fuels and their influence on climate change, there are other important environmental problems facing Canadians today.

Waste management, for instance, not only produces about 3% of Canada's total greenhouse gas emissions, it also faces several challenges, including declining landfill space, rising waste disposal fees, leachate entering ground and surface water, and health issues caused by the release of landfill gases and the contamination of drinking water. Although the waste management sector accounts for a small proportion of Canada's total greenhouse gas emissions, this should not be a reason to ignore the issues related to the disposal of waste. It is widely accepted that multiple strategies, and not a single, focused strategy, will bring about real decreases in greenhouse gas emissions and sustainable practices that will be good for the environment and human health, in general (Ackerman 2000).

Much can be done to improve the ways that waste is disposed of in Canada. Although many districts have adopted recycling strategies, there are only a few places in Canada that encourage and support the diversion of organic waste from landfills (Thompson et al. 2006). Prince Edward Island and Nova Scotia are the only provinces in Canada in which a province-wide ban on organics entering landfills exists (Friesen 2000; Thompson et al. 2006). Since the decomposition of organic matter in landfills typically occurs under anaerobic conditions, landfill gas, consisting mainly of methane, is released into the atmosphere (Ackerman 2000). On the other hand, when organic materials are composted and allowed to decompose under aerobic conditions or when landfill gas is captured for energy or burned off, carbon dioxide is the main byproduct (Mohareb,

Warith, and Narbaitz 2004). The production of carbon dioxide is much preferred to the production of methane because methane has a global warming potential of about 25 times that of carbon dioxide over a 100-year time horizon (Forster et al 2007). With organic waste being a prominent component of municipal solid waste, with food/kitchen and yard waste accounting for about 40% of the residential waste stream alone (Statistics Canada 2005a), it is clear that much can be done to decrease the greenhouse gas emissions resulting from the waste management sector by implementing or improving diversion techniques.

Diverting organic waste from landfills also has other positive side-effects. Decreasing the amount of waste going to landfills allows landfills to operate for longer periods of time, which decreases the cost to society of constructing new landfills (Otten 2001). Leachate is also less of an issue when organic waste is diverted from landfills, decreasing the chances of human illness from the consumption of contaminated ground or surface water (Otten 2001). Diverting organic waste from landfills may also decrease landfill operation costs, since removing organic waste from the waste stream results in a relatively inert waste stream entering landfills that requires less daily cover, less equipment and labour during operations, and less monitoring after landfill closure (Otten 2001). Composting organic waste also constitutes a shift toward sustainable development, since compost, the product of composting, can be used as an organic fertilizer or soil conditioner that adds nutrients to soil and increases soil's organic matter (carbon) content and its water holding capacity (Bogner et al. 2007). Finally, since organic waste represents such a large portion of the waste stream that ends up in landfill, composting organic waste is an effective way by which to extend landfill life and prolong the need to

site a new landfill. Therefore, diverting organic waste from landfills not only benefits the environment in terms of climate change, but also directly benefits humans through savings in disposal fees and a decrease in illnesses due to leachate.

1.2 Problem statement

The purpose of this thesis is three-fold: first, this thesis will determine expert stakeholder opinions of the waste management sector in Manitoba; second, this thesis will present data on the waste management policies of Manitoba, Canada and compare it with the those of Nova Scotia, Canada, New South Wales, Australia, and Denmark; finally, this thesis will estimate the amount of organic waste entering, and the amount of methane emissions released from, landfills in Manitoba.

1.3 Objectives

The objectives of this thesis were as follows:

1) Ascertain expert stakeholder opinions of the waste management sector in Manitoba, specifically concerning organic waste management;
2) Examine best practices for the management of waste in other jurisdictions; and
3) Determine the amount of organic waste entering, and the greenhouse gases (methane) that are released from, landfills in Manitoba.

1.4 Significance

This thesis presents the opinions of expert stakeholders concerning Manitoba's waste management system. However, the opinions gathered in this study represent those

of waste management experts; therefore, the perspectives gathered in this study may not be representative of the Manitoban public, in general. This thesis provides a description of the waste management systems in other jurisdictions and compares these systems with the system that exists in Manitoba. In addition, this thesis estimates the quantity of organic waste entering, and the amount of methane released from, landfills in Manitoba. The opinions of expert stakeholders, coupled with the research of other jurisdictions and the estimates of the amount of organic waste entering landfills and the amount of methane released from landfills in Manitoba, altogether provide an excellent justification for policy-makers to improve Manitoba's waste management system: specifically, by employing organic waste management options. Finally, this thesis provides barriers and opportunities to change in the waste management sector and recommendations to policy-makers with respect to how the waste management sector in Manitoba should evolve.

1.5 Thesis layout

This thesis consists of seven chapters, plus appendices. Chapter 1 is an introduction to waste management and this thesis project, including its problem statement, objectives, and methods. Chapter 2 consists of a literature review and stands as a justification for action within the waste management sector to implement best-options. The third chapter explains the objectives, method, and data collection and analysis techniques of this thesis proposal in greater detail. Chapter 4 presents the findings of the survey and meeting of expert stakeholders. Chapter 5 illustrates the waste management systems in Manitoba, Canada, Nova Scotia, Canada, New South Wales, Australia, and Denmark. Chapter 6 provides an estimation of the quantity of organic waste entering, and

the amount of methane released from, landfills in Manitoba. Finally, Chapter 7 documents the conclusion of the thesis and is followed by the Appendices.

CHAPTER 2: ORGANIC WASTE MANAGEMENT IN A GLOBAL CONTEXT

2.0 Sustainable development

Sustainable development is widely regarded as the integration of social, environmental, and economic consideration in the creation of policy and programs at all levels of government (Sathaye et al. 2007; Folke et al. 2002; Division for Sustainable Development n.d.) to achieve "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987). However, allowing future generations to meet their own needs does not imply that the needs of the less privileged today are neglected (Anand and Sen 2000). Therefore, sustainable development can be seen as a sort of ethical universalism, as both endeavor to bring impartiality within and between generations of humanity (Anand and Sen 2000).

In practice, this comprehensive approach to development has only recently been used to take into consideration social, political, and cultural aspects of development (Sathaye et al. 2007). Indeed, since its First Assessment Report, the Intergovernmental Panel on Climate Change (IPCC) has dramatically changed its view of "sustainable development": this concept has evolved from a focus on simply the technology and cost-effectiveness of climate change mitigation activities to analyses of efficiency and cost-effectiveness on global and regional scales, equity, and societal learning (Sathaye et al. 2007).

At its core, sustainable development recognizes that the human and environmental spheres are intrinsically and intricately linked (Folke et al. 2002): the prosperity of humanity hinges on the prosperity of the environment, while the environment, in its

current state, is desperately dependent on human activity. The natural environment provides humans with essential ecosystems services, such as clean air and water, food production, etc., and humanity can transform the natural environment into conditions that are better or worse providers of these services (Folke et al. 2002). The Natural Step, a non-profit organization founded on the ideals of sustainable development, acknowledges that sustainability is development that is advantageous to humans and ecosystems, alike.

According to The Natural Step (TNS), there are four principles of sustainable development to which our society must hold to become sustainable. First, our society must "eliminate [its] contribution to the progressive buildup of substances extracted from the Earth's crust (for example, heavy metals and fossil fuels)" (TNS n.d.). Second, our society must "eliminate [its] contribution to the progressive buildup of chemicals and compounds produced by society (for example, dioxins, PCBs, and DDT)" (TNS n.d.). Next, our society must "eliminate [its] contribution to the progressive physical degradation and destruction of nature and natural processes (for example, over harvesting forests and paving over critical wildlife habitat)" (TNS n.d.). Finally, our society must "eliminate [its] contribution to conditions that undermine people's capacity to meet their basic human needs (for example, unsafe working conditions and not enough to pay to live on)" (TNS n.d.). These principles are not meant to imply that a sustainable society cannot extract materials from the earth, produce material goods, or modify the natural environment; rather, the application of these principles is meant to prevent a continual buildup of substances that will permanently and irreversibly damage natural processes on which humanity depends for its survival (TNS n.d.). In addition, TNS recognizes that human needs are more than merely materials needs: based on the fundamental human

needs established by Chilean economist Manfred Max-Neef, these needs are subsistence, protection, affection, understanding, participation, leisure, creation, identity, and freedom (TNS n.d.).

Like in any sector, the practices in the waste management sector can be said to be either sustainable or not. For instance, in principle, the disposal of waste in landfills is an unsustainable practice: since there is only a limited amount of space to landfill waste on earth, at some point in the future landfill space will diminish to a point such that people will not be able to meet their waste disposal needs. This is saying nothing of the serious landfill gas and leachate issues that would likely arise in the meantime if not properly dealt with. In terms of organic waste management, the IPCC suggest that composting organic waste is a sustainable option (Bogner et al. 2007). Thus, like every other sector, the waste management sector is amenable to sustainable development.

'Sustainable development' need not refer to an all-or-nothing approach to governance: that is, it need not demand the immediate implementation of practices that can be sustained indefinitely. Rather, 'sustainable development' can refer to the gradual movement or shift in practices toward sustainable ones (Sathaye et al. 2007). For instance, from a human health, environmental, and/or economic perspective, landfilling waste is better than leaving it on the street to rot, having a leachate collection system at a landfill is better than not having one, composting organic waste at the household level is better than landfilling it, and capturing landfill gas is sometimes better than allowing it to seep into the atmosphere. However, the waste management practices that are ultimately chosen in a particular locality will likely depend on local conditions, such as available capital. This does not mean that there is not a "best" option for every locality; this simply

means that options are often limited largely due to social circumstances (Sathaye et al. 2007). The following sections will further outline the economic, social, and environmental considerations of sustainable development with a focus on the waste management sector. First, however, it should be noted that these aspects of sustainable development, namely, economic, social, and environmental concerns, are so inter-related that overlap in these sections is impossible to avoid.

2.1 The economics of sustainable development

Economic growth is typically associated with growing greenhouse gas emissions; but, why economic growth causes this to happen is not clear (Sathaye et al. 2007). While it is self-evident that a growing economy will demand more energy and produce more goods, it also seems obvious that an expanding economy will cause technological advances to occur that will improve efficiency and cause a shift in social conscience toward environmental protection (Sathaye et al. 2007). These seemingly contradictory assumptions suggest that there are multiple paths to sustainable development: some that are more, and others that are less, environmentally damaging (Sathaye et al. 2007). But, what is slowly becoming clear in the literature is that economic growth, alone, will probably not solve the environmental problems that persist today (Sathaye et al. 2007).

2.1.1 The cost of waste management

The cost of an action is necessarily taken into account in the policy-making process. What can *theoretically* be done is almost always different than what *is* done, particularly in developing nations where there is little available capital. However, capital

costs are not the only costs that are at issue when it comes to waste management. Human illness can result from a variety of waste disposal options and must be factored in as a cost to society. As well, environmental and human costs arise from leachate runoff, generated by the decomposition of organic waste, entering the ground or surface water. Therefore, sustainable development demands better waste management because it can improve health, increase resource productivity, and produce better living conditions (Sathaye et al. 2007). For instance, useful resources, in the form of compost or landfill gas, can be derived from the decomposition of organic matter under the right conditions. As well, direct economic benefits arise from improving waste management in the form of increased property value due to better living conditions (Sathaye et al. 2007).

There are times, however, when social and environmental pressures nullify the natural economic outlook. For example, the tipping fee at the largest landfill in Manitoba, the Brady Road Landfill, is $43.50 per tonne of waste (City of Winnipeg 2009). The tipping fee at the Vancouver Landfill and the Vancouver South Transfer Station is $71 per tonne of garbage and $56 per tonne of yard trimming (City of Vancouver 2009). Since the tipping fee at the Vancouver Landfill is much higher than the tipping fee at the Brady Road Landfill, there is a greater economic incentive to compost and recycle to avoid paying the higher fees in the Vancouver area. The effect of this incentive is made evident when the waste diversion rates of these provinces are compared: in 2006, Manitoba had a diversion rate of 13%, while British Columbia had a diversion rate of 31.9% (Statistics Canada 2008b). Without a doubt, tipping fees are not the only reason why Manitoba has a lower waste diversion rate than British Columbia, but a case can be made that it is certainly one of the reasons. In fact, the importance of tipping fees in

increasing waste diversion has been recognized by the Government of Manitoba, since a levy on waste recently came into effect in Manitoba (Green Manitoba n.d.b). However, often for governments to act in this way, that is, to encourage the development of more expensive means of waste disposal, social support and environmental pressures need to exist. A lack of significant social or environmental pressure may act as a barrier to implementing more sustainable practices.

2.1.2 The economic benefits and costs of compost from organic waste

Without a doubt, solid waste is a resource with a value (Beede and Bloom 1995). However, there is some doubt whether solid waste can be economically transformed into a valuable resource, like compost (Beede and Bloom 1995; Braber 1995). There are three components to the management of municipal solid waste (MSW), namely, 1) collection and transport, 2) processing, and 3) disposal (Beede and Bloom 1995). The purpose of collection and transport and disposal are self-explanatory; however, the purpose of processing requires further clarification. The purpose of processing MSW is to change waste, through recycling, composting, burning, compacting, etc, to reduce its threat to human health and the environment, make it more disposable, or capture some of its value (Beede and Bloom 1995). Whether the value of waste can be captured in an economically feasible manner will often depend on local circumstances, like the cost of labour, equipment, energy, and land (Beede and Bloom 1995). Unfortunately, the true value of waste is typically underestimated, since quantifying the value of improved human health or environmental quality is difficult (Beede and Bloom 1995).

According to Braber (1995) it is probably impossible to draw general conclusions regarding the economics of organic waste management options, although many authors have attempted to do so. Chynoweth et al. (1992) propose that, for the organic fraction of MSW, anaerobic digestion is better than aerobic composting because aerobic composting requires aeration or mixing and anaerobic digestion produces a valuable fuel gas, in addition to compost. Braber (1995) found that the anaerobic digestion of the organic fraction of MSW is slightly more expensive than aerobic composting. In Indonesia, Aye and Widjaya (2006) estimate that composting in a centralized facility (CPC) is more cost-effective and environmentally friendly than composting in small, labour intensive local facilities (CPL), producing biogas and compost simultaneously (BGP), engineering landfills for landfill gas capture to produce electricity (LFE), and business as usual (open dumping). Specifically, Aye and Widjaya (2006) found that the benefit-cost ratios for CPC, CPL, BGP, and LFE were 2.2, 1.4, 1.3, and 1.03, respectively. Renkow and Rubin (1998) found from a survey of MSW composting facilities that their operating costs are generally around $50 per ton and that the majority of facilities receive no revenue from their compost. In general, Renkow and Rubin (1998) found that composting is not economically justifiable in the United States, even when prolonged landfill life due to composting and compost sales are taken into account; according to Braber (1995), however, producing compost from MSW is considered commercially viable, in general. Clearly, disagreement exists over the economic viability of composting organic waste.

There are benefits to composting, and using compost; however, these are difficult to quantify. Many farmers, in particular vegetables farmers, use compost to augment soil fertility and quality in order to sustain productivity (Abbasi et al., 2002). Pinamonti

(1998) found that the application of compost improved soil permeability and water storage, while reducing evaporation. Pinamonti (1998) also found that the application of compost reduced weed growth and thereby resulted in the decreased use of herbicides. Compost can improve the physical, chemical, and biological qualities of soil (Pinamonti 1998; Abassi et al. 2002), while providing some control of diseases caused by soil-borne plant pathogens (Abassi et al. 2002). Compost may also be effective at reducing the severity of foliar plant pathogens and improving plant resistance to root and foliar pathogens (Abassi et al. 2002). Compost has been found to improve water drainage and retention in soils and release nutrients at rates appropriate for effective plant uptake (Abassi et al. 2002). Abassi et al. (2002) conclude that compost can reduce economic losses to organic tomato farmers, since the use of compost can increase the health of plants and result in greater productivity. Nevens and Reheul (2003) found that using vegetable, fruit, and garden waste compost, in addition to cattle slurry, significantly reduced the amount of Nitrogen fertilizer that was needed in farm plots in Belgium. In addition, after the four year study, Nevens and Reheul (2003) found that the plots amended with compost had significantly higher concentrations of carbon and nitrogen than the non-amended plots.

Westerman and Bicudo (2005) present many of the challenges facing the use of compost: namely, public acceptance in terms of siting, and odour from, these facilities, acceptable integration into agriculture, quality control of compost, logistics and organization, satisfaction of environmental regulations, economic viability, and sustainability. Government subsidies are likely needed to encourage a significant increase in compost use, particularly among farmers (Westerman and Bicudo 2005).

2.1.2.1 Cost of waste management in Canada

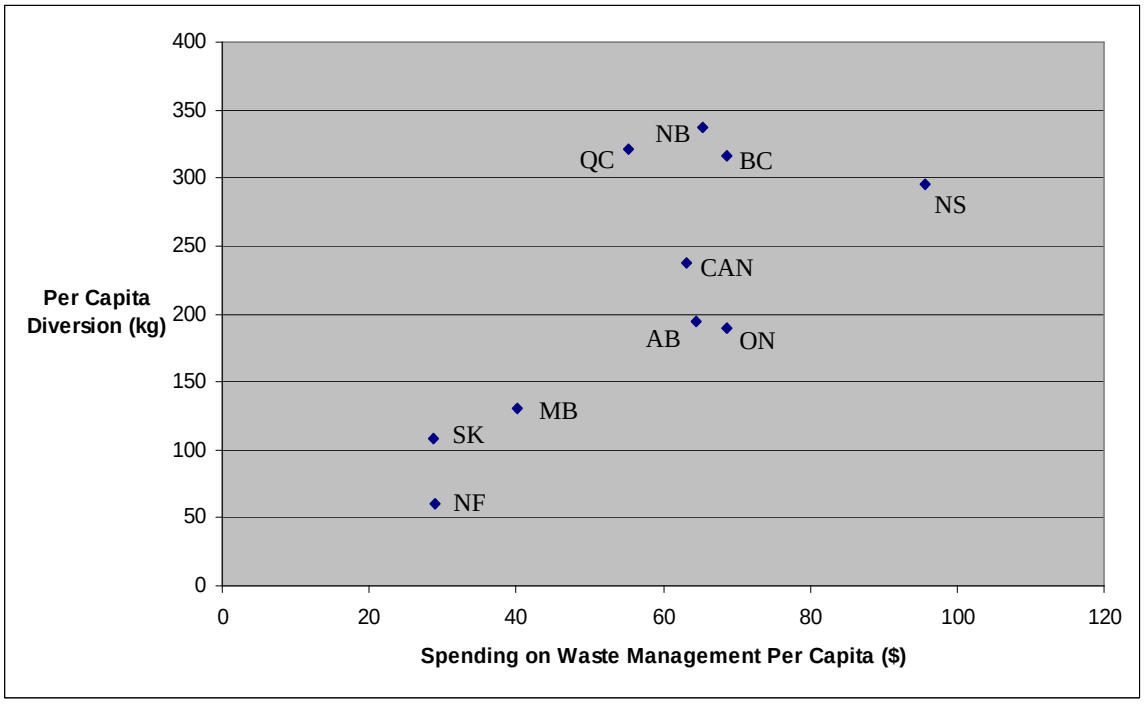
In Nova Scotia, according to Wagner and Arnold (2008), composting waste at a centralized composting facility costs approximately $80 per tonne (including operating and amortized capital costs). This cost, however, does not include revenue generated by the sale of composted materials (Wagner and Arnold 2008). Interestingly, Wagner and Arnold (2008) found that the cost of operating a three-stream (waste, recyclables, and organics), household waste collection system was only $6 more per household per year than operating a two-stream system (waste and recyclables). In Winnipeg, Manitoba, the tipping fee at the local landfill is $43.50, which includes a newly imposed $10 levy (Green Manitoba n.d.b). Therefore, if the cost of operating a centralized composting facility in Manitoba is similar to the cost in Nova Scotia, Winnipeg would need a method of recouping the difference of about $40 per tonne for the management of organic waste, in addition to the extra cost of adding another stream to the existing two-stream system to pick up organic waste.

In Nova Scotia, there is a two-tiered, non-dairy container deposit-refund system: a deposit of 10 cents is made on the purchase of bottles that are 500 ml or less and a 20 cent deposit is made on the purchase of bottles that are larger than 500 ml (Wagener and Arnold 2008). Half of the deposit is returned to consumers who return the bottle to any of the province's 83 ENVIRO-DEPOTS™ (Wagner and Arnold 2008). Of the deposit that remains, about 70% is paid to the depots and the rest goes to fund municipal MSW programs, the four regional processing centres, transportation of recyclable materials, and administration (Wagner and Arnold 2008). In Manitoba, a 2 cent levy on ready to serve

beverage containers exists to fund municipal MSW programs (Manitoba Product Stewardship Corporation [MPSC] 2009).

In terms of spending, Manitoba spent much less on waste management than Nova Scotia in 2006, but Nova Scotia achieved a much higher per capita diversion rate (Figure 2.1). In fact, Nova Scotia spent about 40% more, per capita, on waste management than the Canadian average (Statistics Canada 2008c). On the other hand, Manitoba spent about 64% of the Canadian per capita average on waste management activities in 2006 (Statistics Canada 2008). Interestingly, Quebec (QC), New Brunswick (NB), and British Columbia (BC) achieved greater diversion rates than Nova Scotia (NS), while spending less money per capita to achieve those greater diversion rates; however, there is more to waste management than diversion rates.

Figure 2.1. Provincial per capita diversion rates versus provincial expenditures on waste management (2006).

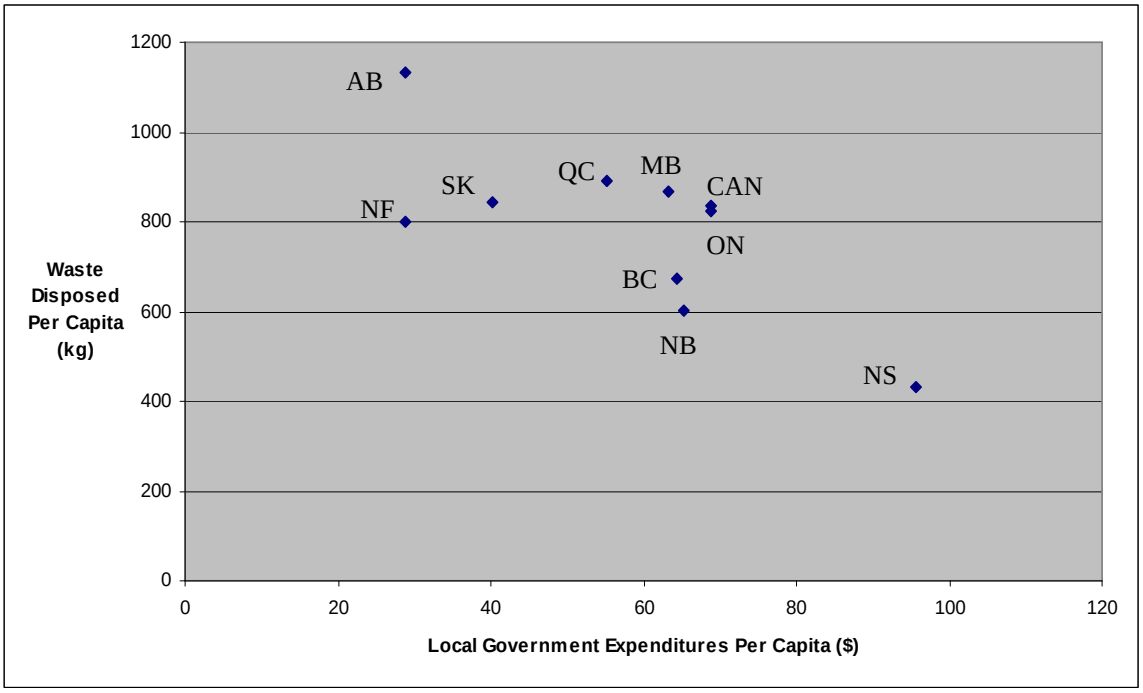


Source: Statistics Canada 2008c
Notes:

1. Where 2006 data was unavailable, 2004 data was used.

Figure 2.2 illustrates that Nova Scotia has a significantly lower waste disposal rate than any other province in Canada. New Brunswick has the second lowest waste disposal rate in Canada and it is about 40% higher than Nova Scotia's (Statistics Canada 2008c). This means that Nova Scotia's waste management expenditures are funding programs that are not only supporting diversion initiatives, but are also supporting source reduction and reuse programs, as well.

Figure 2.2. Provincial per capita disposal rates versus provincial expenditure on waste management (2006).



Source: Statistics Canada 2008c
Notes:
1. Where 2006 data was unavailable, 2004 data was used.

2.2 Social considerations in sustainable development

In the face of changing ideologies and globalization, the inclusion of various levels of government, non-governmental groups, and public and private actors in the policy-making process is essential (Sathaye et al. 2007). Governments are now realizing

the limits of control over their domestic economy in an open and globalized market and are seeking new strategies for economic growth (Sathaye et al. 2007). What follows are social considerations that all levels of government must take into account in the development of sustainable policies.

2.2.1 Socio-economic justice

While the economic literature has always touched on human development, that is, raising the standard of living of some people, this has not been the literature's only focus (Anand and Sen 2000). A disproportionate focus has always existed regarding societal wealth maximization, like annual GDP growth (Anand and Sen, 2000). Economic theory also tends to only promote market efficiency, but not any particular end to which that efficiency leads: ends which may or may not be fair or just (Bishop 1993). While Anand and Sen (2000) concede that the pursuit of wealth maximization has been a substantial motivator and, thereby, a strong reason for why human development has risen to its current level, they contend that the pursuit of wealth maximization is flawed. Judging a society's success by measuring its aggregate wealth ignores the individual predicaments brought about by its distribution (Anand and Sen 2000). In other words, the pursuit of wealth maximization ignores issues of fairness and what it is that constitutes a good life (Anand and Sen 2000). Therefore, the main focus of sustainable development is wealth distribution, rather than wealth maximization.

2.2.2 Intergenerational equity

The concept of intergenerational equity arises out of the concern that future generations will not have enough capital to live as well as the present generation (Anand and Sen 2000; Bishop 1993). This capital includes, but is not limited to, resources that produce food, building materials, pharmaceuticals, aesthetic enjoyment, and energy (Bishop 1993). Intergenerational equity is an extension (or part, depending on when one enters the conversation) of ethical universalism, and is a model of resource distribution that takes into account those who do not yet exist. Intergenerational equity may be conceived as the preservation, but not necessarily the expansion, of the present day economic opportunities (Anand and Sen 2000; Bishop 1993). Since we cannot know the desires of future generations, the best we can do in the present is preserve the ability of future generations to produce well-being: this, perhaps, is what we mean by 'sustainability' (Anand and Sen 2000). In practice, unfortunately, determining how much and what to allocate to future generations is currently an impossibly complex task (Bishop 1993).

2.2.3 The precautionary principle

The precautionary principle states that when scientific evidence is limited or unavailable regarding the management of a perceived risk, action should err on the side of caution until further scientific research is conducted (Barrieu and Sinclair-Desgagné 2006; Gollier, Jullien, and Treich 2000). This is a particularly important concept in environmental protection: given the complexity of environmental systems, and our corresponding lack of understanding of those systems, the precautionary principle

provides a basis for protecting ourselves from environmental catastrophes that are predicted by scientific research that has not yet been validated. In Canada, governments of all levels have the responsibility to protect Canadians from possible risk by following the precautionary principle. However, the precautionary principle, in its stated form, is unclear in terms of when it should be applied (Barrieu and Sinclair-Desgagné 2006): that is, it provides no practical guidelines for its use (Gollier, Jullien, and Treich 2000). For example, some claim the principle saves the lives of unwitting subjects of scientific uncertainty or biases, while others claim it stifles trade and is used by some to slow technological progress (Barrieu and Sinclair-Desgagné 2006). Barrieu and Sinclair-Desgagné (2006) put forward a conception of the precautionary principle that encourages the creation of policy that may not be the best for the given model, but one that is acceptable if the given model is wrong. In-depth analyses of how and when the precautionary principle should be used are given in the literature (Barrieu and Sinclair-Desgagné 2006; Gollier, Jullien, and Treich 2000), but will not be considered here.

2.3 The environmental impacts of waste management

The attention that greenhouse gases have recently received is largely due to their predicted affect on the average surface temperature of the earth. Greenhouse gases absorb some of the energy in the radiation from the sun and this energy, considered over the entire atmosphere, warms the earth to its average surface temperature of about 14°C (Mohareb, Warith, and Narbaitz 2004). In the absence of greenhouse gases, the average surface temperature would be about -19°C (Mohareb, Warith, and Narbaitz 2004). Since the industrial revolution began around 1750, the atmospheric concentrations of

greenhouse gases have risen considerably (IPCC 2007; Mohareb, Warith, and Narbaitz 2004). Greenhouse gases include carbon dioxide, methane, nitrous oxide, sulfur hexafluoride, perfluorocarbon, hydrofluorocarbon, and chlorofluorocarbons (Environment Canada 2006; Mohareb, Warith, and Narbaitz 2004).

In its most recent report, the Intergovernmental Panel on Climate Change (IPCC) asserted that "[w]arming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level" (IPCC 2007). In addition, the IPCC contends that there is a greater than 90% probability that most of this warming is due to human activity: "[m]ost of the observed increase in global average temperature since the mid-20th century is *very likely* due to the observed increase in anthropogenic greenhouse gas concentrations" (IPCC 2007). This announcement from the world's leading experts on climate change should encourage greenhouse gas emission reduction strategies in all areas.

2.3.1 Greenhouse gas emissions from waste

In 2006, Canada emitted 721 Mt CO_2e of greenhouse gases (Environment Canada 2009), 28.1% above the target of 563 Mt established by the Kyoto Protocol (Environment Canada 2007). About 21 Mt, or 2.9%, of Canada's total emissions were a result of solid waste disposal on land, wastewater handling, and waste incineration (Environment Canada 2009). As Table 2.1 indicates, the vast majority of these emissions have come from the disposal of solid waste on land. In fact, 95% of the emissions from the waste sector in Canada result from the leakage of methane from landfills (Mohareb, Warith, and

Narbaitz 2004). It is important to note that the release of carbon dioxide from the decomposition of organic waste does *not* count toward Canada's greenhouse gas emissions because the process is considered cyclical (Mohareb, Warith, and Narbaitz 2004; Thompson and Tanapat 2006): that is, the carbon released into the atmosphere from decaying organic matter is taken up by other organic materials, and then released, and so on.

Table 2.1 Greenhouse gas emissions (Mt CO2e) resulting from waste disposal (1990, 2003, 2005, 2006).

Source	**1990**	**2003**	**2005**	**2006**
Solid waste disposal on land	17.000	19.000	19.000	20.000
Wastewater handling	0.780	0.910	0.940	0.930
Waste incineration	0.400	0.230	0.240	0.240
Total	**18.180**	**20.140**	**20.180**	**21.170**

Source: Environment Canada 2009

In the United States and Australia, reports have estimated that methane from landfill gas accounts for about 4% of total greenhouse gas emissions, measured in terms of greenhouse gas potential (Ackerman 2000). Much of the organic materials in landfills decay anaerobically, which causes the release of certain gases into the atmosphere (Ackerman 2000). This gas, called landfill gas, is a water saturated biogas that is 50% to 60% methane and 40% to 50% carbon dioxide, with trace amounts of other constituents (Spokas et al. 2006). It is the methane in landfill gas, however, that is the concern, as methane has a global warming potential 25 times that of carbon dioxide over a 100-year time horizon (Forster et al. 2007). The estimated proportion of total yearly anthropogenic methane emissions attributable to landfills is varied, with estimates ranging from 2.5% to 4% (Spokas et al. 2006) and 5.7% to 12.1% (IPCC 2007). Worldwide, the waste and wastewater sector accounts for about 2.8% of total anthropogenic GHG emissions (Denman et al. 2007).

2.3.2 Waste generation and diversion in Canada

In Canada, about 35 million tonnes (Mt) of waste was generated in 2006 (Statistics Canada 2008b). Of this total, about 13 Mt of waste came from the residential sector and 22 Mt came from the non-residential sector (Statistics Canada 2008b), which includes the industrial, commercial, and institutional sector (ICI) and construction, renovation, and demolition activities (C&D). As Table 2 illustrates, waste generation in Canada increased from 29.307 Mt in 2000 to 34.998 Mt in 2006, which is an increase of almost 5.7 million tonnes (Table 2.2; Table 2.3).

Table 2.2 Canadian waste generated (Mt) by sources in 2000, 2002, 2004, and 2006.

Sources of Waste	**2000**	**2002**	**2004**	**2006**
Residential	11.242	12.008	12.325	12.983
Non-Residential	18.065[1]	18.447[1]	20.014	22.015
Total	**29.307**	**30.455**	**32.339**	**34.998**

Source: Statistics Canada 2005a; Statistics Canada 2008b

Notes:

1. These numbers were attained by summing the waste produced by the ICI and C&D sectors in Statistics Canada 2005a.

Between 2000 and 2006, the rate at which Canada produced waste steadily increased (Table 2.2). Although there appear to be fluctuations in the rate at which waste generation is increasing over time in the residential sector, this does not seem to be true of the non-residential sector (Table 2.3). In fact, the rate at which the non-residential sector is generating waste appears to be steadily increasing with time (Table 2.3). Indeed, while the non-residential sector contributed to about 33% of the growth in the generation of waste in Canada between 2000 and 2002, between 2004 and 2006 it contributed to over 75% of the growth in the generation of waste (Table 2.3). As is evident in Table 2.3, between 2000 and 2006, not only was the absolute growth in the generation of waste

greater in the non-residential sector than in the residential sector, the percentage growth was greater in the non-residential sector, as well.

Table 2.3 Changes in waste generation by source between 2000 and 2006.

Sources of Waste	Change from 2000-2002	Change from 2002-2004	Change from 2004-2006	Change from 2000-2006
Residential	+0.766 Mt +6.81%	+0.317 Mt +2.64%	+0.658 Mt +5.34%	+1.741 Mt +15.49%
Non-Residential	+0.382 Mt +2.11%	+1.567 Mt +8.49%	+2.001 Mt +10.00%	+3.950 Mt +21.87%
Total	**+1.148 Mt +3.92%**	**+1.884 Mt +6.19%**	**+2.659 Mt +8.22%**	**+5.691 Mt +19.42%**

Source: modified from Statistics Canada 2005a and Statistics Canada 2008b

The total waste generated by Canadians increased between 2000 and 2006 by almost 20% (Table 2.3). As we have seen, the non-residential sector contributed the most to this change (about 69.4%), with an increase in its waste generation over this period by almost 22% (Table 2.3). By comparison, the residential sector increased its waste generation between 2000 and 2006 by about 15.5% (Table 2.3). Table 2.3 indicates that the non-residential sector is having more of an overall impact on the total waste generated in Canada as time passes.

In 2006, Manitoba generated 1.177 Mt of waste, which is about a 4.2% increase over its generation of 1.130 Mt in 2000 (Statistics Canada 2005a, Statistics Canada 2008b). Manitoba's residential sector produced 4.6% more waste in 2006 than in 2000, while its non-residential sector produced about 3.8% more over the same period (Table 2.4). Although the rate at which Manitoba's waste generation is increasing is not as dramatic as Canada's as a whole, there is nevertheless a trend of increasing waste generation over time in Manitoba (Table 2.4).

Table 2.4 Waste generated (Mt) by sources in Manitoba in 2000, 2002, 2004, and 2006.

Sources of Waste	2000	2002	2004[1]	2006[1]
Residential	0.502	0.495	0.522	0.525
Non-Residential	0.628[2]	0.652[3]	0.563	0.652

Total	**1.130**	**1.147**	**1.085**	**1.177**

Source: Statistics Canada 2005a, Statistics Canada 2008b

Notes:

1. These numbers were attained by summing the waste disposed and the waste diverted in Statistics Canada 2008b.
2. This number was attained by subtracting residential waste from total waste in Statistics Canada 2005a.
3. This number was attained by summing the waste produced by the ICI and C&D sectors in Statistics Canada 2005a.

Between 2004 and 2006, waste production increased in both Canada and Manitoba (Table 2.5) (Statistics Canada 2008b). In that time period, Canada's production of waste increased by about 8.2%, while Manitoba's production of waste increased by about 8.4%. In both 2004 and 2006, Manitoba produced less waste per capita than the Canadian per capita average (Statistics Canada 2008b). Manitoba's per capita production of waste was about 928 kilograms (kg) in 2004 and 999 kg in 2006 (Statistics Canada 2008b), a 7.7% increase over the period. The national average per capita production of waste was 1010 kg in 2004 and 1072 kg in 2006 (Statistics Canada 2008b), a 6.1% increase over the period. In 2006, the Canadian per capita production of waste was 7.3% higher than the Manitoba per capita average; however, Manitoba's per capita production of waste increased by a larger percentage between 2004 and 2006 than did Canada's per capita average.

While the amount of waste diverted across Canada increased between 2004 and 2006, this was not the case in Manitoba (Table 2.5) (Statistics Canada 2008b). Across Canada, waste diversion increased by about 8.9%, while waste diversion actually decreased by 2.5% in Manitoba (Statistics Canada 2008b). The proportion of waste that was diverted in Canada increased slightly between 2004 and 2006 from 22.0% to 22.1% (Statistics Canada 2008b). On the other hand, the proportion of waste that was diverted in Manitoba decreased between 2004 and 2006 from 14.5% to 13.0% (Statistics Canada

2008b). In 2006, Manitoba had a much lower waste diversion rate per capita than Canada (Statistics Canada 2008b), diverting about 107 kg per capita less than the Canadian per capita average. In addition, while waste diversion per capita increased in Canada from 222 kg in 2004 to 237 kg in 2006, waste diversion per capita decreased in Manitoba over that same period from 135 kg to 130 kg (Statistics Canada 2008b). Compared to other provincial per capita rates in 2006, Manitoba had the fourth highest waste generation rate, the third highest waste disposal rate, and the seventh highest (or third lowest) waste diversion rate (out of nine provinces; waste data not available for Prince Edward Island) (Statistics Canada 2008c).

Table 2.5 Waste generated and diverted in Canada and Manitoba in 2004 and 2006.

Source	Waste Generated (Mt) [1]	Waste Generated Per Capita (kg)[1]	Waste Diverted (Mt)	Waste Diverted Per Capita (kg)	Waste Diverted (%)
Canada					
2006	34.998[2]	1072[2]	7.749	237	22.14
2004	32.339[2]	1010[2]	7.113	222	22.00
Manitoba					
2006	1.177[2]	999[2]	0.153	130	13.00
2004	1.086[2]	928[2]	0.157	135	14.46

Source: Statistics Canada 2008

Notes:

1. This does not include waste disposed of at hazardous waste disposal facilities or waste managed by the waste generator on site (Statistics Canada 2008b).
2. This is the sum of waste disposed and waste diverted in Statistics Canada 2008b.
3. This is the sum of waste disposed per capita and waste diverted per capita in Statistics Canada 2008b.

In Winnipeg, Manitoba (the largest city in Manitoba) the production of waste by the residential sector increased from about 0.202 Mt to 0.229 Mt between 1997 and 2000 (Table 2.6), which is a 13.5% increase. In addition, residential recycling increased by more than 88% between over the same period, from 0.023 Mt to 0.044 Mt (Table 2.8). In 2007, approximately 19.1% of the waste generated by residences in Winnipeg was diverted (Table 2.6).

Table 2.6 Weight of waste and recycled materials by residences in Winnipeg, MB in various years between 1997 and 2007.

Year	Waste Produced (t)	Waste Recycled (t)
2007	229,361	43,705
2005	255,035	42,163
2002	218,635	32,981
2000	231,766	23,995
1997	202,007	23,143

Source: City of Winnipeg, 2008a, City of Winnipeg, 2008b

2.3.3 Organic waste

Organic waste in the MSW stream is comprised mainly of food/kitchen waste and yard waste (Otten, 2001). As we will see, organic waste makes up a significant proportion (greater than 40% by weight) of municipal solid waste. This portion of municipal solid waste is largely responsible for landfill gas problems (Otten, 2001). Therefore, preventing or limiting organic waste from entering landfills would help to solve this problem (Otten, 2001). There are several other benefits to composting the organic portion of the waste stream. According to Otten (2001), these benefits include the following:

1) Backyard and midsize composting at the source reduces the amount of waste to be collected and transported to landfills;
2) Composting reduces the production of leachate and landfill gas, which are both harmful to the environment;
3) Composting increases the life of landfills;
4) Composting and recycling result in a relatively inert waste stream going into landfills so that landfills require less daily cover, less equipment and labour during operation, and reduced monitoring after closure;
5) Composting produces a useful soil conditioner with some fertilizer value that can often be sold;

6) Composting is one of the least expensive methods of dealing with organic waste; and

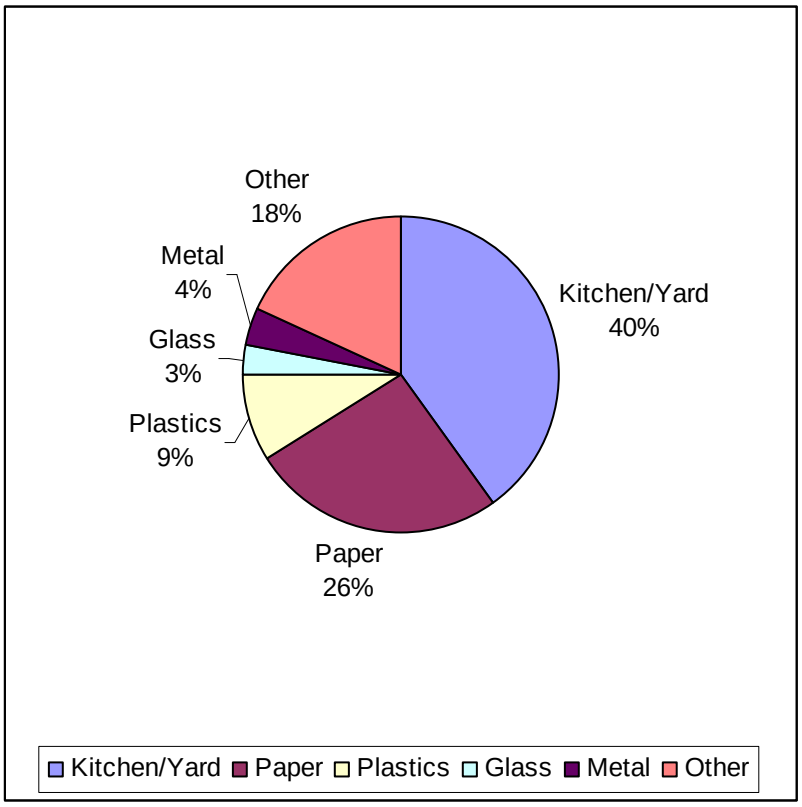
7) Composting can significantly help municipalities achieve waste diversion targets.

2.3.3.1 Organic waste in Canada

Food/kitchen and yard waste, represent a significant proportion of total waste, by weight, going into landfills in Canada (David 2007). In fact, of the 23.8 Mt of waste disposed of in landfills in 2002, about 6.7 Mt, or 28%, were food/kitchen and yard waste (David 2007).

Residential waste can be broken down into the following categories: kitchen/yard, paper, plastics, glass, metal, and other, which includes animal waste, textiles, tires, and wood (Statistics Canada 2005a). Figure 2.3 represents the percentage by weight these categories make up of the total household waste.

Figure 2.3 Composition of residential waste by weight in Canada.



Source: Statistics Canada 2005a

As we have seen, the residential sector produced about 12 Mt of waste in 2002 (Statistics Canada 2005a). Of the 12 Mt of waste produced, only about 2.6 Mt were diverted from landfills (Statistics Canada 2005a). With organic waste *alone* accounting for about 4.8 Mt (40% of 12 Mt), it is clear that waste diversion programs are not achieving their full potential. With a 100% diversion rate for residential organic waste and no diversion of anything else, the overall diversion rate would nearly double. Although a 100% diversion rate for residential organic waste is unlikely, many countries in the European Union, such as Austria, Belgium (Flanders), Germany, Switzerland, Luxembourg, Italy, Spain (Catalonia), Sweden, and the Netherlands, divert greater than 80% of their organic waste from landfills (European Compost Network, n.d.). van der Werf and Cant (2006) believe that a 50% diversion rate for organics is feasible in

Canada. Even with a 50% organics diversion rate, the residential sector would reduce the amount of waste entering landfills by about 2.4 Mt, which is nearly the amount of total waste already being diverted due to diversion activities, such as recycling, reuse, and composting. Therefore, significant advances in organics diversion rates are not only possible, but will substantially lessen the strain on Canadian landfills.

2.3.4 Leachate

Leachate forms as a result of the removal of soluble compounds by the percolation of water, generally from precipitation, irrigation, and runoff, through landfill waste (Christensen et al. 2001; El-Fadel, Findikakis, and Leckie 1997; Kjeldsen et al. 2002). Waste decomposition by microbial activity contributes a small amount to leachate formation (Christensen et al. 2001; El-Fadel, Findikakis, and Leckie 1997). The quantity of leachate formed is also dependent on the location of the landfill and is a function of water availability, weather conditions, and the characteristics of the waste, landfill surface, and underlying soil (Christensen et al. 2001; El-Fadel, Findikakis, and Leckie 1997; Kjeldsen et al. 2002). Although the composition of leachate typically differs between locations, metals, aliphatics, acyclics, terpenes, and aromatics have been found in landfill leachate from domestic, commercial, industrial, and co-disposal sites (El-Fadel, Findikakis, and Leckie 1997).

Leachate is of serious concern because of its significant threat to ground water (Christensen et al. 2001; El-Fadel, Findikakis, and Leckie 1997; Kjeldsen et al. 2002). Once leachate forms and reaches the bottom of the landfill or an impermeable layer within the landfill, one of two things will happen: 1) the leachate will move laterally until

it reaches a point at which is can discharge into the ground or 2) the leachate will pass through the bottom of the landfill (El-Fadel, Findikakis, and Leckie 1997). In either case, depending upon the nature of the rock formations below the landfill and in the absence of a leachate collection system, it has been reported that leachate can contaminate aquifers that exist below the landfill (Christensen et al. 2001; El-Fadel, Findikakis, and Leckie 1997).

2.3.5 Landfill capacity and cost in Canada

In Canada, landfill space is diminishing and many of the nation's active landfills are expected to close by 2020 (Bonam 2009). However, the creation of new landfills sites or the expansion of existing sites is politically and technically difficult due to an extremely negative public perception of landfills and strict environmental regulations (Okeke and Armour 2000). Traditionally, the scarcity value of landfill space has not been taken into account by waste management decision-makers (Curmally 2004). The value of landfill space should be calculated, in part, based on the cost of acquiring a new landfill site and constructing a new landfill (Curmally 2004). Furthermore, creating more landfills to store waste requires the use of land that could otherwise be used for productive purposes. All these costs are what make up the true value of existing landfill space (Bonam 2009).

There are a number of practical initiatives that can be undertaken to reduce the stress on existing landfills. For instance, the depth of landfills and the density of the waste should both be increased (Bonam 2009). Increasing the density of waste decreases surface area on which biological activity can occur, decreasing the gas production rate

(McCabe 1976). Deeper landfills are more economical in terms of the leachate collection infrastructure, land use, and methane recovery (Bonam 2009). Finally, increasing the disposal fee of waste to better account for the actual cost of landfilling waste will make recycling and composting relatively more attractive and therefore increase diversion rates (Bonam 2009).

2.3.6 Actions to reduce landfill waste and greenhouse gas emissions

There are a variety of techniques available for decreasing the amount of greenhouse gases produced by the waste sector and the amount of waste produced in Canada. These techniques include source reduction, recycling, landfill gas capture for energy recovery, incineration for energy recovery, and the biological transformation of waste (Mohareb, Warith, and Narbaitz 2004).

Source reduction refers to changes in the design, manufacturing process, purchase, or use of materials or products that reduces their contribution to the waste stream (Mohareb, Warith, and Narbaitz 2004). It has been observed that source reduction is the best way of decreasing greenhouse gas emissions from the waste sector and decreasing overall waste generation (Mohareb, Warith, and Narbaitz 2004; Min and Galle 1997). Reusing materials or products is considered a kind of source reduction as it frees space in landfills for other waste and prevents the creation of new materials or products to be used in their place (Mohareb, Warith, and Narbaitz 2004; Min and Galle 1997; Huhtala 1997). Extended producer responsibility (EPR) programs, which are programs designed so that producers bear the financial burden of the disposal of their products, is another type of source reduction technique (Mohareb, Warith, and Narbaitz 2004;

Statistics Canada 2005a). Product stewardship programs, which do not specify onto whom the financial burden falls, have been employed, and achieved little success, in Canada (Mohareb, Warith, and Narbaitz 2004; Nichol and Thompson 2007), although, within the last few years, EPR programs, particularly concerning electronic waste, have emerged all over the country (Electronics Product Stewardship Canada n.d.).

Recycling is an important measure to prevent greenhouse gas emissions and reduce waste going into landfills (Mohareb, Warith, and Narbaitz 2004; Min and Galle 1997). Because recycled materials can act as substitutes for raw materials in many manufacturing processes, recycling helps to reduce the amount of raw materials extracted and processed (Mohareb, Warith, and Narbaitz 2004; Statistics Canada 2005a), which results in several favourable outcomes. First, for instance, since recycling aluminum requires far less energy than extracting and processing virgin aluminum, making aluminum cans from recycled aluminum rather than virgin aluminum reduces emissions by 94% and energy use by 93% (Mohareb, Warith, and Narbaitz 2004). Second, since recycled materials are not sent to landfills, recycling opens up space in landfills for other waste (Mohareb, Warith, and Narbaitz 2004; Huhtala 1997).

In landfills, organic wastes, including food waste and yard waste, undergo anaerobic decomposition to produce various gases, including methane (Ackerman 2000; Mohareb, Warith, and Narbaitz 2004; Spokas et al. 2006). Landfill gas capture for energy recovery is used in many places in Canada, since methane is an excellent source of energy when combusted (Environment Canada 2007; Mohareb, Warith, and Narbaitz 2004). Methane capture for energy recovery is useful because, although carbon dioxide is produced by the combustion of methane, carbon dioxide is a much less potent greenhouse

gas than methane (Ackerman 2000; Mohareb, Warith, and Narbaitz 2004; Statistics Canada 2005a, Spokas et al. 2006).

The incineration of waste for energy recovery involves the combustion of municipal solid waste to reduce the volume of the waste and generate electricity or steam (Mohareb, Warith, and Narbaitz, 2004; Statistics Canada, 2005). The incineration of municipal solid waste is not as common in Canada as it is in some European and Asian countries where landfill space is extremely limited (Statistics Canada, 2005). The absence of waste incineration facilities in Canada is likely also due to the health hazards associated with the incineration of waste, including the release of particulate matter, sulfur oxides, and nitrogen oxides (Mohareb, Warith, and Narbaitz, 2004; Statistics Canada, 2005). The cost of operating a waste incineration facility is typically greater than other disposal methods (Mohareb, Warith, and Narbaitz, 2004). The incineration of solid waste, from a climate change perspective, is about as good as, or better than, landfilling for materials other than plastics, but is worse than source reduction and recycling for every material (Ackerman, 2000).

2.3.7 Management options for organic waste

With organic waste management options, organic waste is typically allowed to decompose by one of two methods (Mohareb, Warith, and Narbaitz 2004). The first method is anaerobic digestion: during this process, organic waste is decomposed in the absence of oxygen, producing methane that may be captured for energy recovery (Mohareb, Warith, and Narbaitz 2004; Tiehm, Nickel, and Neis 1997). The second method is composting, which is a process whereby organic waste is decomposed in the

presence of oxygen, resulting in the release of mostly carbon dioxide (Mohareb, Warith, and Narbaitz 2004; Tuomela et al. 2000). Currently, there is a growing demand for compost, which is produced by both processes (Tiehm, Nickel, and Neis 1997; Tuomela et al. 2000), in municipalities where it is available and has been sold in bulk at a price of $30 per tonne in Ontario, Canada (Otten 2001). Unfortunately, although a variety of composting facilities exist in Canada, it is difficult to compare the collection and processing processes of the plants due to varying accounting systems (Otten 2001).

2.3.7.1 Anaerobic digestion

Anaerobic digesters produce methane, reduce waste volume, and produce a useful organic residue that can be used as a peat-like fertilizer; the process of waste decomposition in these kinds of digesters is also accelerated compared to decomposition in landfills (Mohareb, Warith, and Narbaitz 2004; Tiehm, Nickel, and Neis 1997). At the time of their study, Mohareb, Warith, and Narbaitz (2004) found that there were only three locations at which energy recovery from anaerobic digesters was taking place in Canada. Mohareb, Warith, and Narbaitz (2004) estimate that the anaerobic digestion of organic waste with energy recovery has the potential to significantly reduce Canada's greenhouse gas emissions.

2.3.7.2 Composting

Composting occurs when organic waste undergoes aerobic decomposition, resulting in mostly carbon dioxide emissions and a compost product (Elliott 2008; Mohareb, Warith, and Narbaitz 2004; Tuomela et al. 2000). Although some methane is

released from composting, the amount is considered negligible (Elliott 2008; Mohareb, Warith, and Narbaitz 2004). Methane release can be limited by the proper aeration and mixing of compost piles (Elliott, 2008; Mohareb, Warith, and Narbaitz, 2004; Tuomela et al., 2000).

In 2004, 1.669 Mt of organic waste were composted at centralized facilities in Canada, representing about 21.2% of the 7.865 Mt of total waste diverted from landfills (Elliott 2008: Table 1). Since 2000, the amount of organic waste composted in Canada has increased by about 70.4% (Elliott 2008: Table 1). Of the 1.669 Mt of organic waste that was composted in Canada in 2004, about 1.426 Mt, or 85.4%, was composted in Ontario, Alberta, British Columbia, and Quebec (Elliott 2008: Table 2). Manitoba diverted about 0.021 Mt of organic waste to centralized composting facilities in 2004, about 1.3% of the total organic waste composted at centralized facilities in Canada (Elliott 2008: Table 2). However, Prince Edward Island, New Brunswick, Nova Scotia, and Alberta diverted much more organic waste per capita in 2004 than any other province (Elliott 2008: Chart 1). Of all the provinces, Manitoba had the second lowest organic waste diversion per capita in 2004 (Elliott 2008: Chart 1). It is important to note that this data does not reflect the amount of organic waste that Canadians are composting on their own. In 2006, approximately 27% of households in Canada and 23% of households in Manitoba participated in either backyard composting or curb-side organics collection programs (Elliott 2008: Table 3).

Composting reduces greenhouse gas emissions compared to landfilling (Elliott 2008). Without energy recovery, a landfill produces about 1.2 tonnes of carbon dioxide equivalent per tonne of food waste and 0.7 tonne of carbon dioxide equivalent per tonne

of yard trimmings (Mohareb, Warith, and Narbaitz 2004). Mohareb, Warith, and Narbaitz (2004) estimate that in 2000, composting reduced Canada's greenhouse gas emissions by 0.5 Mt.

As mentioned previously, a benefit of composting is that it produces a useful soil conditioner (Mohareb, Warith, and Narbaitz 2004; Tuomela et al. 2000). Mohareb, Warith, and Narbaitz (2004) found that about 0.3 to 0.5 tonnes of compost can be produced from one tonne of organic waste.

2.3.8 Effective waste management

Effective and timely waste management policies are needed to help correct the various problems associated with the waste management sector. As we have seen, the waste management sector must face problems concerning declining landfill space, leachate, landfill gas, etc, but its policies must also be consistent with human behaviour. In other words, waste management policies must take into account the habits, values, opinions, etc, of the people who will have to abide by those policies.

2.3.8.1 Policy-makers

Without a doubt, policy-makers have an essential role in shaping Canadian society. However, it is critical that policy-makers realize that what works for one community may not work for another: that is, according to Read (1999: 282), "[p]olicy that is driven by the centre often fails to adequately take account of local circumstances, funding problems, staffing issues and organizational barriers to change." Wilson, McDougall, and Willmore (2001) concur with Read and assert that policy-makers and

legislators should be aware of the following factors: (1) local conditions differ between locales, making comparisons, and universal declarations and/or policies, useless and/or less than optimally effective; 2) legislation and policy should be qualitatively analyzed to determine its affect upon waste management scope and activity, as well as quantitatively analyzed for its affect upon tonnes managed, etc; and 3) municipal solid waste systems can benefit and impact other systems, like urban resource management. It is also important for policy-makers to realize that there is often a disconnect between waste managers and policy-makers (Wilson, McDougall, and Willmore 2001).

Policy-makers must also be aware of other factors, including the following: population density, which can contribute to planning difficulties in jurisdictions that do not generate enough waste to support certain programs; local governments and stakeholders can provide a different perspective and important insight into how waste management could be improved, particularly in smaller communities; public education is necessary to increase participation in waste management programs; citizens living in apartments or condominiums should be included, specifically, in waste management programs, since these groups are least likely to be involved in these programs; and, finally, relying on voluntary participation or a single, narrow approach to waste management will not likely result in a successful program (Haque and Hamberg 1996; Hamburg, Haque, and Everitt 1997).

2.3.8.2 Waste management and human behaviour

When developing an effective waste management strategy, it is important to take into account how the people within the affected area will act. Ferrara and Missios (2005),

for instance, investigated the relationship between recycling policy options and recycling behaviours and came to many of the following important findings:

(1) User fees for waste disposal increases recycling intensity; however, user fees may lead to illegal dumping;

(2) Weekly recycling has a positive effect on the recycling of glass, aluminum, and toxic chemicals, but has a negligible effect on the recycling of newspaper, plastic bottles, tin cans, and cardboard. This result is consistent with the idea that recycling intensity increases when it occurs concurrently with waste collection: that is, when recycling is more convenient;

(3) Offering free units under a user fee program for waste disposal negatively impacts recycling;

(4) Limiting the number of bags at the curb has a negligible impact on recycling;

(5) Promoting curb-side recycling increases the rate of non-curb-side recycling (i.e., the recycling of toxic materials);

(6) For most materials, education level does not significantly affect recycling intensity, except for university undergraduate and/or post graduate degrees, which increase the intensity of newspaper, aluminum, tin can, and toxic chemical recycling. Education has a positive impact on the recycling of glass above a high school degree;

(7) Recycling generally decreases as income increases for newspaper, plastic, and toxic chemicals. This may occur because as income increases, time is more valuable to the recycler;

(8) Home ownership is strongly, and positively, correlated to recycling. This suggests that homeowners are more attached to their community and/or are more concerned about their neighbours' perception of them, causing them to recycle more.

Although these behavioural traits are associated with recyclables rather than organics, these finding may nonetheless be useful in predicting how people would react to the implementation of specific organic waste management programs.

Public participation in source separation is also higher and more effective when appropriate educational programs are provided to citizens (Otten 2001). In Guelph and Lunenburg, where source separation is mandatory and public education is provided, these municipalities have achieved an organics diversion rate of about 70% (Otten 2001).

2.3.8.3 Waste Streams

A waste stream is a group of sorted materials destined for a particular location. Generally, source separation, which is the sorting of waste into waste streams, occurs within the home. Policy makers have a number of choices when it comes to the number of waste streams imposed onto users of waste disposal services. In a t*wo stream* system, users separate wet waste, including food and yard waste, from dry waste, including recyclable materials and residues (Otten 2001). In a *three stream* system, users separate

wet waste, recyclable materials, and residues (Otten 2001). In a *four stream* system, users separate wet waste, recyclable materials, residues, and paper and magazines (Otten 2001).

Otten (2001) found that a *two stream* system is more effective than a *three stream* system in terms of source separation: in the *two stream* system, there has been found to be a 97% diversion rate for organics and 94% for recyclable materials compared to 85% for organics and 79% for recyclable materials in the *three stream* system. In addition, in a *two stream* system, one truck can be used to pick up waste, while a *three stream* system requires at least two trucks (Otten 2001). Consistent with other previously stated positions, Otten (2001) found that whether users preferred using containers or bags for waste disposal was locale-specific. However, while users may in general find bins more convenient than bags, it is important for policy makers to bear in mind that bags are easier to handle for manual curb-side pickup than bins (Otten 2001).

2.3.9 Landfill gas models

A landfill gas model is a tool to provide an estimate of the amount of methane or landfill gas released from a landfill over a period of time (Thompson, Sawyer, and Valdivia 2009). A model that can accurately predict methane or landfill gas emissions is useful for several reasons. First, an accurate landfill gas model is necessary for determining the feasibility of capturing methane from landfills and using that methane as an alternative energy source (Thompson, Sawyer, and Valdivia 2009). Second, accurate models can assist in the creation of policy decisions, such as utilizing, burning off, and/or reducing methane emissions (Thompson, Sawyer, and Valdivia 2009). Third, an accurate model is necessary if Canada is to accurately predict its own greenhouse gas emissions,

which it is required to do under the Kyoto Protocol (Thompson, Sawyer, and Valdivia 2009).

Past models have made municipalities and companies looking to invest in landfill gas recovery projects reluctant to follow through in their endeavors. This is largely due to the inaccuracies of landfill gas models in general, with some methane recovery projects yielding only 10% of predicted volumes (Goldstein 2007 in Thompson, Sawyer and Valdivia 2009). Therefore, if significant steps are to be taken to prevent or slow the release of methane from Canadian landfills an accurate and validated landfill gas model is needed.

Unfortunately, to date, landfill gas models are considered to have poor accuracy and are seldom validated (Bogner and Matthews 2003; Barlaz et al. 2004; Borjesson et al. 2000). Furthermore, aside from a study by Thompson, Sawyer, and Valdivia (2009), there have been no studies attempting to validate any landfill gas model for a wide, rather than a site-specific, application.

2.4 Waste management in Manitoba, Canada

Although the Government of Manitoba has played an active role in waste management since about 1990, there is no publicly accessible document describing an integrated strategy for waste management in Manitoba. However, in the past, the Government of Manitoba has produced, or commissioned the production of, an integrated waste management strategy. This section will describe some of the history related to waste management in Manitoba.

2.4.1 Waste management history in Manitoba

In 1989, the goal of reducing waste generation in Canada by 50% by the year 2000 was adopted by the Canadian Council of Ministers of the Environment (Hamburg, Haque, and Everitt 1997). In order to achieve this goal, the Manitoba Minister of the Environment established the Manitoba Recycling Action Committee (Haque and Hamberg 1996). The 14-member Committee represented the interests of industry, consumers, and the environment (Haque and Hamberg 1996). The Minister tasked the Committee with the creation of a strategy by which Manitoba could achieve a 50% reduction in waste disposal by 2000 compared to 1988 (Haque and Hamberg 1996). The Committee was instructed to develop a strategy based on the 4Rs: namely, reduce, reuse, recycle, and recover. Beginning with the Recycling Action Committee Action Plan, this section summarizes many of Manitoba's efforts to improve its waste management system since 1990.

2.4.1.1 Manitoba Recycling Action Committee Action Plan

The strategy put forward by the Recycling Action Committee (RAC) was designed to meeting the Minister's goal of reducing waste going to landfill per capita by 50% compared to 1988 levels (Recycling Action Committee 1990). Although the name of the committee suggests that its focus was recycling, the emphasis of the strategy was broadened to prioritize source reduction and reuse of waste (Recycling Action Committee 1990). The RAC public the Action Plan: A Waste Minimization Strategy for Manitoba in

the 1990s in May 1990: the Plan consisted of 56 recommendations in seven broad areas (Haque and Hamberg 1996).

The RAC's Plan provided criteria for developing priorities and setting targets; the criteria included the proportion of the material in the waste stream, toxicity, landfilling issues, public concern, ease of waste reduction, and environmental intensity (i.e., energy use, material content, etc.) (Recycling Action Committee 1990). The Plan also called for the Minister of the Environment to develop a list of priority products for waste minimization. It was proposed that distributors of products in Manitoba above a certain sales volume, in conjunction with government, would be required to create Action Plans to minimize associated waste (Recycling Action Committee 1990). The Plan proposed the following deadlines: 1) June 1990: start date; 2) January 1991: Manitoba Environment identifies priority substances; 3) July 1992: priority Action Plans submitted by distributors; and 4) January 1995: predisposal levies imposed on non-performers (Recycling Action Committee 1990). In addition, the RAC Plan suggested setting a mid-term target of a 20% reduction compared to 1988 levels by January 1, 1995 (Recycling Action Committee 1990). The Action Plan identified several materials, including tires, batteries, and lubricating oils, disposable diapers, newspapers, corrugated and commercial waste paper, yard waste, and beverage containers (Recycling Action Committee 1990).

The RAC Plan also identified key messages that needed to be communicated to the public (Recycling Action Committee 1990). These messages included, 1) why waste minimization and recycling was needed; 2) what can be done to improve the situation; 3) what can be done to reduce or reuse material; 4) where can materials be recycled; and 5)

how to implement a waste minimization and recycling program in a business, school, or industry (Recycling Action Committee 1990). The intended targets of this information were school age children, consumers, the public at large, industry, post-secondary professionals, and technical education programs (Recycling Action Committee 1990). Other information the RAC Plan suggested disseminating to the public included 1) the composition of the waste stream; 2) an appreciation of packaging waste; 3) the environmental and social cost associated with waste; and 4) the role of citizens in the creation of environmental problems and their responsibility to find a solution (Recycling Action Committee 1990). School-age children were specifically targeted because of their active interest in environmental issues (Recycling Action Committee 1990).

The RAC Plan suggested the adoption of methods used in other jurisdictions to meet Manitoba's waste management needs; however, it stressed that governments at all levels needed to understand that a suitable waste management strategy could only be developed through trial-and-error (Recycling Action Committee 1990).

In 1990, there were over 450 landfills in Manitoba; the RAC Plan suggested reducing the number of landfills by consolidating sites into larger, upgraded ones (Recycling Action Committee 1990). In this way, greater environmental protection could be achieved, full-time staff could be hired to weight and inspect waste, which would help to implement waste management strategies (Recycling Action Committee 1990). It also recommended transfer stations that would combine small waste loads into larger loads that were more economical to transport (Recycling Action Committee 1990). The Plan proposed that transfer stations could effectively replace many of the smaller landfills in Manitoba (Recycling Action Committee 1990).

The RAC Plan suggested that a user pay system of waste management be imposed in Manitoba, rather than using money from property taxes (Recycling Action Committee 1990). This would give citizens an indication of the true cost of waste management.

Finally, the Plan recommended research and development to create economic opportunities and employment in Manitoba (Recycling Action Committee 1990). It also recommended mandating product composition, like newsprint being required to have a certain amount of recycled content (Recycling Action Committee 1990).

2.4.1.2 Waste Reduction and Prevention Act

The Government of Manitoba proclaimed the *Waste Reduction and Prevention* (WRAP) *Act* on August 31, 1990 to allow the implementation of the RAC Plan (Haque and Hamberg 1996). The WRAP Act describes the responsibilities of various stakeholders, including consumers, distributors, and government (Haque and Hamberg 1996). The WRAP Act requires the Government of Manitoba to identify roles for waste minimization, negotiate waste reduction targets, monitor progress, provide technical assistance, and allocate money for infrastructure development (Haque and Hamberg 1996). The Act also recognizes the importance of ongoing coordination among all levels of government and neighboring provinces and states to achieve regional waste management opportunities (Haque and Hamberg 1996). The Act includes provisions for industry stakeholder consultations, reporting, establishing waste reduction targets, and establishing financial mechanisms, including deposits, handling fees, and pre-disposal fees (Manitoba Environment 1991). As well, the Act provides the power to license

distributors or prohibit the sales of products or materials in Manitoba (Manitoba Environment 1991).

Within six months of the WRAP Act coming into force, the Act calls for the preparation of "Waste Reduction and Prevention Strategy Report", and annually thereafter (Manitoba Environment 1991). According to Manitoba Environment (1991), the Report should include the following:

1. Specific goals for waste reduction and prevention;
2. A plan for achieving those goals; and
3. A report of the waste reduction and prevention activities in Manitoba.

2.4.1.3 Waste Reduction and Prevention Strategy Report 1991

The WRAP Report, prepared to comply with the WRAP Act, emphasized acquiring data concerning waste composition, setting realistic targets, setting priority materials, and building partnerships (Manitoba Environment 1991). It highlighted the importance of distributor responsibility, identifying materials with secondary applications, establishing a process for planning waste reduction and prevention, strengthening the market for recyclables and source reduction, and promoting and assisting new industries (Manitoba Environment 1991).

The Report recommended supporting pilot and demonstration projects, maintaining an efficient and equitable funding process, evaluating and sharing information, and establishing collection and processing systems in Manitoba (Manitoba Environment 1991). In terms of province-wide cooperation, the strategy recommended building on grassroots involvement, providing access for all Manitobans, and building on

existing strengths and capabilities (Manitoba Environment 1991). In terms of education and information, the strategy supported providing information to increase public awareness, providing education materials and activities, and strengthening technical skill development.

Importantly, the Report discusses progress made on the 56 recommendations of the RAC Plan (Manitoba Environment 1991). The following is a summary of the actions taken in response to specific RAC recommendations (Table 2.13).

Table 2.7 RAC Plan recommendations and action taken on recommendations

RAC No.	Recommendation	Action Taken
3	Target-setting for major subcategories of waste for the long-term goal of 50% reduction.	Manitoba Environment accepts these broad goals, it does not acknowledge the need to accept setting targets for major subcategories.
5	Target-setting for major subcategories of waste for the interim goal of 20% reduction.	Manitoba Environment accepts these broad goals, it does not acknowledge the need to accept setting targets for major subcategories.
6	Conducting a province-wide analysis of waste composition entering landfills.	Manitoba Environment agreed that waste composition data is important and is pursuing cost-sharing arrangements for accomplishing this with other levels of government.
28	The Minister of Environment establish a committee to prepare a viable strategy for composting by January 1991 and that would review existing operations and include representatives from the provincial and municipal government, universities, and community organizations.	The formation of the composting committee was delayed, but several initiatives relating to organic waste were supported.
41	The Government of Manitoba encourages municipalities and local government districts to form waste minimization regions or districts.	The Government of Manitoba supported one pilot regional waste management study for the Pembina Valley Development Corporation, from which more specific recommendations will be considered following its review.
44	The Government of Manitoba	This was under review by an

	encourages municipalities to levy charges for waste collection and handling on a per volume basis, rather than through property taxes.	Interdepartmental Recycling and Waste Management Working Group at the time the WRAP 1991 Report was issued.
45	The Government of Manitoba provides financial and technical assistance to municipalities to develop waste minimization plans.	This was were under review by an Interdepartmental Recycling and Waste Management Working Group at the time the WRAP 1991 Report was issued.

Source: Manitoba Environment 1991.

The Recycling Action Committee's recommendations seem to have all been addressed in a meaningful way. However, several important recommendations were ignored. For instance, the Recycling Action Committee recommended setting targets for major subcategories of waste for the long-term and interim goals; Manitoba Environment did not believe setting targets for major subcategories was required. Furthermore, while the Government of Manitoba did not disagree with the recommendations concerning acquiring waste composition data, establishing a composting strategy, encouraging municipalities to levy charges for waste collection, and providing provincial government funding for municipalities to develop waste management plans, these recommendations were either delayed or under review.

2.4.1.4 Waste Reduction and Prevention Strategy Report 1996

The Waste Reduction and Prevention (WRAP) 1996 Strategy Report was required to be produced under the *Waste Reduction and Prevention (WRAP) Act* (Manitoba Environment 1996). Although the WRAP Act requires the production of a Report on an annual basis, this Report was only the first produced since 1991; however, summaries of progress made since the WRAP 1991 Report were provided in Manitoba Environment's State of Environment Reports in 1993 and 1995 (Manitoba Environment 1996). The point

of the Report was to establish a plan to achieve the waste reduction target of 50% by building on experience since 1991 (Manitoba Environment 1996).

From 1990-1996, total provincial funding for 211 projects related to waste management was $5.9 million (see Table 2.14) (Manitoba Environment 1996). Municipalities were encouraged to examine the feasibility of regional waste management programs through the Regional Waste Management Assistance Fund, which provided over $400,000 to conduct 22 regional studies involving 90 municipal corporations from 1992 to 1994 (Manitoba Environment 1996). By 1993, it became evident that recycling programs were being heavily subsidized by volunteers and were in danger of collapse from volunteer burn-out (Manitoba Environment 1996). In addition, fee-for-service recycling programs were only able to attract an estimated 10% of Manitoba households (Manitoba Environment 1996). A stable source of funding was identified as a key factor limiting recycling expansion (Manitoba Environment 1996).

Table 2.8 Funding provided by the Government of Manitoba for various waste management activities (1990-1996).

Activity	Funding ($)	Percent of Total (%)
Recycling and Stewardship	2,735,167	46.22
Education and Awareness	1,484,113	25.08
Regional Waste Management	678,425	11.46
Market Development	516,719	8.73
Regional Recycling	391,725	6.62
Composting	112,000	1.89
Total	**5,918,149**	**100.00**

Source: Manitoba Environment 1996.

During this period, despite the enactment of the first regulation developed under the Waste Reduction and Prevention Act, the Beverage Container and Packaging Regulation, significant difficulties were met in terms of establishing stewardship programs for beverage containers and paper (Manitoba Environment 1996). For instance,

negotiations among the Canadian Industry Packaging Stewardship Initiative (CIPSI), Manitoba newspaper publishers, and the City of Winnipeg to develop a comprehensive recycling program failed in April 1994 (Manitoba Environment 1996). However, the Manitoba Product Stewardship Program (MPSP) was formed shortly thereafter, in 1995; the program was funded by a two cent WRAP levy applying to all non-deposit, non-dairy beverage containers (Manitoba Environment 1996). The MPSP Board, called the Multi-Material Stewardship Board, would eventually become known as the Manitoba Product Stewardship Corporation (Manitoba Environment 1996).

In the period 1990-1996, Manitoba experienced substantial progress in terms of its waste management system. In 1988, Manitobans generated 1000 kg of waste annually per capita; by 1994, Manitobans were generating 790 kg per capita annually (Manitoba Environment 1996). In addition, between 1991 and 1995, active municipal waste disposal sites decreased by 10% and, in 1996, an additional 57 sites were scheduled for closure (Manitoba Environment 1996). In 1996, recycling services were available to 85% of households and, in Winnipeg, 170,000 single family households were provided service, with an expansion to an additional 80,000 units planned (Manitoba Environment 1996). The City of Winnipeg curb-side pickup recycling program began in 1995 (Manitoba Environment 1996).

In 1996, it was estimated that about 40% of the total waste generated came from the residential sector; of this amount, it was estimated that about 40% of the residential waste stream was organic, 20% non-recyclable, and 40% potentially recyclable (Manitoba Environment 1996). In 1995, it was estimated that about 16% of eligible materials were recovered through MPSC (Manitoba Environment 1996). In terms of

recovered materials, 95% (41,798 tonnes) of Class A beverage containers and 26% (4,332 tonnes) of Class B beverage containers were recovered in the period 1993-1994[1], 113% (904,000) of tires generated in Manitoba were recovered in 1995, compared to less than 1% in 1991, and 17.5% (6,300,000 litres) of used oil was recovered, compared to 9% in 1991 (Manitoba Environment 1996).

The Report presented a strategy for waste management 1996-2000 (Manitoba Environment 1996). The categories of waste that were to be targeted in 1996 included used oil, filters, and containers; construction and demolition waste; and organic waste (Manitoba Environment 1996)

In 1995, the WRAP levy generated revenue of $5.6 million, of which $2.0 went to recycling support payments (Manitoba Environment 1996). Total MPSC materials collected was 15,559 tonnes (Manitoba Environment 1996). The 1995 MPSC Business Plan included the need for expansion of WRAP levies to other product packaging and paper fibres to meet the MPSC's projected financial need (Manitoba Environment 1996). However, a lower than anticipated tonnage recovery rate diminished the urgency for levy expansion (Manitoba Environment 1996).

The Report established the objective of having the diversion of organic waste integrated into all waste management programs operated by the municipal and industrial, commercial, and institutional (ICI) sectors by the year 2000 (Manitoba Environment 1996). The strategy recognized that composting of organic waste was necessary if Manitoba was going to reach its 50% diversion goal by 2000 (Manitoba Environment 1996). Plans for 1996 included establishing a multi-stakeholder working group to develop

[1] Class A beverage containers include the following: glass, liquor glass, P.E.T., aluminum, 2 piece steel; Class B beverage containers include the following: HDPE, other plastic, aseptic, table top, other steel, others.

an Organic Waste Diversion Action Plan, documenting activities and barriers with respect to organic waste, developing educational/promotional material for organic waste management, and providing financial support through SDIF (Manitoba Environment 1996). By 2000, the plan was to have a sustained program that contains systematic and comprehensive diversion or organic waste for the residential and ICI sectors (Manitoba Environment 1996).

A strategy for reducing waste at the source was also discussed, but only to the extent that this waste management option was not explored to any great depth between 1991 and 1996 (Manitoba Environment 1996).

2.4.1.5 Capital Region Waste Management Inventory

In the mid-1990s, Wardrop Engineering Inc. was retained by Manitoba Environment to survey the waste management activities in the Capital Region of Manitoba, which includes the following communities and rural municipalities: City of Winnipeg, Towns of Selkirk and Stonewall, and Rural Municipalities of East St. Paul, West St. Paul, St. Francois Xavier, St. Clements, Headingley, Cartier, Springfield, St. Andrews, Richot, Tache, Macdonald, Rosser, and Rockwood (Wardrop Engineering Inc. [WEI] 1996). The survey determined that there were 28 waste disposal grounds operating in the Capital Region, serving approximately 726,022 people (WEI 1996); in 1994, the City of Winnipeg disposed of 509,348 tonnes of waste (WEI 1996).

The following summarizes the kinds of recycling programs operating in the municipalities within the Capital Region: 75% had curb-side collection; 25% had bins for the commercial and industrial sectors; 81% had a depot for drop-off; 81% were members

of MPSP; 75% had a waste education program; and 25% had a program to collect and compost yard waste (WEI 1996).

Wardrop Engineering Inc. (1996) offered Manitoba Environment ten recommendations for improving waste management in the Capital Region; those recommendations are as follows:

1. A waste management plan for the Capital Region should be developed to address the following:
    a. Development of regional waste disposal grounds and recycling facilities;
    b. Development of waste disposal ground closure strategies;
    c. Economic analyses of transfer stations and haulage;
    d. Cooperative arrangements between members and other jurisdictions;
    e. Waste generation profile for the region;
    f. Development of waste minimization programs for the Region; and
    g. Environmental analysis of waste management activities.
2. Site suitability analyses should be conducted on all waste disposal grounds that are not planned to be closed within five years.
3. Environmental assessments should be performed on all closed waste disposal grounds;
4. Members should keep accurate records of their waste management costs and waste collection quantities;
5. A comprehensive waste education program should be developed for the Region;
6. A program for collect/disposal of household hazardous waste should be implemented;

7. Depot drop-off areas for recyclables should be provided in convenient locations by all members;
8. Tipping fees should be charged on large loads;
9. Members should consider operating a composting area within existing waste disposal grounds;
10. Tire storage compounds should be available within all jurisdictions.

Wardrop Environmental Inc. (1996) also identified the need for Capital Region cooperation with other municipalities outside the Region, and for an overall provincial waste management strategy to assist in coordination activities.

2.4.1.6 Manitoba Regional Waste Management Report 1999

The *Final Report of the Manitoba Regional Waste Management Task Force: Regional Solid Waste Management Action Plan and Recommendations* was produced through a multi-stakeholders consultation process and developed to better understand Manitoba's waste management system in comparison to other jurisdictions (Manitoba Conservation 1999). The purpose of the Task Force was to present a "regional solid waste management plan that would propose a vision for a province-wide solid waste management system that would minimize the risk to human health and the environment and support the continued growth of the Manitoba economy" (Manitoba Environment 1999: 3).

The Task Force (Manitoba Conservation 1999) presented several important trends in waste management found in other jurisdictions:

1. Establishment of waste reduction targets;

2. Large engineered landfills with better environmental protection;
3. Regionalization of waste management services and planning;
4. Increased transfer of solid waste (transfer stations);
5. High solid waste management regulatory standards (landfill design, designated facilities for other waste (e.g., organic waste);
6. Greater emphasis on waste reduction, diversion, and development of integrated solid waste management systems (e.g., integrated solid waste management systems, landfill bans, user-pay systems);
7. Movement toward product stewardship;
8. Employment of full-cost accounting (environmental, social, economic).

The Task Force highlighted several aspects of Manitoba's waste management system at the time (Manitoba Conservation 1999). Manitoba's Capital Region produced about 60% (560,000 tonnes) of Manitoba total waste (950,000 tonnes) in 1999 (Manitoba Conservation 1999). In 1999, there were 314 waste disposal grounds operating in Manitoba, including 11 Class 1 landfills, 77 Class 2 landfills, and 207 Class 3 landfills (Manitoba Conservation 1999). Since 1991, 127 landfills had closed; at the time, 53 transfer stations were operational (Manitoba Conservation 1999). In 1999, there were ten regional waste management systems that included three or more partners (Manitoba Conservation 1999). In addition, eight other regional waste management partnerships were being planned to be established over the following few years (Manitoba Conservation 1999).

The Task Force met with stakeholders to discuss various aspect of Manitoba's waste management system (Manitoba Conservation 1999). The following barriers to

regional waste management partnerships were identified by stakeholders (Manitoba Conservation 1999):

1. Getting approval to construct a Class 1 landfill, compared to approval to construct a Class 2 or 3 landfill, is much more difficult;
2. Perceived high cost;
3. Complacency and competing priorities;
4. Lack of a perceived problem with existing system;
5. Perceived lack of control within a partnership (decision making, costs);
6. Difficulty in coming to a fair cost sharing agreement;
7. Resistance to change;
8. Difficulty in establishing partnerships with other jurisdictions; and
9. Lack of technical assistance associated with the establishment of regional partnerships.

The following means by which barriers to regional waste management partnerships could be overcome were identified by stakeholders (Manitoba Conservation 1999):

1. Financial incentives;
2. More information and technical assistance;
3. Establishment of pilot projects to demonstrate the benefits of regional approach;
4. Education;
5. Support for regional planning and coordination;
6. Coordination was critical in establishing regional partnerships. These agencies were identified as being candidates for encouraging cooperation:

a. Department of Environment;

b. Association of Manitoba Municipalities;

c. Manitoba Planning Districts;

d. Stewardship organization;

e. New multi-sectoral agency or board.

Local governments identified several elements of Manitoba's waste management systems that they were interested in improving (Manitoba Conservation 1999):

1. Waste reduction;
2. Multi-material recycling and marketing;
3. Composting;
4. Waste disposal ground(s);
5. White goods recycling and ozone depleting substance recovery;
6. Used tire pick up service;
7. Used oil collection facilities; and
8. Household hazardous waste collection.

The Task Force provided general observations concerning Manitoba's regional and integrated waste management system (Manitoba Conservation 1999). These observations were presented by the Task Force as matters that may warrant attention by the Government of Manitoba (Manitoba Conservation 1999):

1. Local governments are on their own to determine the most effective kind of waste management system to adopt. The outcome of their determination is dependent on, and often limited by, resource constraints, a lack of incentives to establish

regional partnerships, limited evaluation of available options, and limited long term planning.

2. Training and certification for waste disposal grounds operators would be beneficial.
3. There is no funding program or coordinating agency in place to support the development of waste management systems.
4. Some waste management trends do not support Manitoba's efforts to increase waste reduction:
    a. Low cost waste disposal options;
    b. Large number of small waste disposal sites;
    c. Continued development of disposal sites in close proximity to other facilities;
    d. Lack of coordination, vision, and/or direction;
    e. Limited overall planning; and
    f. Increasing commercialization of waste services (public and private) and competition for waste volumes to increase landfill revenues.
5. There is a strategic opportunity to connect waste reduction to a greenhouse gas reduction strategy.
6. Disposal ground classification and environmental approval process discourages development of regional partnerships for populations greater than 5,000 and encourages development of small landfills.

7. To encourage broader waste minimization practices, weight based tipping fees and user pay systems of waste management should be implemented and promoted.
8. Improved coordination and planning between stewardship agencies and government departments is needed.
9. Northern and remote communities in Manitoba face unique solid waste management challenges that sometimes require programs that differ from those designed for communities in southern Manitoba.

The Task Force produced a waste management vision statement for Manitoba: "Manitoba will strive to develop an integrated waste management system that protects human wealth and the environment, reduces dependence on landfilling through waste reduction and diversion, and, where appropriate, activities will be coordinated and planned on a regional basis" (Manitoba Conservation 1999: 30). Specifically, the following provides some of the recommendations by the Task Force for consideration by the Government of Manitoba (Manitoba Conservation 1999).

Environmental Protection:

1. Require proposed waste management facilities to submit an environmental impact assessment and a regional impact assessment to address broader social and economic impacts, etc.;
2. Establish a uniform approval process for all waste management disposal facilities; and
3. Establish high environmental standards (e.g., eliminate waste disposal facilities posing an environmental risk).

Integrated Waste Management:

1. Continue to work toward 50% waste reduction beyond year 2000:
    a. Provide incentives for organic waste management and ensure that demonstration projects be implemented;
2. Develop integrated waste management activities on a regional basis;
3. Encourage all local governments to plan to be a part of a regional waste management system within 10 years:
    a. Province of Manitoba should designate or establish an agency to facilitate further development of regional waste management activities and support public and private sector planning of regional waste management systems;
4. Promote waste minimization practices and waste transfer over landfill disposal; and
5. Encourage local governments to adopt and regularly update an integrated regional waste management plan.

Regional Coordination:

1. Establish eight benchmark waste management districts to facilitate regional cooperation and planning:
    a. Allow boundaries to be flexible to allow formation of appropriate regional waste management systems over time;
2. Designate or establish a lead agency that will be responsible for coordinating the development of regional solid waste management systems.
3. Ensure consultation processes continue in developing and delivering integrated waste management systems;

4. Support waste minimization activities by enhancing coordination and partnerships between and among local governments and stewardship agencies.

Funding:

1. The Province of Manitoba should establish a funding program to support the development of regional integrated waste management systems; and
2. Funding for the development of new "regional" waste disposal facilities should be considered only if a plan is developed that demonstrates the need for the facility and shows that it is the only viable option for a municipality.

2.4.1.7 Green and Growing 2005

The Report *Green and Growing: Building a Green and Prosperous Future for Manitoba Families* outlines some of the milestones achieved in Manitoba's waste management system (Manitoba Energy, Science and Technology [MEST] 2005). In 2005, over 200 local governments received funds to operate residential recycling services from the two-cent levy on beverage containers paid by the manufacturer or seller (MEST 2005). Community recycling programs received more than $7.8 million in 2004/05 and recovered 70% of available materials (64,613 tonnes of eligible materials) (MEST 2005). Manitoba communities generated an additional $6 million in revenue for the sale of recyclable materials (MEST 2005).

In 2005, $3 million in revenue was generated annually by a product levy established and paid for by members of the Association for Resource Recovery (MEST 2005). Seventy EcoCentres and collection facilities were set up to collect oil, oil filters, and containers (MEST 2005). The recovery and recycling rate of used oil that is available

for recovery is almost 80% (MEST 2005). In 2004, about 1.6 million filters and 350,000 kg of containers were recovered and recycled (MEST 2005).

In 2004/05, for collecting tires at landfills, local governments received more than $60,000 and tire processors received almost $2.7 million (MEST 2005). As a result, about 14,000 tonnes of scrap tires were recycled and kept out of landfills (MEST 2005). In 2004/05 the Government of Manitoba announced new funding and that the tire stewardship board would shift to an industry-led model due to the success of the oil recycling program (MEST 2005).

In 2000, the Waste Reduction and Pollution Prevention Fund was established to stimulate organic composting and other waste reduction initiatives (MEST 2005). From 2000-2005, the WRAPP fund supported 147 projects, providing about $2.4 million in funding (MEST 2005).

2.4.1.8 Action on Climate Change 2008

The document *Beyond Kyoto: Manitoba's Green Future* included some highlights of Manitoba's waste management strategy (Manitoba Science, Technology, Energy and Mines [MSTEM] 2008). These highlights included new legislation requiring the capture or flaring of methane from large landfills to reduce methane emissions, the acknowledgement that changes to waste management in Manitoba would be beneficial to reach its greenhouse gas emission goal, and a retail sales tax exemption for manure treatment equipment, including slurry tanks, lagoon liners, biodigesters, composters, and separation systems (MSTEM 2008). In 2005, greenhouse gas emissions from Manitoba's waste management system were about 1.0 Mt (MSTEM 2008).

2.4.1.9 Manitoba Association for Resource Recovery Report 2008

The Manitoba Association for Resource Recovery Corp. (MARRC) is a non-profit corporation established in 1997 by manufacturers and marketers of lubricating products in Manitoba (Manitoba Association for Resources Recovery Corp. [MARRC] 2009). Its mandate is to develop, implement, and administer a cost-effective, sustainable, and user-financed, province-wide stewardship program for used oil, used oil filters, and used oil containers (MARRC 2009). MARRC derives revenue principally in the form of Environmental Handling Charges applied to the sale or consumption of selected lubricating products in Manitoba (MARRC 2009). In 2009, 72% of total recoverable used oil, 85% of total recoverable filters, and 27% of total recoverable containers were collected (MARRC 2009). In 2008, 53 EcoCentres were in operation, along with 22 other licensed collection facilities (MARRC 2009). In 2008, MARRC ran several educational campaigns for the public (MARRC 2009).

2.4.1.10 Manitoba Product Stewardship Corporation Report 2008/2009

In 2009, the Manitoba Product Stewardship Corporation (MPSC) produced an annual report highlighting its 14 years of results (Manitoba Product Stewardship Corporation [MPSC] 2009). Over the course of 14 years, the MPSC expanded recycling from 15,000 tonnes in 1995 to 70 million tonnes in 2009 (MPSC 2009). In 2001/2002, the MPSC achieved a 50% recovery rate from the household recycling stream (MPSC 2009). Between 1995 and 2009, the MPSC collected more than $100 million from the 2 cent levy on all non-deposit, ready to serve beverage containers, returning about $85

million to Manitoba communities based on tonnes collected; $6 million was invested in public awareness; $4 million was invest in school education programming; and $1.8 million was provided to municipal technical and promotion and education support (MPSC 2009). In 2009, the total population in participating communities reached 1,115,834 people (MPSC 2009).

2.4.1.11 Tire Stewardship Manitoba Annual Report 2009

Tire Stewardship Manitoba is a not-for-profit association formed as a stewardship agency to represent the tire retailers of Manitoba who manage a province-wide scrap tire recycling program (Tire Stewardship Manitoba 2010). The program is financially viable due to an eco-fee based revenue system that has varying eco-fees according to tire type to avoid cross-subsidization (Tire Stewardship Manitoba 2010). Tire Stewardship Manitoba is governed by a Board with representation from industry (Tire Stewardship Manitoba 2010). In 2009, there were 1300 registered collection points, there was a 93% diversion rate, and tire processors sold 1,431 tonnes of crumb rubber and manufactured goods within the recycled products market and produced 12,942 tonnes of tire derived aggregate and fuel for end use markets (Tire Stewardship Manitoba 2010).

2.4.2 Winnipeg's waste management strategy

On February 24, 2010, the Winnipeg City Council determined that the Council should direct the Public Service to develop a city-wide waste reduction plan in consultation with the public (City of Winnipeg 2010b). The plan should consider all options for reducing waste, including curb-side organics pickup as well as bi-weekly

collection schedules for some materials and include an early and orderly implementation schedule (City of Winnipeg 2010b). Specifically, the Council Decision adopted the following:

1. That the Winnipeg Public Service be authorized to negotiate an extension to the Collection of Recyclables Contract…and the Residential Automated Garbage Collection Services…for a period of 12 months to allow for completion of the waste management strategy.
2. That funding up to $350,000 be approved for an additional 2010 Capital Project with funding from the Solid Waste Utility for the preparation of the comprehensive waste management strategy.
3. That the Chief Administrative Officer be delegated authority to finalize the terms and conditions of the aforesaid extension agreements.
4. That the Proper Officers of the City be authorized to do all things necessary to implement the intent of the foregoing (City of Winnipeg 2010b).

The City of Winnipeg first adopted a waste management strategy in 1996; this strategy was updated in 2001 (City of Winnipeg 2010b). Since that time, Winnipeg's City Council has determined, the perspective on waste management has changed dramatically: that is, from the current practice of landfilling most of the waste stream to a resource recovery model that keeps valuable materials out of landfills (City of Winnipeg 2010b). The Council recognized the importance of organic waste diversion through composting as a means by which greater diversion rates can be achieved (City of Winnipeg 2010b).

The Council points out that in Winnipeg, as in much of the prairies, landfilling waste is a cheaper option than implementing resource recovery options (City of Winnipeg 2010b). While, the Council recognizes that a successful recycling program is operating in the City of Winnipeg, diverting about 17% of the total residential waste stream, it also recognizes that Winnipeg has one of the lowest diversion rates in Canada (City of Winnipeg 2010b). Therefore, it recommends that a comprehensive waste management strategy is required to increase diversion rates and better understand the opportunities associated with resource recovery (City of Winnipeg 2010b).

The Council expects, based on discussions with other municipalities, that the development of a comprehensive waste management strategy would take 12 to 16 months, although the Council does not anticipate any interruption in current services (City of Winnipeg 2010b). The application for a grant for up to 50% of the costs associated with this study will be made to the Federation of Canadian Municipalities' Green Municipal Fund (City of Winnipeg 2010b).

2.4.2.1 Winnipeg's organic waste management strategy

On February 24, 2010, the Winnipeg City Council adopted the following with respect to an organic waste management strategy:

1. That a curb-side collection program be implemented in the North-West automated cart collection area in order to collect surplus yard waste during the peak spring and fall period.
2. That the St. James area Leaf-it-with-Us depot be closed after the implementation of recommendation 1.

3. That the City contract out the collection program as well as the construction and operation of a yard waste composting facility to promote the anticipated yard waste.
4. That the Proper Officers of the City be authorized to do all things necessary to implement the intent of the foregoing (City of Winnipeg 2010a).

The following (City of Winnipeg 2010a) represents the strategies that were identified as feasible to the Council with respect to managing organic waste in the City of Winnipeg (strategy #2 was chosen, as indicated above):

1. Depot Program – Status Quo: continue with the yard waste collection program, which collected approximately 5,000 tonnes of spring and fall yard waste at the 12 Leaf-it-with-Us drop-off depots city-wide.
2. Manual collection of about 19,000 tonnes of bagged yard waste city-wide, using certified compostable bags. The City will contract the collection of yard waste, and yard waste processing for compost. The estimated cost is approximately $1,043,000 annually for the whole city; $232,000 for the north-west sector that already has the automated collection carts.
3. Seven month (May to November) yard waste collection program: city-wide manual collection of about 42,000 tonnes of bagged yard waste, Estimated program cost is $2,217,000.
4. Twelve month (year-round) organics and yard waste curb-side collection: city-wide manual collection of kitchen and bagged yard waste – about 64,400 tonnes of bagged waste. Cost: $4,995,000.

2.4.3 Audit of Manitoba's management of contaminated sites and landfills

In 2007, the Office of the Auditor General (OAG) released a document titled *Audit of the Province's Management of Contaminated Sites and Landfills,* which outlined how the Government of Manitoba should be managing its contaminated sites and landfills (Office of the Auditor General [OAG] 2007). The OAG provided recommendation in these five broad groups:

1. Oversight and financial reporting of contaminated sites by entities and municipalities;
2. Department of Conservation's oversight of contaminated sites;
3. Department of Conservation's oversight of landfills;
4. Financial reporting of environmental liabilities of the government reporting entity in the public accounts; and
5. Municipal management of contaminated sites and landfills and the financial reporting of associated environmental liabilities (OAG 2007).

With respect to landfills, the OAG made 30 recommendations. Most of the recommendations involved improving and making more rigorous the licensing and permitting process, improving environmental monitoring and protection, enhancing communication between government and owners and operators of landfills, and ensuring compliance with legislation (OAG 2007). The following summarizes the OAG's conclusions: the risks, liabilities, and due diligence associated with landfills was not adequately addressed by legislation; protection of the environment was not ensured by policy and procedures to guide the management of landfills; and the licensing of landfills

was inconsistent for landfills with similar risks: the Brady Road landfill, by far the largest in Manitoba, was operating under a less stringent environmental license than other, far smaller Class 1 landfills (OAG 2007).

2.4.4 Other comments on Manitoba's waste management

To achieve sustainable waste management, an integrated waste management approach is desirable (Haque and Hamberg 1996). The key components of an integrated waste management strategy include source reduction, reuse, recycling, resource recovery through energy recovery, and land disposal of residual materials (Haque and Hamberg 1996). One strategy can be compared to another by assessing "its ability to generate less waste, conserve more raw material resources, save more energy, and create fewer environmental impacts (Haque and Hamberg 1996: 250). Strategies for waste management should be viewed in light of population distribution patterns: in Manitoba, a large percentage of the population lives in the capital city (Haque and Hamberg 1996). In addition, about 90% of Manitoba's population lives within 200 km of its southern border with the United States (Haque and Hamberg 1996); this means, given that the length of the Manitoban border with the United States is about 497 km long (International Boundary Commission n.d.) and assuming that Manitoba's eastern and western boarders are perpendicular to the boarder with the United States, about 90% of Manitoba's population lives in an area of 99,400 km^2. This area is about 15% of Manitoba's total area, as well as an area 80% larger than Nova Scotia and 36% larger than New Brunswick (Statistics Canada 2005b). As we have seen, both Nova Scotia and New Brunswick have successful waste management strategies, insofar as they reduce waste disposal and

increase waste diversion. Given that a vast majority of Manitobans live within a similar sized area of land to provinces that operate successful waste management strategies, Manitoba's large size, and its resultant population distribution, is no excuse for its poor track record when it comes to waste diversion and disposal. However, there has been a wide-spread belief among Manitobans that because Manitoba is so large and sparsely populated, there is abundant land suitable for waste disposal, which is one reason why recycling began later in Manitoba than in other provinces (Haque and Hamberg 1996). Interestingly, between 1990 and 1996, governments placed a far greater emphasis on residential recycling, rather than on reduction and reuse strategies: this is possibly due to the former requiring little or no government action (Haque and Hamberg 1996). As Hamburg, Haque, and Everitt (1997) pointed out at the time, the participation level of recycling programs in Manitoba during the mid-1990s was well below the level that would have been required to attain the goal of a 50% reduction in waste disposal by 2000. Indeed, according to Haque and Hamberg (1996), the Government of Manitoba's general strategy was at fault, since a wide range of actions was needed, not a narrowly focused strategy, to achieve its waste management goals by 2000. Interestingly, Haque and Hamberg (1996) identified the waste management strategy at the time as "centered on ideas and superficial plans rather than specific schemes for any definite action. Considering the current development of reduction practices, it will be difficult to attain by AD 2000 the stated goal for a 50% reduction from the 1988 level of amount of waste going to landfill" (264). Indeed, these authors predicted correctly: Manitoba failed to achieve this goal. In 2006, per capita waste disposal in Manitoba had fallen to 869 kg,

which is a 13.1% decrease from the 1000 kg per capita waste disposal rate in 1988 (Recycling Action Committee 1990, Statistics Canada 2008c)

2.5 Conclusion

Properly implemented, sustainable development allows society to strike a balance among the social, economic, and environmental spheres. Although environmental concerns, particularly in the form of climate change, are pervading public thought and action, social and economic concerns cannot be lightly pushed aside. Indeed, environmental concerns *are* social and economic concerns; and, other social and economic matters are important in their own right. Social and economic considerations, such as wealth distribution, intergenerational equity, and the precautionary principle, must be taken into account when acting to prevent climate change; otherwise, the sacrifice of this generation for future generations may be too large or too small. Governments must also recognize that artificially increasing the price of unwanted practices, such as landfilling, is useful for increasing the rates of wanted practices, such as waste diversion. However, raising tipping fees at landfills is only one option among many to increase waste diversion in Manitoba and Canada, in general. What is needed to produce a sustainable waste management system is an integrated waste management system that is tailored to specific elements of the waste stream. Indeed, as Manitoba clearly demonstrated throughout the 1990s, relying on residential recycling, alone, to reduce waste disposal failed to achieve its goal of 50% reduction in waste disposal. Therefore, in our frenzy to address climate change, we must not forget that our

development path should be one that encompasses many kinds of policy options that are amenable to maximizing the public good of present and future generations, alike.

CHAPTER 3: METHODOLOGY

3.1 Introduction

The method is constructed for the purpose of meeting the objectives, as reiterated in this section.

3.1.1 Objectives and method

The objectives, presented in Chapter 1, are listed below, as well as the means by which they were achieved:

1) Ascertain expert stakeholder opinions of the waste management sector in Manitoba, specifically concerning organic waste management.
    a. Every community in Manitoba that had a population over 1,000 people was contacted to conduct a written survey or phone interview with a local expert concerning his/her perspective on organic waste management; a census of these communities was conducted to determine the activities on-going relating to organic waste management. There were 102 communities in Manitoba that fit this description based on the 2006 census (Manitoba Local Government n.d.) and one municipality was contacted that had a population less than 1,000 people. In general, the Chief Administrative Officer (CAO) was contacted in order to determine the person with which to speak regarding waste management in the respective community. Additional contacts were found by asking survey participants to provide contact information of people they deemed suitable for the survey; it was

through this method of discovering potential participants that I came to interview someone from a community of less than 1,000 people. The opinions and perspectives gathered by the written surveys and phone interviews were compiled so that common patterns and themes were made evident.

b. Next, a group of eight survey participants gathered in June, 2010 to present the survey results for feedback and validation and to discuss potential options for waste management in Manitoba. The participants included people from the cities of Winnipeg and Brandon (with populations of 687,619 and 51,350, respectively), which are the two largest cities in Manitoba, representing about 61% of Manitoba's total population (Manitoba Health and Healthy Living 2009). The purpose of the meeting was to enter into a greater depth of discussion of waste management options than is possible on a written survey or interview. A note-taker was used to record the discussion.

2) Determine best practices for waste management.

a. The waste management schemes in Manitoba, Canada, Nova, Scotia Canada, New South Wales, Australia, and Denmark were studied through a literature review and personal communications in order to determine best practices for the management of waste. Organic waste management strategies were compared for effectiveness at achieving various goals, including waste diversion, producing compost, creating local jobs, developing long term, sector specific waste management strategies, and

constructing partnerships. Manitoba, Canada is the focus of this research while the other jurisdictions were selected because of their extensive waste management strategies, which include organic waste composting of some kind.

3) Determined the amount of organic waste entering, and the amount of greenhouse gases (methane) released from, landfills in Manitoba.

    a. An estimation of the amount of organic waste going into landfill was derived by taking the following steps:

        i. A residential waste composition study of Brady Road Landfill in 2000 was used to estimate organic waste disposal for the City of Winnipeg in 2006 (Table 3.1);

        ii. Two waste composition studies were used to estimate a low and high organic waste disposal for communities other than Winnipeg in 2006;

        iii. The waste disposal rate of the Brandon Landfill in 2006 was used to check the accuracy of the waste disposal rate for communities in Manitoba excluding Winnipeg

        iv. Data on population and waste generation, disposal, and diversion in Manitoba were retrieved from Statistics Canada; and

        v. Data on diversion rates from communities other than Winnipeg were retrieved from the now-defunct MPSC website.

Table 3.1 The fractions of the residential waste stream entering Brady Road Landfill that are organic.

Category	Percent of MSW (by weight)
Paper and textiles	31.0%
Food waste	26.1%

Garden, park waste and other organics	6.6%
Wood and straw waste	2.3%
Total	**66.0%**

Source: Earthbound Environmental 2000

b. An estimation of the methane released from landfills in Manitoba was derived by taking the following steps:

   i. Both the RETScreen Clean Energy Project Analysis Software and Scholl Canyon Model were used to estimate methane emissions from landfills in Manitoba;

   ii. Inputs into the models were based on estimates at the Brady Road Landfill (Table 3.2). The methane generation constant (k) was calculated by using an equation from Thompson et al. (2009) and the average rainfall pattern at the Winnipeg Richardson International Airport between 1971 and 2000 (Environment Canada Weather Office Environment Canada 2006). The percent of landfill gas that is methane at Brady Road Landfill was based on a study by Tanapat (2004). The methane generation rate from waste (Lo) at Brady Road Landfill was taken from Thompson et al. (2009). All waste in Manitoban landfills was assumed to be under these conditions;

   iii. To check the accuracy of RETScreen, an estimate of methane emissions was made for the Brady Road Landfill in Winnipeg, from which 10 years of waste quantities had been received. Brady Road Landfill reports its methane emissions to Environment Canada;

iv. As waste data was unavailable for every landfill in Manitoba, methane was calculated by developing a model for one large landfill that excluded waste entering the Brady Road and Summit Road landfills. There are well over 200 landfills operating in Manitoba (Green Manitoba n.d.a); and

v. Waste data in Manitoba between 1990 and 2006 were used (Green Manitoba n.d.a, Statistics Canada 2008a); an estimate of the waste landfilled in Manitoba in 2009 was acquired by using a Growth Trend and Linear Trend analysis in Microsoft Excel 2003. Waste entering either the Brady Road or Summit Road landfills was subtracted from the total value. Summit Road landfill data was estimated in 1990 by assuming that Winnipeg has had a consistent 38% contribution to the total waste disposed in Manitoba (which is the average between 2000 and 2009).

Table 3.2 Inputs into RETScreen and Scholl Canyon Model.

Input	Value
Methane generation constant (k)	0.023
Methane by volume of landfill gas (%)	56
Methane generation from waste (Lo) (m^3/tonne)	136

REFERENCES

Abbasi, P. A., J. Al-Dahmani, F. Sahin, H. A. J. Hoitink, and S. A. Miller. 2002. Effect of compost amendments on disease severity and yield of tomato in conventional and organic production systems. Plant Disease 86:156-161.

Ackerman, F. 2000. Waste Management and Climate Change. Local Environment 5(2): 223-229.

Anand, S., and A. Sen. 2000. Human development and economic sustainability. World Development 28(12):2029–2049.

Aye, L., and E. R. Widjaya. 2006. Environmental and economic analyses of waste disposal options for traditional markets in Indonesia. Waste Management 26:1180–1191.

Barlaz, M. A., G. Green, J. P. Chanton, C. D. Goldsmith, and G. R. Hater. 2004. Evaluation of a biologically active cover for mitigation of landfill gas emissions. Environmental Science and Technology 38:4891–4899.

Barrieu, P., and B. Sinclair-Desgagné. 2006. On precautionary policies. Management Science 52(8):1145–1154.

Beede, D. N., and D. E. Bloom. 1995. The economics of municipal solid waste. The World Bank Research Observer 10(2):113–150.

Bishop, R. C. 1993. Economic efficiency, sustainability, and biodiversity. Ambio 22(2/3):69–73.

Bogner, J., and E. Matthews. 2003. Global methane emissions from landfills: New methodology and annual estimates 1980-1996. Global Biogeochemical Cycles 17(2):34-1–34-18.

Bogner, J., M. Abdelrafie Ahmed, C. Diaz, A. Faaij, Q. Gao, S. Hashimoto, K. Mareckova, R. Pipatti, T. Zhang. 2007. Waste Management. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Retrieved October 24, 2010 from <http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter10.pdf>.

Bonam, R. 2009. Understanding Waste from a Climate Change Perspective: Municipal Solid Waste Management in Canada (Master's thesis). Retrieved November 26, 2010 from <http://umanitoba.ca/institutes/natural_resources/pdf/theses/Masters%20Thesis%20Bonam%202009.pdf>.

Borjesson, G., B. Samuelsson, J. Galle, and B. H. Svensson. 2000. Methane emissions from landfills: Options for measurement and control. Stratford-upon-Avon.

Braber, K. 1995. Anaerobic digestion of municipal solid waste: a modern waste disposal option on the verge of breakthrough. Biomass and Bioenergy 9:365–376.

Chynoweth, D. P., J. Owens, D. O'Keefe, J. F. K. Earle, G. Bosch, and R. Legrand. 1992. Sequential batch anaerobic composting of the organic fraction of municipal solid waste. Water Science and Technology 25:327–339.

City of Vancouver. 2009. Vancouver Landfill & Vancouver South Transfer Station rates. Engineering Services. Retrieved February 20, 2009 from http://vancouver.ca/engsvcs/solidwaste/landfill/rates.htm

City of Winnipeg. 2009. Brady Road Landfill. Retrieved February 20, 2009 from http://www.winnipeg.ca/WaterandWaste/garbage/bradyroad.stm

City of Winnipeg. 2008a. Water and waste. Retrieved June 20, 2008 from http://www.winnipeg.ca/waterandwaste/recycle/recyclingReport.stm

City of Winnipeg. 2008b. Water and waste. Retrieved June 20, 2008 from http://www.winnipeg.ca/waterandwaste/garbage/residentialReport.stm

City of Winnipeg. 2010a. Organic Collection Options. Report – Standing Policy Committee on Infrastructure Renewal and Public Works – February 9, 2010. Minute No. 232.

City of Winnipeg. 2010b. Preparation of a Comprehensive Waste Management Strategy. Report – Standing Policy Committee on Infrastructure Renewal and Public Works – May 25, 2010. Minute No. 442.

Christensen, T. H., P. Kjeldsen, P. L. Bjerg, B. D. Jensen, J. B. Christensen, A. Baun, H. J. Albrechtsen, and G. Heron. 2001. Biogeochemistry of landfill leachate plumes. Applied Geochemistry 16:659–718.

Curmally, A. 2004. Exploring Economic Incentives for Effective Solid Waste Management in Rhode Island. Retrieved January 19, 2009 from http://envstudies.brown.edu/oldsite/env/theses/master0304/Curmally_Atiyah/Atiyah%20Curmally.pdf

Czepiel, P., J. Shorter, R. Harriss, C. Kolb, and B. Lamb. 2002. The influence of atmospheric pressure on whole-landfill methane emissions observed during a multi-season study. Scientific poster. Retrieved July 7, 2008 from http://lst.sb.luth.se/iclrs/web/post2002/ppt/poster/Czepiel.pdf

David, A. 2007. Overview of municipal solid waste (MSW) management in Canada. Environment Canada. *Government of Canada*. In proceedings "Municipal Waste Management Workshop: Different Approaches and Solutions." Retrieved January 16, 2009 from http://www.awma-ovc.ca/AWMA_OVC_WMWorkshop_Alain_David.pdf

Denman, K. L., G. Brasseur, A. Chidthaisong, P. Ciais, P. M. Cox, R. E. Dickinson, D. Hauglustaine, C. Heinze, E. Holland, D. Jacob, U. Lohmann, S. Ramachandran, P. L. da Silva Dias, S. C. Wofsy and X. Zhang. 2007. Couplings Between Changes in the Climate System and Biogeochemistry. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor and H. L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Division for Sustainable Development. n.d.. *U.N. Department of Economic and Social Affairs*. Retrieved February 18, 2009 from http://www.un.org/esa/dsd/dsd/dsd_index.shtml

El-Fadel, M., A. N. Findikakis, and J. O. Leckie. 1997. Environmental Impacts of Solid Waste Landfilling. Journal of Environmental Management 50:1–25.

Electronics Product Stewardship Canada. n.d. EPSC's Industry-Led Provincial Programs. Retrieved October 26, 2010 from <http://www.epsc.ca/>.

Elliott, A. 2008. Is composting organic waste spreading? *Statistics Canada*. *Government of Canada*. Retrieved January 19, 2009 from http://www.statcan.gc.ca/pub/16-002-x/2008001/10540-eng.htm#4

Environment Canada. 2009. Canada's 2006 Greenhouse Gas Inventory. *Government of Canada*. Retrieved February 11, 2009 from http://www.ec.gc.ca/pdb/ghg/inventory_report/2006/tab_eng.cfm

Environment Canada. 2007. Landfill gas – overview. *Government of Canada*. Retrieved February 11, 2009 from http://www.ec.gc.ca/wmd-dgd/default.asp?lang=En&n=10E36DBA-1

Environment Canada. 2006. Greenhouse gases. *Government of Canada*. Retrieved January 16, 2009 from http://www.ec.gc.ca/pdb/ghg/about/gases_e.cfm

Environment Canada Weather Office Environment Canada. 2006. Canadian climate normals or averages 1971-2000. Retrieved July, 2007. <http://www.climate.weatheroffice.ec.gc.ca/climate_normals/index_e.html>.

European Compost Network. n.d.. Biological waste treatment in Europe – technical and market developments. Retrieved January 19, 2009 from http://www.compostnetwork.info/index.php?id=10

Ferrara, I., and P. Missios. 2005. Recycling and Waste Diversion Effectiveness: Evidence from Canada. Environmental & Resource Economics 30:221–238.

Folke, C., S. Carpenter, T. Elmqvist, L. Gunderson, C. S. Holling, and B. Walker. 2002. Resilience and sustainable development: Building adaptive capacity in a world of transformations. Ambio 31(5):437–440.

Forster, P., V. Ramaswamy, P. Artaxo, T. Berntsen, R. Betts, D. W. Fahey, J. Haywood, J. Lean, D. C. Lowe, G. Myhre, J. Nganga, R. Prinn, G. Raga, M. Schulz, and R. Van Dorland. 2007. Changes in Atmospheric Constituents and in Radiative Forcing. *In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor and H. L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Friesen, B. March 2000. Landfill Ban Stimulates Composting Programs in Nova Scotia. BioCycle Magazine 41(3):53.

Gollier, C., B. Jullien, and N. Treich. 2000. Scientific progress and irreversibility: an economic interpretation of the 'Precautionary Principle.' Journal of Public Economics 75:229–253.

Green Manitoba. N.d.a. History of waste minimization in Manitoba. *Government of Manitoba*. Retrieved June 23, 2010 from <http://www.greenmanitoba.ca/cim/dbf/history.pdf?im_id=150&si_id=1001>.

Green Manitoba. N.d.b. Landfill levy program (WRARS). *Government of Manitoba*. Retrieved October 24, 2010 from <http://www.greenmanitoba.ca/cim/1001C7_1T1T19T777T3T123T12T753T13T1551.dhtm>.

Hamburg, K. T., C. E. Haque, and J. C. Everitt. 1997. Municipal waste recycling in Brandon, Manitoba: Determinants of participatory behaviour. *The Canadian Geographer* 41(2): 149-165.

Haque, C. E., and K. T. Hamberg. 1996. The challenge of waste stewardship and sustainable development: A study of municipal waste management in rural Manitoba. *Great Plains Research* 6: 245-268.

Huhtala, A. 1997. A post-consumer waste management model for determining optimal levels of recycling and landfilling. *Environmental and Resource Economics* 10:301–314.

International Boundary Commission. N.d. Boundary Facts. Retrieved October 28, 2010 from <http://www.internationalboundarycommission.org/boundaryfacts.html>.

IPCC. 2007. Summary for Policymakers. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor and H. L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom, and New York, NY, USA.

Kjeldsen, P., M. A. Barlaz, A. P. Rooker, A. Baun, A. Ledin, T. H. Christensen. 2002. Present and long-term composition of MSW landfill leachate: A review. Critical Reviews in Environmental Science and Technology 32(4):297–336.

Lay, J., Y. Li, and T. Noike. 1996. Effect of moisture content and chemical nature on methane fermentation characteristics of municipal solid wastes. In proceedings:

Japan Society of Civil Engineers. Journal of Environmental Systems and Engineering Div. 1: 101–108.

Manitoba Association for Resources Recovery Corp. [MARRC]. 2009. 2008 annual report.

Manitoba Conservation. 1999. Final report of the Manitoba regional waste management task force: Regional integrated waste management action plan and recommendations. *Government of Manitoba*.

Manitoba Energy, Science and Technology [MEST]. 2005. Green and growing: Building a green and prosperous future for Manitoba families. *Government of Manitoba*.

Manitoba Environment. 1991. Waste reduction and prevention: 1991 strategy report. *Government of Manitoba*.

Manitoba Environment. 1996. Waste reduction and prevention: Waste reduction and prevention strategy report 1996. *Government of Manitoba*.

Manitoba Local Government. n.d. Municipalities. Government of Manitoba. Retrieved May 17, 2010 from <http://web5.gov.mb.ca/public/municipalities.aspx>.

Manitoba Product Stewardship Corporation [MPSC]. 2009. 2008/2009 annual report: Fourteen years of recycling success, performance and results.

Manitoba Science, Technology, Energy and Mines. 2008. Beyond Kyoto: Manitoba's green future. *Government of Manitoba*.

McCabe, D. J. 1976. Progress Report of Efforts Completed during the Second Year of Baled and Unbaled Solid Waste Studies. System Technology Corp., Xenia, Ohio.

Min, H., and W. P. Galle. 1997. Green purchasing strategies: Trends and implication. The Journal of Supply Chain Management 33(3):10–17.

Mohareb, A. K., M. Warith, R. M. Narbaitz. 2004. Strategies for the municipal solid waste sector to assist Canada in meeting its Kyoto Protocol commitments. Environmental Revue 12:71–95.

Nevens, F., and D. Reheul. 2003. The application of vegetable, fruit and garden waste (VFG) compost in addition to cattle slurry in a silage maize monoculture: nitrogen availability and use. European Journal of Agronomy 19:189–203.

Office of the Auditor General [OAG]. 2007. Audit of the Province's Management of Contaminated Sites and Landfills. *Government of Manitoba*.

Okeke, C., and A. Armour. 2000. Post-landfill siting perceptions of nearby residents: a case study of Halton landfill. Applied Geography 20:137–54.

Otten, L. 2001. Wet-dry composting of organic municipal solid waste: current status in Canada. Canadian Journal of Civil Engineering 28:124–130.

Pinamonti, F. 1998. Compost mulch effects on soil fertility, nutritional status and performance of grapevine. Nutrient Cycling in Agroecosystems 51:239–248.

Read, A. D. 1999. Making waste work: Making UK national solid waste strategy work at the local scale. Resource, Conservation and Recycling 26:259–285.

Recycling Action Committee. 1990. Action plan: A waste minimization strategy for Manitoba in the 1990s. *Prepared for Manitoba Environment, Government of Manitoba*.

Renkow, M., and A. R. Rubin. 1998. Does municipal solid waste composting make economic sense? Journal of Environmental Management 53:339–347.

Sathaye, J., A. Najam, C. Cocklin, T. Heller, F. Lecocq, J. Llanes-Regueiro, J. Pan, G. Petschel-Held , S. Rayner, J. Robinson, R. Schaeffer, Y. Sokona, R. Swart, H.

Winkler. 2007. Sustainable Development and Mitigation. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O. R. Davidson, P. R. Bosch, R. Dave, L. A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Spokas, K., J. Bogner, J. P. Chanton, M. Morcet, C. Aran, C. Graff, Y. Moreau-Le Goluan, and I. Hebe. 2006. Methane mass balance at three landfill sites: What is the efficiency of capture by gas collection systems? Waste Management, 26(5):516–525.

Statistics Canada. 2008a. Disposal and diversion of waste, by province and territory, 2004 and 2006 (Diverted materials per capita). *Government of Canada*. Retrieved May 4, 2010 from <http://www40.statcan.ca/l01/cst01/envir32d-eng.htm>.

Statistics Canada. 2008b. Waste management industry survey: Business and government sectors. *Government of Canada*. Catalogue no. 16F0023X.

Statistics Canada. 2005. Human activity and the environment: Solid waste in Canada. *Government of Canada.* Catalogue no. 16-201-XIE.

Statistics Canada. 2005b. Land and freshwater area, by province and territory. *Government of Canada*. Retrieved Mar 4, 2010 from <http://www40.statcan.ca/l01/cst01/phys01-eng.htm>.

Tanapat, S. 2004. A feasibility study of municipal waste-to-energy management: Measurement of landfill gas quality at Brady Road Landfill in Canada. Unpublished Master's thesis, University of Manitoba, Winnipeg, Canada.

The Natural Step. n.d.. The Four System Conditions. Retrieved March 6, 2009 from http://www.thenaturalstep.org/en/canada/the-system-conditions

Thompson, S., J. Sawyer, and J. E. Valdivia. 2009. Building a better methane generation model: Validating models with methane recovery rates from 35 Canadian landfills. *Waste Management* 29(7): 2085-2091.

Thompson, S., and R. Bonam. Best practices for expanding the life of landfills: Results of a 2005 Canadian landfill survey. Unpublished Manuscript.

Thompson, S., J. Sawyer, R. Bonam, and S. Smith. 2006. Recommendations for Improving the Canadian Methane Generation Model for Landfills. University of Manitoba prepared for Environment Canada, March 2006.

Tiehm, A., K. Nickel, and U. Neis. 1997. The use of ultrasound to accelerate the anaerobic digestion of sewage sludge. Water Science and Technology 36(11): 121–128.

Tire Stewardship Manitoba. 2010. 2009 annual report.

Tuomela, M., M. Vikman, A. Hatakka, and M. Itävaara. 2000. Biodegradation of lignin in a compost environment: a review. Bioresource Technology 72:169–183.

van der Werf, P., and M. Cant. 2007. State of Composting in Canada, part 2. Solid Waste Magazine December/January: 43–46.

Wardrop Engineering Inc. [WEI]. 1996. Capital region waste management inventory: Volume 1 of 2. *Prepared for Manitoba Environment, Government of Manitoba.*

WCED. 1987. Our common future: World Commission on Environment and Development. Oxford University Press, Oxford.

Westerman, P. W., and J. R. Bicudo. 2005. Management considerations for organic waste use in agriculture. Bioresource Technology 96:215–221.

Wilson, E. J., F. R. McDougall, and J. Willmore. 2001. Euro-trash: Searching Europe for a more sustainable approach to waste management. Resource, Conservation and Recycling 31:327–346.

CHAPTER 4: SURVEY AND MEETING OF EXPERT STAKEHOLDERS: ORGANIC WASTE MANAGEMENT PERSPECTIVES IN MANITOBA, CANADA

4.0 Introduction

In 2006, Canada had an overall waste diversion rate of about 22.0% (Statistics Canada 2008). In 2009, by far the largest municipality in the province of Manitoba was Winnipeg, with about 55.2% of the provincial population; the second largest city in Manitoba was Brandon, which had about 4.2% of the provincial population (City of Winnipeg 2010a, Manitoba Health and Healthy Living 2009). At this time, Winnipeg had a diversion rate of about 9.9%, although its residential waste diversion rate was about 19.2% (City of Winnipeg 2010a, City of Winnipeg 2010b, City of Winnipeg 2010c, T. Kuluk personal communication April 9, 2010). In 2006, the province of Manitoba had an overall diversion rate of 13.0% (Statistics Canada 2008). Considering the low diversion rates in Winnipeg and Manitoba compared to other municipalities and provinces in Canada, Manitoba's waste management system is in need of change: specifically, the inclusion of an organic waste diversion program, particularly in the City of Winnipeg, would be helpful in achieving a higher diversion rate. The Federation of Canadian Municipalities and the Government of Nova Scotia, for instance, have provided a guideline and an example, respectively, for how to implement successful waste management strategies.

Federation of Canadian Municipalities

Canadian municipalities are increasingly recognizing that targeting organic waste is critical to achieving a high rate of waste diversion (Federation of Canadian Municipalities [FCM] 2009). According to FCM (2009), many municipalities in Canada are implementing waste management options for organic waste; the following list describes some successful waste management activities within certain Canadian communities:

- Regional District of Nanaimo, British Columbia:
    - Commercial and institutional food waste landfill ban;
    - Curb-side collection of residential food waste; and
    - Population of 146,000 and a diversion rate of 64%
- Hamilton, Ontario:
    - Curb-side collection of residential food waste and yard waste; and
    - Population of 518,200 and a diversion rate of 44%.
- Owen Sound, Ontario:
    - A landfill ban on yard waste;
    - An outdoor windrow composting site for yard waste;
    - Subsidizes backyard composters; and
    - Population of 21,800 and a diversion rate of 51%.
- Victoriaville, Quebec:
    - Three-stream curb-side pickup program;
    - Optional pickup food and yard waste (80% participation rate);
    - Automated collection vehicles;

    - Collects yard waste seasonally in paper bags; and
    - Population of 41,316 and a diversion rate of 64%.
- Charlottetown, Prince Edward Island:
    - Three-stream curb-side pickup program;
    - Weekly pickup of food waste;
    - Spring and fall yard waste pickup program;
    - Mandatory organic waste diversion program for residents and business; and
    - Population of 32,200 and a diversion rate of 60% (FCM 2009).

According to the FCM (2009), the following lessons have been learned from communities that have implemented effective waste management strategies:

- Provincial government assistance with recycling can help offset the cost of recycling and reduce the market variability for recycled materials;
- Public involvement in decision-making can improve community buy-in;
- Consulting businesses is useful since they may be able to develop models that can adapt to change (e.g., in markets);
- Regional waste management programs are key to the efficient management of waste in rural communities;
- A waste management strategy is needed;
- Allowing sufficient time for planning, developing, and implementing waste management options is critical;
- Bylaws can increase waste diversion by increasing public awareness and participation;

- Twelve-month pilot programs are effective for testing and promoting new initiatives;
- Clear disposal bags allow for proper enforcement of source separated waste;
- Residents are often motivated by environmental and/or social concerns;
- Residents should be given warning when violating bylaws;

Municipalities should build on previous successes to gain support.

Another model that might be useful to consider, other than those produced by individual municipalities, is the waste management strategy implemented by the Government of Nova Scotia.

Nova Scotia

In 1989, the Government of Nova Scotia decided to set the target of reducing waste disposal by 50% by the year 2000 compared to 1989 levels (Wagner and Arnold 2008). In 1993, the Government of Nova Scotia initiated the process of developing an integrated waste management system by administering a series of studies to determine how to proceed in order to meet their waste diversion goal (Wagner and Arnold 2008). The studies found that economies of scale could be realized through regional and municipal collaboration (Wagner and Arnold 2008). Then, in 1995, based on seven public consultations, Nova Scotia's Solid Waste-Resource Management Strategy was created (Wagner and Arnold 2008). This provincial strategy had the broad goals of achieving a 50% disposal reduction by 2000, create more stringent standards for waste disposal, reduce waste management costs through regionalization of services, and to recognize waste as a resource with economic value (Wagner and Arnold 2008). In 1995, seven solid

waste management regions were created based on studies of demographics and waste management needs and capacity (Wagner and Arnold 2008). These waste management regions, along with the 55 municipalities contained within them, are largely responsible for implementing their waste management regimes (Wagner and Arnold 2008). The municipalities and regions are partially funded through the RRFB, which operates a deposit/refund system for beverage containers and provides some of the funds from that system to municipalities; however, the RRFB is also responsible for public education and awareness campaigns regarding waste (Wagner and Arnold 2008). Funding levels from the RRFB are based on per capita municipal waste disposal rates (Wagner and Arnold 2008). Another source of regional funding is provided through levies on certain goods, such as tires, paint, and milk cartons (Wagner and Arnold 2008).

Beginning in 1996, Nova Scotia began implementing regulations with regard to waste, starting with a ban of the open-burning of waste and the implementation of strong emissions standards for waste incinerators (Wagner and Arnold 2008). Also beginning in 1996 were provincial bans on certain items from entering landfills, culminating in 1998 with an organic waste ban (Wagner and Arnold 2008). However, as materials were banned from landfills, the Government of Nova Scotia recognized the need to develop a system to capture these materials (Wagner and Arnold 2008). The approach for managing this system is as follows: 1) implement a municipal three-stream (garbage, recyclables, and organics) curb-side pickup system; 2) establish province-wide waste drop-off centres; 3) develop industry stewardship agreements in order to promote the capture of product-specific materials; and 4) create provincial educational programs to improve source separation (Wagner and Arnold 2008). In 1997, the Government of Nova Scotia

implemented strict standards for the design and operation of landfills; landfills that did not meet these new standards were required to close by 2006 (Wagner and Arnold 2008). As a result of these standards, only seven engineered landfills existed in Nova Scotia by August 2006 (Wagner and Arnold 2008). Finally, landfill tipping fees in the province slowly increased over time in response to the changing waste management regime (Wagner and Arnold 2008). In Halifax Regional Municipality before 1989, there was no tipping fee at the landfill; by 2001, the tipping fee had reached $115 per tonne of waste (Wagner and Arnold 2008). In 2006, other regions of the province saw an average tipping fee of $80 per tonne (Wagner and Arnold 2008).

Study Purpose

This study sought to acquire expert stakeholder opinions of waste management, in particular organic waste management, in Manitoba. A written or phone survey of expert stakeholders from various municipalities throughout Manitoba and an expert stakeholder meeting were conducted to determine how organic waste management and waste management, in general, might be improved in Manitoba. The results of the survey and stakeholder meeting are discussed with respect to the recommendations of the FCM and the strategy actually implemented by the Government of Nova Scotia. The results are also discussed in the context of implementing a successful organic waste management system in Manitoba, Canada.

4.1 Method

Every community in Manitoba that had a population over 1,000 people was contacted to conduct a written survey or phone interview with a local expert in waste management concerning his/her perspective on organic waste management and the activities on-going in the community relating to organic waste management. In Manitoba, 102 communities with populations greater than 1,000 people, based on the 2006 census (Manitoba Local Government n.d.), were contacted; in addition, one municipality was contacted that had a population less than 1,000 people. The 103 communities contacted represented about 86.5% (Table 4.1) of the total population of Manitoba in 2006 (City of Winnipeg 2010a, Manitoba Local Government n.d.). Community details can be found in Appendix C.

Table 4.1 Number of surveyed municipalities, by population range, and total population in 2006.

Population Range	Number of Municipalities	Population
> 50,000	1	633,451
15,000 – 50,000	1	41,511
10,000 – 15,000	6	73,460
5,000 – 10,000	15	109,156
1,000 – 5,000	80	166,115
< 1,000	1	692
Survey Totals	103	1,024,385
Provincial Population		1,184,000

Source: City of Winnipeg 2010a, Manitoba Local Government n.d.

In general, the Chief Administrative Officer (CAO) was contacted in order to determine the person with which to speak regarding waste management in the respective community. Additional contacts were found by asking survey participants to provide contact information of people they deemed suitable for the survey; it was through this method of discovering potential participants that I came to interview someone from a community of less than 1,000 people. The opinions gathered by the written surveys and

phone interviews were compiled so that common patterns and themes were made evident. The survey can be found in Appendix A.

Next, a group of eight survey participants (expert stakeholders) was gathered in June, 2010 to present the survey results for feedback and to discuss potential options for waste management in Manitoba. The participants included people from the cities of Winnipeg and Brandon (with populations of 687,619 and 51,350, respectively), which are the two largest cities in Manitoba, representing about 61% of Manitoba's total population (Manitoba Health and Healthy Living 2009). The purpose of the meeting was to enter into a greater depth of discussion of waste management options than is possible on a written survey or interview. A note-taker was used to record the discussion. The minutes of the meeting can be found in Appendix B

It should be emphasized that the general public was neither surveyed nor included in the meeting. The persons who participated in the survey and meeting were identified as experts in the field of waste management. Therefore, neither the results of the survey nor the results of the meeting can be extrapolated to the general public.

4.2 Results

4.2.1 Survey/Interview Participation

One-hundred and two communities in Manitoba (all the communities with a population of at least 1,000 people) provided information on tipping fees and on-going organic waste management programs: that is, a census of communities was conducted to acquire information on tipping fees and organic waste management programs, not a

sample. In addition, 14 communities and 28 people participated in a more detailed written or phone survey. The population of communities that participated in the survey was 729,523, or 61.6% of the total Manitoba population, in 2006 (City of Winnipeg 2010a, Manitoba Local Government n.d.). The low community participation in the written/phone survey was a result of two factors. First, many of the communities contacted do not manage their own municipal solid waste; rather, they send their waste to other communities that have landfills. In many of these communities, the CAOs did not know of anyone to whom they could refer me. Second, of the people to whom I was directed, many declined either because of being too busy or because they did not believe they could contribute constructively to the survey. What was consistent across the smaller communities was that public works departments, which are typically responsible for solid waste management, are often understaffed and required to do more work than they are generally able. As such, many potential participants declined the survey simply due to time constraints and 13 individuals from 13 different communities agreed to do the survey, but, after numerous attempts to get them to fill it out, did not. On the other hand, many potential participants did not feel they could contribute to the survey, since the waste management in their respective communities is simple with no signs of changing: that is, waste is picked up or dropped off for landfilling, with some limited recycling. Waste management in these communities is either not a priority or a low enough priority that it cannot be addressed in a meaningful way.

4.2.2 Survey/Interview Results

The results of the survey will be broken down as follows. First, the data on tipping fees and organic waste management programs on-going in communities will be presented. Next, the broad perspectives of the participants of the survey with regard to waste management and policy direction will be put forward. The third section will focus on whether participants felt that implementing organic waste management options is justified. Next, options for organic waste management that were cited by participants will be revealed, including what past options were chosen and what options they believe will be implemented in the future. Then, the participants' view of public participation in decision-making for waste management will be presented. Finally, the participants' perspective on barriers to change in waste management and how these barriers can be overcome are documented.

4.2.2.1 Landfill tipping fees and organic waste management programs

The amounts charged as landfill tipping fees in Manitoba vary widely. The tipping fees that were collected by the survey apply to residential waste, as opposed to commercial, industrial, or construction and demolition waste. The survey found that, often, contractors bringing in commercial, industrial, and construction or demolition waste are charged much higher tipping fees than local residents; however, these tipping fee rates were not collected given the complexity of the rate schemes at each landfill. The statistics of residential landfill tipping fees in Manitoba are presented in Table 4.2. It should be pointed out that many landfills have unique means by which to charge residents for landfilling their waste, since weight scales are not available at many landfills; as such,

some statistics, in particular the range, may be skewed. The most useful statistic is the weighted average because it most accurately represents tipping fees in Manitoba. This weighted average gives more importance to the fee in Winnipeg since it is by far the largest community in Manitoba and has a much higher than average tipping fee at its landfill. Also interesting is the number of people who dispose of their waste at landfills that are not charged for waste disposal. This number is slightly misleading, however, because, although more than 10% of the Manitobans surveyed do not pay to dispose of their waste at their local landfill, many are taxed specifically for waste management on their property taxes.

Table 4.2 Landfill tipping fee and population statistics in Manitoba (June 2010).

Total population of communities surveyed: 1,023,693 (n=102)	
Statistic	**Survey finding**
Range	$0.00/tonne to $146.34/tonne
Average	$18.38/tonne
Mode	$0.00/tonne
Median	$0.00/tonne
Weighted Average	$37.53/tonne
Population paying no tipping fees	107,559
Percent of surveyed population with no tipping fees	10.51%

Notes:

1. See Appendix C for tipping fee data for all communities.

Table 4.3 presents the accessibility of organic waste management options to Manitobans. More than four out of five Manitobans surveyed had access to some form of organic waste management option, with nearly all of these people having access to yard, garden, and/or food waste curb-side pickup or drop-off at a municipally-operated compost pile. Far fewer participants had access to food waste curb-side pickup or drop-off at a local compost pile, with only one community having curb-side pickup of food waste, namely, the City of Winkler. It should be noted that there is a private contractor in Winnipeg that provides an organic waste pickup service for a fee, including food waste; however, the population of Winnipeg was not counted in Table 4.3 as having an organic

waste curb-side pickup program, because the operation is relatively small and did not, at the time of the survey, serve residences.

Table 4.3 Accessibility of organic waste management options to Manitobans (June 2010).

Total population of 102 communities surveyed: 1,023,693 (n=102)		
Access to organic waste management option	**Population**	**Percent of Population (%)**
Organic program of any kind	853,759	83.40
Yard, garden, and/or food waste curb-side pickup or drop-off	825,674	80.66
Compost bin sales and/or subsidies	725,264	70.85
Food waste curb-side pickup or drop-off	131,694	12.86
Food waste curb-side pickup	9,106	0.89

The weighted average tipping fee for the communities that provided organic waste management options to their residents was higher than the overall weighted average tipping fee found by the survey. The weighted average tipping fee for communities providing yard, garden, or food waste management options was $42.88, about 14% higher than the overall weighted average (see Table 4.2). The weighted average tipping fee for communities providing food waste management options was $42.04, about 12% higher than the overall weighted average (see Table 4.2).

Of the 35 communities participating in some form of composting, only seven communities provided organic waste diversion quantities. Furthermore, of these seven communities, only four were able to provide precise diversion numbers for the whole community. In 2009, the total estimated amount of organic waste diverted, as reported by the seven communities, was 35,269.83 tonnes.

4.2.2.1 Broad opinions and perspectives of survey participants

In general, the participants of the survey showed a great interest in organic waste management issues, with 26 out of the 28 participants (93%) rating organic waste

management as having a greater than average (greater than 4 out of 7) importance in the overall waste management sector, while 21 (75%) responded 6 or greater (See Table 4.4). Furthermore, all participants agreed that Manitoba could, in general, better manage its organic waste, while 27 participants stated that their municipality of residence could better manage its organic waste.

Table 4.4 Survey Rating Scale.

1	2	3	4	5	6	7
Not important			Neutral			Very Important

Twenty-four out of 28 participants (86%) rated the importance of sustainable organic waste management options as 6 or greater; 26 participants (93%) gave a rating of 5 or greater, while two (7%) gave a rating of 4. But, interestingly, the participants were divided over the meaning of 'sustainable development' (Table 4.5).

Table 4.5 Participant responses to the question "How would you describe the concept of "sustainability" or "sustainable development?"

Total Respondents = 22		
Number of respondents	**Percent of total respondents (%)**	**Stated View**
11	50	Practices that do not have negative, long term environmental impacts.
6	27	Practices that balance environmental, economics, and social considerations.
6	23	Practices that balance environmental and economic issues.
1	5	Programs involving regional planning to increase efficiency.
1	5	Taking the precautionary principle into account.
1	5	A political term that is overused and misused.

More people were concerned with implementing sustainable practices than with the threat of climate change. When asked whether they were, in general, concerned with the predicted effects of global climate change due to greenhouse gas emissions, 19 out of 25 participants (76%) said they were, while four (16%) said they were not. One participant (4%) said he/she were "somewhat" concerned and one other (4%) was "undecided."

Finally, 24 out of the 28 participants (86%) at the time of the interview held a job related to municipal solid waste management. Three other participants (11%) each worked within a local government, while one participant (4%) had no direct connection to municipal solid waste management in Manitoba.

4.2.2.2 Wide-spread policy/program implementation

Most participants agreed that wide-spread organic waste management options would benefit Manitoba (Table 4.6). Table 4.6 presents the survey participants' reasons for why not the implementation of wide-spread organic waste management policies and/or practices could benefit, or be a detriment to, Manitoba.

Table 4.6 Participant responses to the question "Do you think that the implementation of wide-spread organic management policies and/or practices could benefit Manitoba? Why?"

Total Respondents = 28		
Response: "Yes" **Total: 22/28**		
Number of respondents	**Percent of total respondents (%)**	**Stated View**
12		Reduce waste generation, which would extend landfill life, decrease landfill operational costs, and postpone landfill re-siting.
5		Reduce GHG emissions and farm chemical use.
5		Produce compost (do not waste resources).
3		Broad regulatory instruments work best.
1		Take pressure off of smaller communities
1		Large urban centres would benefit
1		Increase waste management awareness/education
Response: "No" **Total: 5/28**		
4		Organized, long-term planning and unique plans for rural communities are needed.
1		Need a holistic view of waste management and not just a focus on organic waste.
1		Government communication with public is needed for any wide-spread policies/programs to be successful.
Response: "Maybe" **Total: 1/28**		
1		"One size does not fit all." What works for large urban communities will not work in small urban and rural communities.

In general, the participants provided a wide range of responses for why it would benefit Manitoba to implement organic waste management options (Table 4.7). Table 4.7 presents participants' responses to why it is or is not important to invest in organic waste management options.

Table 4.7 Participant responses to the question "Do you think that it is in the best interest of Manitoba, in general, to invest in finding a better solution to the management of organic waste than dumping it in landfills? Why?"

Total Respondents = 20		
Response: "Yes" **Total: 18/20**		
Number of respondents	**Percent of total respondents (%)**	**Stated View**
9		Environmental concern, including decreased GHG emissions and leachate from landfills, reduced synthetic fertilizer use, and increased nutrient cycling.
8		Combined environmental and economic concern, including reducing waste, increasing reuse, and extending landfill life.
8		Economic benefits, including production of compost, mitigating energy use to create synthetic fertilizers (due to use of compost), and ceasing to waste resources.
2		Waste management cost savings in terms of landfill maintenance and transportation costs.
1		Create more 'green' jobs.
1		Use of compost would increase agricultural productivity.
1		Increases community well-being
1		Incinerate waste to produce energy
Response: "Maybe" **Total: 2/20**		
1		Organic waste management options will only be successful in urban areas with populations greater than 5000 people.
1		The cost-benefit analysis of organic waste management options must be positive, which has not yet been determined.

4.2.2.3 Options for organic waste management

Most participants were in favour of composting in one form or another (Table 4.8). Two composting schemes had an equal amount of support: backyard composting (in general, and in rural and small urban areas) had the same number of proponents as the curb-side pickup of organics (in large urban centres; for restaurants and grocery stores). However, even more popular than backyard composting was the combination of

regulatory and economic instruments, such as a landfill ban on organics and unit pricing or a pay-as-you-throw system. Several participants praised waste management funding coming out of the existing provincial WRARS and WRAPP programs, while some participants wanted to see regional partnerships develop for waste management issues.

Table 4.8 Participant responses to the question "Of all the policies and/or practices of which you are aware, which do you think would be best suited to Manitoba?"

Total Respondents = 24		
Number of respondents	**Percent of total respondents (%)**	**Stated View**
17		Composting: six for backyard composting, in general; six for curb-side pickup of organics in large urban centres; two for backyard composting in small urban and rural communities; two for composting by restaurants and grocery stores; one for organic waste drop-off at a centralized facility.
12		Regulatory instruments: landfill ban on organics; waste burning ban; garbage bag limit; elimination of Class 2 and Class 3 landfills.
8		Economic instruments: pay-as-you-throw/unit pricing; increased tipping fees.
6		Provincial funding programs: five for WRARS program; one for WRAPP program.
5		Creation of regional partnerships.
3		Use compostable bags for lawn/garden waste collection; mulch yard waste
2		Public education of composting, mulching, and avoiding and reducing waste
2		Energy from waste: landfill gas capture; anaerobic digesters
1		Incinerators for commercial/industrial sources of waste
1		Develop market for recyclables (including compost)
1		Guidance from provincial government for small- to mid-size operations
1		Develop stewardship programs

When asked whether participants were aware of any groups, initiatives, or people advocating for new organic waste management policies or practices in their respective municipalities, 12 out of 18 respondents said "yes" and the other six said "no." Besides the mention of Resource Conservation Manitoba, which is a non-profit, non-governmental organization that is involved in community education related to sustainable development, including composting, waste reduction, and resource conservation (Resource Conservation Manitoba 2010), there was no consistent trend among responses.

4.2.2.4 Past and future options for organic waste management

Table 4.9 presents the organic waste management policies or practices that survey participants stated were currently operating in their respective communities. Table 4.10 describes the participants' beliefs concerning why these options were chosen as opposed to others.

Table 4.9 Participant responses to the question "In your municipality of residence, what organic waste management policies and/or practices currently exist?"

Total Respondents = 25		
Number of respondents	**Percent of total respondents (%)**	**Stated View**
14	56	Backyard composting, backyard composter subsidies, and/or promotion of backyard composting.
14	56	Composting yard and lawn, with curb-side pickup.
5	20	No programs.
3	12	Christmas tree drop-off program.
2	8	Tree branch chipping (for mulch); tree burning site.
2	8	Private organic waste pickup.
2	8	Free compost for citizens.
2	8	CLER (Community Led Emissions Reduction) program.
2	8	Compost education.
1	4	Master Composting program.
1	4	Neighbourhood composting sites.
1	4	Area depots for voluntary organic waste drop-off.
1	4	Landfill levy.

Table 4.10 Participant responses to the question "Why were these options [i.e., the options that currently exist in your municipality of residence] chosen as opposed to others?"

Total Respondents = 22		
Number of respondents	**Percent of total respondents (%)**	**Stated View**
14	64	Lowest cost; reduced landfill operating costs; reduced cost of curb-side garbage pickup by reducing the volume of waste.
4	18	Easiest sell to public.
2	9	Backyard composting is best option for dealing with organic waste.
2	9	Backyard composting implemented due to public demand and fit with neighbourhood composting programs.
2	9	Lack of political will.
2	9	Unsure why options were chosen.
1	5	Lack of direction/regulation from provincial government.
1	5	Voluntary programs do not have non-compliance issues (littering).
1	5	Councilors are environmentally progressive.
1	5	Compost is valuable.
1	5	Organic waste is not a priority.

1	5	Expansion to curb-side pickup of organics left open.

In terms of what the participants expected their communities to implement in the near future, some kind of composting, again, dominated the outlook (Table 4.11). Regulatory instruments, on the other hand, in the form of a landfill ban on organics was expected by only three participants, while a biosolid land application ban was mentioned by one participant as being a future possibility. Increased landfill tipping fees was mentioned by only one participant (although this has occurred for major landfills and will come into force for all landfills on January 1, 2011).

Table 4.11 Participant responses to the question "Do you think that new organic waste management policies and/or practices will be implemented in your municipality in the near future? If so, which one(s)?"

Total Respondents = 26				
Response	"Yes"	"No"	"Maybe"	"Unsure"
Response rate	13 (50%)	6 (23%)	6 (23%)	1 (4%)
Total Respondents = 19				
Number of respondents	**Percent of total respondents (%)**	**Stated View**		
16	84	Centralized, large-scale composting of organic waste, possibly with curb-side pickup of organic waste and/or yard waste and/or community composting.		
4	21	Promotion of backyard composting with composting education.		
3	16	Restrictions on landfill waste; landfill ban on organics.		
2	11	Landfill gas capture.		
1	5	Organic waste reduction.		
1	5	Waste limits.		
1	5	Biosolid land application ban.		
1	5	Voluntary participation will encourage more participation.		
1	5	Increased tipping fees.		
1	5	Unknown.		

4.2.2.5 Public involvement in decision-making

Table 4.12 presents survey participants' views concerning the scope of discussion with regard to organic waste management options. A lack of public engagement and discussion and a lack of recognition of the importance of organic waste management were the most cited problems.

Table 4.12 Participant responses to the question "Are you satisfied with the scope of discussion with regard to organic waste management at meetings, conferences, etc?"

Total Respondents = 25			
Response	"Yes"	"No"	"Somewhat"
Response rate	4 (16%)	19 (76%)	2 (8%)
Response: "Yes"			
Number of respondents	**Percent of total respondents (%)**	**Stated View**	
2	8	Increasingly more attention to organic waste management options; increase in composting.	
1	4	Job is directly related to organic waste management.	
Response: "No"			
11	44	Lack of public engagement/discussion.	
7	28	Lack of recognition of importance of organic waste management; lack of knowledge of the issue.	
1	4	Scope is too narrow.	
Response: "Somewhat"			
1	4	Organic waste management is receiving more attention, but change is difficult.	
1	4	Organic waste management options are on the agenda, but more research into options is needed.	

Table 4.13 presents survey participants' opinions concerning the general level of public involvement in the decision-making process with regard to choosing organic waste management options. Participant responses were divided on the issue, with nearly the same percentage of respondents being satisfied with the general level of involvement as dissatisfied.

Table 4.13 Participant responses to the question "Are you satisfied with the general level of involvement in the decision-making process with regard to choosing these options [that is, the organic waste management options already chosen at the municipal level]?"

Total Respondents = 22				
Response	"Yes"	"No"	"Somewhat"	"Unsure"
Response rate	9 (41%)	10 (45%)	2 (9%)	1 (5%)
Number of respondents	**Percent of total respondents (%)**	**Stated View**		
Response: "Yes" [1]				
3	14	Organic waste management options are much easier to "sell" to the public now; some consultations; situation could improve.		
1	5	Involvement at the neighbourhood level is good.		
Response: "No" [1]				
5	23	More community attention and involvement is needed.		
Response: "Somewhat" [1]				
2	9	Staff members sometimes choose to make decisions without public consultations.		

1	5	Decisions are often determined by budget.

[1] Most participants did not provide a reason for their response.

4.2.2.6 Barriers to implementing organic waste management options

It is interesting to observe how participants' perceived the barriers to implementing past (Table 4.15) and future (Table 4.16) organic waste management options (present barriers, showed in Table 4.17, were ignored in the analysis in Table 4.14 because too few participants responded to this question). The three most prominent responses remained the same (Table 4.14): that is, public education, communication, and support (PE), cost and funding (CF), and political will (PW).

Table 4.14 Proportion of participants that claim public education, communication, and support, cost and funding, and political will have been/are/will be barriers to the implementation of organic waste management options in the past, present, and future.

Barrier	Past	Future
Public Education	16 (73%)	12 (48%)
Cost and Funding	15 (68%)	18 (72%)
Political Will	5 (23%)	8 (32%)
Total Respondents	22	25

While, PW remained the third most stated response, the relative importance of PE and CF changed depending on whether the participants were talking about the past or the future (Table 4.13). There are several interesting trends occurring in terms of the proportion of participants referring to each barrier. First, the perceived importance of PE as a barrier by participants drops significantly moving from the past to the future. Second, the significance of CF is perceived as being about the same in the past and in the future. Third, PW is perceived as being a greater barrier to change in the future than in the past.

Table 4.15 Participant responses to the question "What did you perceive as the barriers to implementing these organic waste management options [that is, the organic waste management options already chosen at the municipal level]?"

Total Respondents = 22

Number of respondents	Percent of total respondents (%)	Stated View
16		Lack of public education, communication, acceptance.
15		High costs and lack of funding.
5		Lack of political will; priorities; lack of provincial government guidance.
2		Lack of infrastructure.
2		Inability to justify options by quantifying emissions from waste.
2		Creating a market for compost; addressing compost contamination
1		Unwillingness of general population.
1		Limited labour/land availability.
1		Low landfill tipping fees make alternatives to landfilling relatively expensive.
1		Difficult to force businesses to source separate their waste.

Table 4.16 Participant responses to the question "What do you perceive to be the biggest hurdles preventing the implementation of new organic waste management policies and/or practices in your municipality [in the future]?"

Total Respondents = 25		
Number of respondents	**Percent of total respondents (%)**	**Stated View**
18	72	High cost; lack of funding; limited infrastructure.
12	48	Lack of public education/support; public perception of issues.
8	32	Lack of political will/support.
2	8	Lack of provincial government guidance and planning.
2	8	Other priorities.
1	4	Low landfill tipping fees.
1	4	Connecting organic waste management to climate change (GHGs).
1	4	Political pressure to change must exist.
1	4	Patience – things will change, but slowly.
1	4	Public consultations are needed.

Present barriers identified by survey participants included cost and funding, a lack of government communication and education, a lack of political will, a lack of public will and commitment, and low landfill tipping fees (Table 4.17).

Table 4.17 Participant responses to the question "What do you perceive as the barrier(s) to implementing [a Manitoba-wide, organic waste management] policy and/or practice?"

Total Respondents = 18		
Number of respondents	**Percent of total respondents (%)**	**Stated View**
9	50	High cost; lack of funding.
9	50	Lack of government action: implementing programs, encouraging communication, public education regarding true cost of waste.
8	44	Lack of political will, commitment, desire to change.
6	33	Lack of commitment, desire to change, willingness to pay for resource recovery by individuals and businesses.

1	6	Low landfill tipping fees.
1	6	Forcing change too quickly will result in failure.
1	6	No incentives to change.
1	6	Lack of facility operators (specializing in composting).
1	6	Timing.
1	6	Not considering the waste management system as a whole.
1	6	Lack of infrastructure.

6.2.2.7 Overcoming the barriers to change

Tables 4.18, 4.19, and 4.20 present the methods by which survey participants thought barriers to implementing organic waste management options could be overcome. The most stated method was persistent public education, including time spent in schools and workshops and linking waste management with climate change and economics. Other methods included, receiving and seeking out funding from all levels of government and gaining local council support. A few participants thought that government instruments (regulatory or economic) and/or a waste management plan could help to overcome the aforementioned barriers.

Table 4.18 Participant responses to the question "How were [past barriers to implementing organic waste management options in your municipality of residence] overcome?"

Total Respondents = 22		
Number of respondents	**Percent of total respondents (%)**	**Stated View**
12	55	Ongoing public education/communication with media coverage; time spent in schools.
9	41	Receiving and seeking out funding from all levels of government.
2	9	Local council financial support combined with strong political will.
2	9	Public involvement in changing priorities.
2	9	Developing a specific waste management plan with full cost accounting.
2	9	Demonstrating results on a small-scale and keeping programs running over time to generate support.
1	5	Government regulations.
1	5	Ensuring sustainability.
1	5	Raising tipping fees.
1	5	Better landfill management.
1	5	Barriers still exist, but emerging public pressure drives change.
1	5	Training through NGOs
1	5	Contracting experienced companies.

1	5	Barriers were ignored.
1	5	Volunteers.

Table 4.19 Participant responses to the question "How do you think the hurdle(s) [for implementing organic waste management options in your municipality in the future] could be overcome?"

Total Respondents = 21		
Number of respondents	**Percent of total respondents (%)**	**Stated View**
11	52	Persistent public education with workshops.
6	29	Public consultations, with discussion regarding the financial and environmental benefits and drawbacks of options.
6	29	Federal/provincial funding (like the WRARS levy on waste going to landfills) for new programs, public education, and communication.
4	19	Waste management needs to be linked to important issues, including climate change, economics, and health.
3	14	Develop a long-term, organic waste management plan.
3	14	Increase political/citizen desire to participate in and fund activities.
2	10	Market for compost needs to be created, along with strict regulations on contaminant limits.
2	10	Landfill ban on organic waste.
2	10	Promotion with incentives.
2	10	Creating partnerships between a city and its neighbourhoods; community-based approach.
1	5	Regional environmental officer is needed to inform people about organic waste.
1	5	Clear, concise, and logical rules/regulations for small- to mid-size composting operations.

Table 4.20 Participant responses to the question "How do you think the barrier(s) [to implementing wide-spread, organic waste management policies and/or practices in Manitoba] could be overcome?"

Total Respondents = 15		
Number of respondents	**Percent of total respondents (%)**	**Stated View**
13	87	Public education/awareness campaigns.
4	27	Government funding/subsidies (for instance, WRARS and WRAPP programs).
4	27	Government action: regulations, creation of regional/municipal partnerships and regional environmental committees, requirement of government facilities to compost.
3	20	More public participation in decision making.
2	13	Garbage bag limit with fees.
2	13	Starting small with a larger goal in mind.
1	7	Research what other jurisdiction have done.
1	7	Environmental lobby groups/general public need to encourage political change.
1	7	Full cost accounting of organic waste management options is needed.

4.2.3. Expert stakeholder meeting results

The results of the expert stakeholder meeting will be presented in three parts. First, the highlights of the meeting will be presented, including details of the waste management sector in Manitoba. Next, a summary of the main points the participants made clear will be documented. Finally, how the participants thought that waste management policy should proceed will be revealed.

4.2.3.1 The highlights of the meeting

The participants explained that the most significant challenge facing the waste management sector in Manitoba is the public perception that waste should cost nothing: that is, that waste management is a service rather than a utility. Therefore, more public education and consultation is needed to help citizens understand the cost and environmental impact of waste. In fact, the participants agreed that waste management is more of a social issue than a technical issue because change in waste management seems to only occur when there is a change in public perception toward waste. The participants also agreed that waste diversion could improve in Manitoba.

It was noted by the participants that, about 12 years ago, there was a working group on waste management in Manitoba. This working group included good consultation with communities, including taking local circumstances into consideration, but led to minimal results. This kind of cooperation between all levels of government and all regions of Manitoba was praised by participants.

There was agreement that although many communities have already implemented voluntary organic waste drop-off site programs, these compost piles will always have

contamination issues because they are unsupervised. The participants therefore concluded that curb-side pickup is a better option. However, with the implementation of the WRARS landfill levy, communities will have more of a vested interest in organic waste management. With the levy, only waste that is sent to landfills is levied the extra $10 per tonne; therefore, all waste that is recycled or composted is not levied. Furthermore, the greater a community's diversion rate (i.e., the more waste that is recycled) the more money it receives through the Manitoba Product Stewardship Corporation. Communities now have a financial incentive to monitor their organic waste diversion to lower the total cost of waste disposal, which may result in more organic waste diversion and in less compost pile contamination.

Next, participants pointed out that landfill gas burning (i.e., flaring) is starting in Manitoba, with a project in the City of Brandon coming into operation in December 2010. Presently, the City of Brandon is intending to burn the landfill gas to reduce the methane to carbon dioxide. In the future, however, the City of Brandon is planning to harness the energy from the landfill gas to provide a nearby food processing plant with heat. Interestingly, participants pointed out that, as a result of an agreement made between the City of Brandon and the Province of Manitoba Government, the Province provided the City of Brandon with funding for the infrastructure of the landfill gas capture project and the greenhouse gas credits went to the province rather than the City of Brandon. As participants pointed out, this was an interesting choice for the province, since instead of selling the credits on the market, the province decided to retire the credits, which the participants agreed was a good option from an environmental

standpoint, but a loss in potential revenue for the province. Winnipeg is currently considering options to harness landfill gas.

According to the participants, only Class 1 landfills should be required by Provincial legislation to capture their landfill gas. This is because Class 1 landfills are the largest landfills in Manitoba and are likely the only landfills where it makes economic sense to implement landfill gas capture. However, out of the approximately 245 landfills (consisting of Class 1, Class 2, and Class 3) in Manitoba, only 12 are designated as Class 1 (personal communication, J. Ferguson, April 2009). Because of the large number of existing landfills, the participants believed that a reduction in the number of landfills had to occur before landfill gas capture is considered: the participants suggested closing all of the Class 2 and Class 3 landfills, since these landfills are, for the most part, poorly monitored with little or no environmental safe-guards. The participants recognized that a reduction in the number of landfills in Manitoba would increase the quantity of waste going to the remaining landfills (i.e., the Class 1 landfills), which would increase the amount of landfill gas produced by these sources, thereby, making landfill gas capture from them more economical. This point, however, is important only to the extent that Manitoba ignores diverting organic waste from landfills. A significant challenge to reducing the number of landfills is that, in general, residents want to keep their local landfills because of the low cost of waste disposal (again, due to the idea that waste management is a service rather than a utility). The participants thought that many residents would be against paying more money to close their local landfill that has likely been in operation for many years in order to either send their waste elsewhere or build a new, state-of-the-art landfill.

Another issue relating to landfills was that there are approximately three landfills in Manitoba that are not publicly owned. A participant brought up the point that if the City of Winnipeg were to increase its tipping fees, or ban a substance from landfills, in order to increase waste diversion, the privately owned landfills would simply begin receiving more waste due to it either having lower tipping fees or accepting the banned substance. Therefore, the participants points out, only provincial regulations can bring about an equal playing field for all actors in the waste management sector.

In the City of Winnipeg, one participant stated that the cost of waste disposal and recycling per resident per year is about $70. This cost is funded through the tipping fees collected at Winnipeg's Brady Road Landfill. This participant suggested that organic waste curb-side pickup could be implemented in the City of Winnipeg with an increase in property taxes by 1% to 2%. Alternatively, a charge for waste management could appear on a regular utility bill, similar to a water bill, which would describe the cost of waste management per resident or household. The latter choice was preferred by the participants, since user fees can be applied to encourage certain activities, like waste diversion.

Next, participants pointed out the need for a proper waste management plan with a waste tax that included scheduled increases. To this end, the participants praised the WRARS landfill levy, which comes into effect for all Manitobans next year. The participants thought the $10 per tonne levy would be an excellent financial incentive to encourage waste diversion. However, participants believed that the WRARS levy would be even more effective if, included in the legislation, were scheduled increases to the levy over time.

Another option for organic waste management that participants supported was a landfill ban on organics. One participant explained that there would be a landfill ban for organics in Montreal coming into effect in 2015. The time delay between stating that a landfill ban will come into effect and actually implementing the ban will allow residents and businesses to adapt to the upcoming legislation and allow organic waste processing facilities to expand to meet the increasing demand for their services. Participants largely believed this kind of strategy would be effective in Manitoba.

Finally, one participant noted that Calgary initiated a 50% increase in its waste tax a year ago, with a possible organics ban from landfills. On the other hand, Edmonton residents pay $292 per year for their waste management system, while residents of Winnipeg pay approximately $70 per year. He reiterated that in order to move forward with waste management options there has to be strong political will, a way for stakeholders to speak with one voice, and the establishment of a proper focus on waste.

4.2.3.2 Summary of emerging issues

What follows is a summary of the main issues noted by the expert stakeholders:

- Public education and awareness campaigns are needed to change public perception of waste and waste management.
- Public consultation and planning at the provincial, regional, and community scale are needed to establish a provincial waste management strategy.
- Provincial regulations are needed to bring about an equal playing field for all actors.

- The WRARS landfill levy is a good start, but would benefit by having scheduled increases.
- Class 2 and Class 3 landfills should eventually close.
- Class 1 landfills should implement landfill gas capture.
- Cost for waste management should appear to citizens in the form of a utility bill.
- A landfill ban on organics would be useful if residents and businesses were given time to adapt to the legislations.

4.2.3.3 Where Manitoba should go from here

On a national scale, the participants agreed that a holistic waste management strategy is needed, with working groups to help improve all provinces' waste management sectors. On a provincial scale, all participants agreed that provincial government leadership in waste management is necessary because only provincial legislation can bring about an equal playing field for all actors in the waste management sector. Therefore, participants called for the creation of provincial targets and goals for the waste management sector and a consistent, but flexible, provincial waste management strategy that will be useful in achieving those targets and goals.

According to the participants, a necessary part of any provincial waste management strategy would be the creation of regional and province-wide discussion groups, or think tanks, with provincial government representation to help set policy direction. At the province-wide discussion groups there should be representation from all regions of Manitoba to discuss issues that are only seen by a particular locality or region. Regional discussion groups that, ultimately, feed into a province-wide group would

ensure that unique, local circumstances are taken into consideration when developing policy. Furthermore, the participants stressed, a strategy would need to recognize that time is needed for businesses and citizens to adapt to changes: that is, a waste management strategy should establish a time-line for the implementation of certain policies so that citizens and businesses have time to adapt to the new rules. The participants also mentioned the possibility of using triple bottom line as a means by which the best options for Manitoba could be chosen.

Next, the participants agreed that a successful strategy would require or encourage a regionalization of waste management options. The participants offered the following example of how a series of scheduled policy implementations over time might cause a regionalization of services to occur:

1) Create provincial guidelines for the construction and operation of landfills, which would include forcing Class 2 and Class 3 landfills to eventually close if they did not meet these standards;
2) Ban the open burning of all waste;
3) Employ scheduled increases in the WRARS landfill levy, with education on how the schedule would work;
4) Identify key waste items and create waste management options for those items; and,
5) Ban those key items from landfills.

The participants further affirmed that for any waste management strategy to be successful, public education on waste management must be continuous and on-going. For instance, with the WRARS landfill levy, the participants claimed that many communities

are confused with where the money from the levy is going and how they will pay for the new levy.

Interestingly, some participants were pushing for a user-pay system of waste management in the City of Winnipeg. In a user-pay system, residents would know exactly how much they paid for waste management and how much it cost to dispose of, recycle, and compost their waste. Charges in a user-pay system are based on the use of the utility and households could potentially see a charge for waste management appear, for example, on their water bill or a separate bill, entirely. For example, in the City of Brandon, if a resident desires an additional waste cart, there is essentially a rental fee for additional carts. One participant explained that carts with mechanized disposal by a garbage truck are more economical than bins or bags that must be manually thrown into the truck, since manual labour inevitably leads to job-related injuries in the workforce. Meanwhile, participants thought that the curb-side pickup of organic waste is probably only economical in larger communities, but that smaller communities may be able to benefit from this kind of pickup in a regionalization scheme.

Finally, the expert stakeholders noted the importance of continuing the momentum of the discussion by having a follow-up meeting later in 2010. If this meeting occurs, the stakeholders may have taken the first step toward the implementation of provincial and regional discussion groups, which are what they stated is needed in Manitoba for a waste management plan to succeed.

4.3 Discussion/Conclusion

4.3.1 Landfill tipping fees in Manitoba

The amounts charged as landfill tipping fees in Manitoba vary widely among communities. About one in ten Manitobans living in the communities surveyed did not pay a waste disposal fee at their local landfill; however, the weighted average tipping fee of all the communities surveyed was $37.53 per tonne. The average tipping fee was found to be much lower than the weighted average ($18.38 per tonne), but that is because there are many small landfills that service small populations in Manitoba. Indeed, the weighted average is similar to the tipping fee charged in the City of Winnipeg, at $43.50 per tonne. This highlights an important aspect of Manitoba's population distribution: a large portion of the population lives in Winnipeg. In fact, in 2009, about 55.2% of the total population of Manitoba resided in Winnipeg, (City of Winnipeg 2010a). Therefore, Winnipeg has a large impact on waste generation, diversion, and disposal in the province of Manitoba.

Despite the weighted average tipping fee in Manitoba (in the surveyed communities) being relatively high for tipping fees in Manitoba, the fact that waste management fees are mostly charged as a fixed fee on property taxes in communities in Manitoba sends the wrong message to Manitobans, in general. With a fixed waste management fee, there is no financial incentive for residents that pay this fee to reduce the amount of waste they produce or send to the landfill. Waste disposal operates unlike other utilities, like electricity utilities, where a customer's bill is based upon the quantity of electricity used by the customer over a period of time. Since the customer of the electricity utility can lower her bill by using less electricity, the customer has a financial

incentive to reduce unnecessary electricity consumption. This same incentive does not exist for users of waste disposal facilities that are not charged user fees. Therefore, a user-pay system of waste management might send an effective signal to Manitobans that will help to reduce waste generation and disposal.

In general, tipping fees represent barriers to implementing certain waste management options. For instance, when tipping fees are lower than the cost of recycling or composting, there is a financial incentive to dispose of waste at landfill rather than to recycle or compost it. For instance, in Nova Scotia, the cost of implementing composting at a centralized composting facility is approximately $80 per tonne (Wagner and Arnold 2008), which is about twice the weighted average tipping fee in Manitoba. For Manitoba to implement a waste management option like composting, then, the cost difference between composting and disposal at landfill must be recouped by some means. A possible source of funding for waste management options of this nature is to levy "environmental fees", such as the two cent WRAP levy that applies to all non-deposit, non-dairy beverage containers in Manitoba (Manitoba Environment 1996).

4.3.2 Organic waste management in Manitoba

A high number of Manitobans living in the surveyed municipalities have access to some kind of organic waste management program (83.4%). Most communities surveyed offer seasonal yard waste pickup, yard waste drop-off at compost sites, and/or compost bins sales and/or subsidies (70.5%). About 12.86% of communities surveyed offer the curb-side pickup of food waste or a community compost site for food waste, while about 0.89% of the population of the communities surveyed (one surveyed community) has

access to the curb-side pickup of food waste. Interestingly, communities that offered organic waste management options had higher tipping fees, on average, than other communities: the weighted average tipping fee for communities that provided yard and food waste management options was $42.88/tonne, while the weighted average tipping fee for communities that provided food waste management options was $42.04/tonne, both of which were greater than the overall weighted average ($37.53/tonne).

Table 4.21 presents the waste generated and organic waste diverted by Canadian provinces and Canada in 2006. The amount of organic waste diverted as a percent of waste generated in Manitoba (1.1%) is well below the Canadian average (5.7%) (Table 4.21). In the context of organic waste management options, this likely indicates that the options undertaken in Manitoba in 2006 were not as successful as other options used in other provinces in Canada. Therefore, to the extent that organic waste management has not changed in Manitoba since 2006, Table 4.21 seems to suggest that Manitoba should pursue additional methods of diverting organic waste to achieve a greater diversion rate. Indeed, the survey of communities in Manitoba demonstrates that the vast majority of communities in Manitoba offer organic waste drop-off at a local compost site or seasonal yard waste pickup, but few communities offer year-round organic (yard and/or food) waste pickup. For many communities in Manitoba, pickup of source-separated organic waste might not be an economically viable option; however, in large municipalities, Winnipeg in particular, the weekly pickup of organic waste would make more economic sense and might have a large impact on organic waste diversion for Manitoba, in general.

Table 4.21 Waste generated and organic waste diverted by the provinces and Canada (2006)

Province	**Waste generated (tonnes)**	**Organic waste diverted (tonnes)**	**Organic waste diverted as percent of waste generated**
Newfoundland	438,113	0	0.0%

Nova Scotia	677,653	133,934	19.8%
Quebec	9,264,740	360,000	3.9%
Ontario	12,834,636	732,000	5.7%
Manitoba	1,177,071	12,490	1.1%
Saskatchewan	1,131,140	3,627	0.3%
Alberta	4,472,509	231,459	5.2%
British Columbia	4,283,271	292,031	6.8%
Canada	34,998,208	2,006,462	5.7%

Source: Statistics Canada 2008

Notes:

1. Data unavailable or suppressed for Prince Edward Island, New Brunswick, and Yukon Territory, Northwest Territories and Nunavut.

4.3.3 Survey results

Although only a small number of people were surveyed, this fact, alone, should not be a reason to ignore the results: in total, 24 participants held professional positions directly related to solid waste management in Manitoba (e.g., government, university, non-profit, private business), three held positions related indirectly within local governments in Manitoba, and one participant had no direct connection to waste management in Manitoba, but is knowledgeable on the topic. Without a doubt, the opinions gathered by the survey represent the opinions of a vast minority compared to the population of the province as a whole. However, all the participants are knowledgeable concerning waste management and were able to offer perspectives that were influenced by both education and experience. This survey was not intended to capture the opinions of the broad public; rather, the survey was intended to capture the opinions of people well versed on the topic. Therefore, the perspectives found by the survey, although representative of only a small number of people, are relevant in assessing Manitoba's waste management system, given their respective backgrounds and/or experiences.

4.3.3.1 Broad opinions and perspectives of survey participants

The interest in organic waste management among the survey participants was extremely high, with most participants believing that Manitoba and their respective municipalities of residence could better manage its organic waste. The participants' interest in organic waste is likely a result of their knowledge that a large proportion of the total waste stream is organic waste. If the general public is unaware of organic waste's impact on the total waste stream, which may explain why organic waste management is not as sophisticated in Manitoba as it is in other provinces, public education and awareness campaigns may help to improve the situation.

Public education may also be required if the general public is to understand the concept of 'sustainable development'. Sustainable development is a complicated topic and it is perhaps unsurprising that the survey participants were unable to clearly explain the concept in a few words. In the literature, sustainable development is widely regarded as the integration of social, environmental, and economic considerations in the creation of policy and programs at all levels of government (Sathaye et al., 2007; Folke et al., 2002; Division for Sustainable Development, n.d.) to achieve "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). As pointed out by The Natural Step (TNS), the 'needs' of people are not solely material, but extend to subsistence, protection, affection, understanding, participation, leisure, creation, identity, and freedom (TNS, n.d.). What is evident from the results of the survey is that this concept is not well understood, in general. Specifically, six out of 22 participants thought the concept involved only environmental and economic concerns, while the same number perceived the concept as

encompassing environmental, economic, and social concerns. Only one participant repeated all the general concepts associated with sustainable development, as explained above. Interestingly, probably due to the complexity of the issue, one participant even said of sustainable development that it is an over-used, misused, and politicized term. Indeed, since the term is generally touted as a positive force and since it means different things to different people, its use in everyday language is misleading. Therefore, public education should include discussion concerning the meaning of 'sustainable development'.

Another interesting finding what there was a slight disconnect between survey participants' concern for sustainable development and climate change. Of the four participants that were unconcerned with climate change, their average response to the importance of implementing sustainable organic waste management practices was 6 out of 7 (see Table 4.4). Perhaps these participants are more concerned with local matters and, thereby, perceive how they manage their organic waste as more of an issue than climate change, which they may or may not perceive as a threat on a global scale, but certainly do not perceive it as a threat at the community level.

4.3.3.2 Wide-spread policy/program implementation

Greater than 75% of survey participants believed that Manitoba could benefit from wide-spread organic waste management policies and/or practices. Interestingly, those participants who responded that Manitoba would "maybe" or "not" benefit explained that they responded this way essentially because what is needed in Manitoba needs a directed and holistic waste management strategy that includes organized, long

term planning, public education and communication, and unique approaches to rural communities.

In general, the survey participants provided a wide range of responses for why it would benefit Manitoba to implement organic waste management options. While they gave various environmental, economic, and social reasons for why Manitoba would benefit, these perceived benefits are all intricately connected, as well as connected to government policies and/or programs. For example, voluntary backyard composting, will not produce significant reductions in greenhouse gas emissions, synthetic fertilizer use, or the amount of waste going to landfill: Manitoba's current situation is evidence of this supposition. However, the curb-side pickup of organic waste and enforced and transparent regulations concerning compost quality might improve the outcome. In terms of the participants, it seems reasonable to assume that the broad range of reasons participants provided for why Manitoba would benefit from organic waste management options is because waste management represents a complex system: that is, waste management options often complement each other in ways that are not easily intuited.

4.3.3.3 Options for organic waste management

Survey participants suggested a broad variety of organic waste management policies and practices as being best suited to Manitoba, such as composting (e.g., backyard and centralized), regulatory instruments (e.g., landfill bans, waste burning bans, closing Class 2 and Class 3 landfills), economic instruments (e.g., pay-as-you-throw pricing), funding programs, regional partnerships, public education, etc. Given the variety of management options for organic waste suggested by the survey participants, it might

seem like there is no consensus regarding the direction in which Manitoba should be moving in terms of how to manage its organic waste. However, many of these options go hand-in-hand. For instance, composting become more feasible when certain regulatory and economic instruments, such as a waste burning ban or increased tipping fees, come into force. In addition, with funding, partnerships, and education the possibility of diverting the organic portion of the waste stream might not seem as ominous and, as a result, might garner more public and political support.

4.3.3.4 Past and future options for organic waste management

Although organic waste management options exist in many of the participants' respective communities (Table 4.9), it is clear from their responses that these options were not chosen due to organic waste management being a priority (Table 4.10). Indeed, the majority of respondents had a negative view of why these options were chosen, which seems to suggest that waste diversion was not the real impetus behind the implementation of the options. Survey participants believed these options were chosen because they were the least cost option, reduced existing costs, they were an easy "sell" to the public, or arose out of a lack of political will. Overall, the survey participants expressed dissatisfaction and frustration with regard to the chosen options. Two participants, however, did respond that backyard composting was chosen because it is the best option, since it deals with waste at the source. Other participants were convinced that more is needed than to encourage backyard composting to reach the levels of waste diversion seen in other provinces.

In the near future, many participants thought that some kind of centralized, large-scale composting facility would be built. Since many of the participants are directly involved in the waste management sector, this response may be due to a shift in attention in the sector toward organic waste. On the other hand, few participants mentioned landfill gas capture or increased tipping fees as a possibility in the near future, even though both will be occurring in the near future or have already occurred. Landfill gas capture will be implemented at the City of Brandon's Eastview Landfill and possibly at the City of Winnipeg's Brady Road Landfill and at the BFI Canada Prairie Green Landfill, which are three of Manitoba's largest landfills (Government of Manitoba 2010). In addition, beginning on July 1, 2009, a WRARS levy of $10 per tonne of waste disposed at landfills was imposed on waste entering landfills receiving more than 30,000 tonnes of waste annually (Green Manitoba 2009). By January 1, 2011, all landfilled waste in Manitoba will be subject to the levy (Green Manitoba 2009). It is curious why more participants did not refer to these changes, although they perhaps did not connect these issues specifically with organic waste management options. Another possibility is that survey participants were unaware of these changes due to a lack of transparency and/or public communication concerning changes.

4.3.3.5 Public involvement in decision-making

Curiously, although participants were generally dissatisfied with the scope of discussion with regards to organic waste management options, they were much more satisfied with the general level of public involvement in choosing these options. However, the people who were satisfied with the level of public involvement did not state

that they were satisfied because the public was actually involved in decision making; instead, they claimed they were satisfied because the public is now more accepting of organic waste management options. It appears that those participants who answered that they are satisfied with either the scope of discussion or amount of public involvement did so because they are simply pleased with the direction in which things are moving: that is, they are pleased that the scope of discussion and public involvement are increasing, but not necessarily at an acceptable level. In any case, this may be a sign that public acceptance of organic waste management options is increasing, which may lead to political pressure to initiate more extensive options, like curb-side pickup of organic waste.

Many of the survey participants stated that they were dissatisfied with the scope of discussion because of a general lack of knowledge of organic waste management, coupled with a lack of recognition of its importance. If this is the case, public education and consultations are needed to resolve this issue, which is exactly what many survey participants suggested.

4.3.3.6 Barriers to implementing organic waste management options

The three most common barriers to implementing organic waste management options mentioned by survey participants were a lack of public education, communication, and support, cost and funding, and political will. The results of the survey showed that the importance of public education, communication, and support declined moving forward in time: this may be due to participants believing that public education, communication, and support is becoming increasingly less of a barrier to

change. Indeed, as we have seen, some participants pointed out that they are pleased with steadily increasing levels of public involvement, communication, and education, although they still think progress is needed. Next, the results showed that participants' believe that, as a barrier to change, cost and funding has remained relatively constant between the past and future: this is somewhat expected, since the cost and funding of projects will always be an issue whenever people are considering barriers to change. On the other hand, that the survey found that participants perceived political will as a greater barrier to future change than past change is unexpected. This may suggest that people have a tendency to perceive past change as being less difficult than it really was, thereby expecting future change to come with a comparative (and too little) amount of time and effort However, this might also have to do with the relative complexity of implementing a new option, like centralized, large-scale composting or a landfill ban on organics, compared to promoting backyard composting or subsidizing composting bins, which have been done in the past and continue in the present.

Some participants mentioned barriers to change that are worthy of attention. Two participants mentioned creating a market for compost and addressing compost contamination as barriers. Without providing publicly accessible and transparent guidelines for compost contamination, there will be confusion concerning compost quality, possibly negatively affecting the market for compost. Without a well established market for compost, there is less of a financial incentive to set up a large-scale composting operation. Another barrier, which is connected to the issue of compost, which only a few participants addressed, is the low landfill tipping fees in Manitoba. When landfill tipping fees are low, it makes any other kind of waste diversion relatively more

expensive: that is, when it is less expensive to landfill organic waste than to compost it, people will tend to landfill that waste. Therefore, low landfill tipping fees in Manitoba are probably one of the more important barriers to composting and, thereby, to setting up a market for compost.

Another surprising result is that only a few participants identified Manitoba's lack of an integrated waste management strategy as a barrier to change. In particular, goals for organic waste diversion, regulations, economic incentives, and government guidance seem important factors that can contribute to communities' success in implementing waste management options.

4.3.3.7 Overcoming the barriers to change

It is perhaps unsurprising that the most frequently stated method by survey participants of overcoming barriers to change was persistent public education, including time spent in schools and workshops and linking waste management with climate change and economics. Intuitively, it makes sense to think that public awareness and knowledge of the issues will help to get organic waste management options implemented. It is surprising, however, how few participants thought that funding from all levels of government could help to overcome barriers to change, particularly because of how many people cited this as a barrier. Finally, few participants thought that government instruments (regulatory or economic) and/or a waste management plan could help to overcome the aforementioned barriers, which is also odd, since these instruments could help to overcome financial barriers.

4.3.3.8 Expert stakeholder meeting results

The expert stakeholder meeting was crucial to understanding the survey responses. While the survey responses did not typically enter into great detail, the discussions that occurred at the expert stakeholder meeting were lengthy and in-depth. As such, the results of the expert stakeholder meeting help to expand upon the findings of the survey. In addition, the perspectives of expert stakeholders from the two largest cities in Manitoba (Winnipeg and Brandon) helped to broaden the focus of the discussion to incorporate the needs and difficulties of communities other than the City of Winnipeg.

First, an outcome of the meeting that was unexpected was the desire for the participants to hold another meeting on waste management later in 2010. This desire emphasized the importance of discussion groups and communication among the participants. The participants were eager to discuss their concerns with their peers to collectively determine a strategy to overcome the difficulties they all face in the waste management sector. The participants felt that there was a disconnect between players in the waste management sector and that progress would only be made by working together. One challenge that the meeting participants face in terms of setting up a future meeting will be its location, particularly since the participants suggested that the next meeting be held in Brandon, which is 200 km away from Winnipeg. Considering that Winnipeg is the capital of the province and contains a little more than half of the population of Manitoba, if a meeting is held outside of Winnipeg, it may be a challenge to ensure that representation from both the governments of Manitoba and Winnipeg will be present at the meeting.

The participants in the meeting largely agreed in the direction that Manitoba's waste management system should be moving. First, there was strong agreement that, to move forward, there is a need for regional and provincial working groups to talk about waste management problems and solutions. The participants believed that without cooperation on this scale, waste management in Manitoba would not move forward. To this end, the participants agreed that the Government of Manitoba needs to lead the way by establishing a waste management strategy with targets and goals in order to create a fair and equal playing field for all actors in the sector. While the participants recognized that the Government of Manitoba is currently working on several waste management projects, its piecemeal approach was unsatisfactory to the participants. The participants also agreed on the usefulness of regulatory instruments to encourage waste diversion, such as the WRARS landfill levy and landfill bans. However, the participants were dissatisfied with the public education concerning the levy, particularly with how smaller municipalities were supposed to abide by the levy. The participants were also in agreement that landfill tipping fees, in general, in Manitoba were too low to encourage diversion; for this reason, they wanted to see scheduled increases in the levy over time. The participants also stressed that new regulations should be implemented over time to allow people and businesses time to adapt to a changing regulatory environment.

There was also a strong consensus among participants that organic waste is only a portion of the waste stream and should thereby be dealt with only in the context of an integrated waste management system. In fact, the participants proposed a waste management strategy very similar to what the Federation of Canadian Municipalities (2009) suggests and the plan actually implemented by Nova Scotia in the mid 1990s.

4.3.3.9 Conclusion

Participants in the survey and meeting provided some much needed perspective on the waste management sector in Manitoba. As Manitoba's waste diversion rate is one of the lowest in the country, the time is ripe for knowledgeable people within the waste management sector to provide input into determining how Manitoba's diversion rate can be improved.

The main point brought out by the survey and meeting of expert stakeholders is that an integrated strategy for all of Manitoba is needed before waste management will improve in the province. In addition, participants believed that organic waste management options should be implemented in Manitoba, provided that smaller municipalities are provided with unique solutions. To this end, participants suggested regional cooperation to achieve economies of scale for organic waste options, such as centralized composting facilities. The participants pointed out that determining what options will work in which municipality will require extensive on-going public education, communication, and consultation. Similarly, connecting waste management with climate change and greenhouse gas emissions was also expressed as an important means by which to get people interested in organic waste management. In terms of specific options that participants suggested that Manitoba should implement, opinions were divided. However, the many options for organic waste management provided by the participants point toward the implementation of an integrated approach, where multiple options are implemented that aim toward the same end. For instance, public education, backyard composting, large-scale centralized composting, pay-as-you-throw pricing, eliminating

Class 2 and Class 3 landfills, increasing tipping fees, and banning organic waste from landfills can all be different options for promoting organic waste management, but can also all work together to achieve successful waste diversion.

It should be noted that the suggestions from participants in the survey and meeting are generally consistent with the summaries of how the Federation of Canadian Municipalities (FCM) suggests municipalities implement waste management systems and what Nova Scotia actually implemented in the early 1990s, which is presented in the introduction to this Chapter. In particular, the participants agreed with FCM concerning the following recommendations for a successful waste management program:

- Provincial government assistance;
- Public involvement in decision-making;
- Regional cooperation;
- Developing a waste management strategy;
- Implementing waste management options over time to allow people and businesses to adapt to a changing regulatory environment; and
- Connecting waste management with climate change.

The following list points out the similarities between the participants' suggestions and the Nova Scotia strategy:

- Provincial leadership on developing a strategy;
- Economies of scale can be realized through regional cooperation;
- Waste incineration ban;
- Landfill bans (e.g., for organic waste);
- Organic waste curb-side pickup (e.g., for food waste);

- Stricter design standards for landfills; and
- Increase tipping fees over time.

It is interesting that the results of the survey and meeting are in such acute agreement with Nova Scotia's waste management strategy, which has enjoyed great success. In addition, participants' opinions largely agree with the strategy presented by the Federation of Canadian Municipalities, which is based upon the successes of other municipalities. It seems clear that if the Government of Manitoba should want assistance in developing an integrated waste management strategy of its own, it should look to the perspectives of the people within Manitoba's waste management sector to help guide its development.

REFERENCES

City of Winnipeg. 2010a. Population of Winnipeg. Retrieved November 6, 2010 from <www.winnipeg.ca/cao/pdfs/population.pdf>.

City of Winnipeg 2010b. Residential garbage report. Retrieved November 6, 2010 from <http://www.winnipeg.ca/waterandwaste/garbage/residentialReport.stm>.

City of Winnipeg. 2010c. Residential recycling report. Retrieved July 1, 2010 from <http://www.winnipeg.ca/waterandwaste/recycle/recyclingReport.stm>.

Division for Sustainable Development (n.d.). About. *U.N. Department of Economic and Social Affairs*. Retrieved February 18, 2009 from <http://www.un.org/esa/dsd/dsd/dsd_index.shtml>.

Federation of Canadian Municipalities [FCM]. 2009. Getting to 50% and beyond: Waste diversion success stories from Canadian municipalities. Retrieved July 5, 2010 from <http://gmf.fcm.ca/files/Capacity_Building_-_Waste/WasteDiversion-EN.pdf>.

Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L., Holling, C.S., and Walker, B. (2002). Resilience and sustainable development: Building adaptive capacity in a world of transformations. *Ambio*, 31(5): 437-440.

Government of Manitoba. 2010. Province, Brandon sign deal to reduce landfill greenhouse gas emissions. Retrieved November 14, 2010 from <http://news.gov.mb.ca/news/index.html?archive=2010-7-01&item=9160>.

Green Manitoba. 2009. Waste reduction and recycling support (WRARS) program guide. *Government of Manitoba*. Retrieved June 29, 2010 from

<http://www.greenmanitoba.ca/cim/dbf/wrars_guide_december_09_(v1.1).pdf?im_id=392&si_id=1001>.

Manitoba Health and Healthy Living. 2009. Population Report: June 1, 2009. Government of Manitoba. Retrieved May 17, 2010 from <http://www.gov.mb.ca/health/population/pr2009.pdf>.

Manitoba Environment. 1996. Waste reduction and prevention: Waste reduction and prevention strategy report 1996. *Government of Manitoba*.

Manitoba Local Government. n.d. Municipalities. Government of Manitoba. Retrieved May 17, 2010 from <http://web5.gov.mb.ca/public/municipalities.aspx>.

Sathaye, J., A. Najam, C. Cocklin, T. Heller, F. Lecocq, J. Llanes-Regueiro, J. Pan, G. Petschel-Held , S. Rayner, J. Robinson, R. Schaeffer, Y. Sokona, R. Swart, H. Winkler, 2007: Sustainable Development and Mitigation. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Resource Conservation Manitoba. 2010. Welcome to RCM. Retrieved May 18, 2010 from <http://www.resourceconservation.mb.ca/>.

Statistics Canada. 2008. Waste management industry survey: Business and government sectors. *Government of Canada*. Catalogue no. 16F0023X. Retrieved Mar 12, 2010 from <http://www.statcan.gc.ca/pub/16f0023x/16f0023x2006001-eng.pdf>.

The Natural Step (n.d.). The Four System Conditions. Retrieved March 6, 2009 from <http://www.thenaturalstep.org/en/canada/the-system-conditions>.

Wagner, T., and P. Arnold. 2008. A new model for solid waste management: an analysis of the Nova Scotia MSW Strategy. *Journal of Cleaner Production* 16: 410-421.

CHAPTER 5: BETTER OPTIONS FOR ORGANIC WASTE MANAGEMENT: COMPARING MANITOBA, CANADA WITH NOVA SCOTIA, CANADA, NEW SOUTH WALES, AUSTRALIA, AND DENMARK

5.1 Introduction

Effective waste management options are badly needed to lessen the strain placed on society by ever-increasing waste generation and methane emission rates. Waste management options targeted at organic materials have several positive benefits, including increased landfill life span and decreased greenhouse gas emissions. First, since organic waste represents a large portion of the total waste disposed of at landfills, its diversion can significantly increase the operational life-span of landfills. In 2002, about 28% of the total waste by weight entering landfills in Canada was either food or yard waste (David, 2007). Similarly, according to the US EPA (2008), food and yard waste made up about 12.7% and 13.2% of the total waste generated in the United States in 2008, respectively. Second, the decomposition of organic waste in landfills causes the release of methane (CH_4) into the atmosphere, which is a greenhouse gas with approximately 25 times the global warming potential of carbon dioxide (CO_2) over a 100-year time horizon (Forster et al. 2007). In 2006, about 20 Mt CO_2e, or 2.8%, of Canada's 721 Mt CO_2e emissions were due to landfill methane emissions (Environment Canada 2009a). In 2008, methane from landfills was responsible for about 126.8[2] Mt CO_2e (US EPA 2010b), or 2.1%, of the 6,016.4 Mt net CO_2e produced in the United States (US EPA 2010a).

[2] This value may be as high as 151.0 Mt CO_2e, since the US EPA used a global warming potential for methane of 21 instead of 25.

Other benefits of composting organic waste include decreased contamination of water sources due to leachate created by the decomposition of organic materials in landfills, the production of compost, which reduces synthetic fertilizer and, potentially, pesticide use, improves soil quality, and creates local jobs through the local management of resources (Bogner et al. 2007; Nevens and Reheul 2003; Nova Scotia Environment 2009c; Otten 2001).

Traditionally, organic waste management options have largely been seen in terms of their cost instead of their benefits. Indeed, past disregard for the environment and the difficulty of performing full cost accounting for composting are largely to blame for the lack of composting initiatives in North America. However, waste management options, including waste reduction, re-use, recycling, and composting are becoming increasingly mainstream in North America. If this trend continues, policy makers will need to develop long term waste management strategies for their respective jurisdictions. Therefore, it is prudent to analyze the strategies, successes, and failures of other jurisdictions in order to provide policy makers with the tools to make sound policy decisions with regard to organic waste management options.

5.2 Method

A literature review and personal communications were conducted to research the waste management systems in Manitoba, Canada, Nova Scotia, Canada, New South Wales, Australia, and Denmark. Organic waste management strategies were compared for effectiveness at achieving various goals, including waste diversion, producing compost, creating local jobs, developing long term, sector specific waste management strategies,

and constructing partnerships. Manitoba, Canada is the focus of the study, while the other jurisdictions were selected because of their extensive waste management strategies, which include organic waste composting of some kind.

Nova Scotia, Canada, New South Wales, Australia, and Denmark were selected because, through research, they were identified as leaders in waste management. Indeed, these jurisdictions continue to improve upon their respective waste management sector and, as a result, have achieved high levels of waste diversion and environmental protection. In addition, since these jurisdictions are in three distinct continents, altogether they present a broad perspective of waste management.

5.3 The four jurisdictions

The four jurisdictions, Manitoba, Canada, Nova Scotia, Canada, New South Wales, Australia, and Denmark are described below. Each section begins with a general description of the jurisdiction, including population and political structure. This is followed by a description of the broad national or international strategy for waste in which the jurisdiction finds itself. Manitoba and Nova Scotia will be discussed within the context of Canada. Next, a description of the jurisdiction's specific waste management strategy will be discussed. Finally, an overview of some of the more prevalent programs will be provided, along with detailed tables of diversion achievements.

5.3.1 Canada

The Federal Parliament of Canada is located in Ottawa, Ontario (National Capital Commission 2008). The Constitution Act, 1867 and the Constitution Act 1982 delineate

the matters about which the Federal and Provincial governments are entitled to legislate, respectively (Department of Justice 2010). Under the Constitution Act, 1867, Section 92(10), the provinces are entitled to exclusively legislate in matters of local works and undertakings, as long as these matters do not extend beyond the province in question or are deemed a national concern (Department of Justice 2010). Therefore, provincial waste management is, under most circumstances, within the jurisdiction of the provinces.

5.3.1.1 Canada's Environmental Management Policies and Strategies

The Canadian Environmental Protection Act, 1999 (CEPA, 1999) is an important piece of Canadian legislation for pollution prevention and the protection of the environment and human health (Environment Canada 2005a). The main objective of CEPA, 1999 is to move Canadian society toward sustainable development (Environment Canada 2005a). Other pieces of federal legislation aimed at protecting the environment include the Fisheries Act, the Canada Water Act, the Species at Risk Act, the Canada Wildlife Act, the Migratory Birds Convention Act, 1994, and the Wild Animal and Plant Protection and Regulation of International and Interprovincial Trade Act (Environment Canada 2005b). With regards to CEPA, 1999, it contains important concepts like sustainable development, ecosystems approach, the precautionary principle, the polluter pays principle, and science-based decision-making as guiding principles (Environment Canada 2005c); however, CEPA, 1999 and the other Acts mentioned have not led to a national waste management strategy for non-hazardous waste.

Other organizations that assist Canadian governments formulate waste management policy include the Canadian Council of Ministers of the Environment

(CCME) and the Federation of Canadian Municipalities. The CCME is composed of the 14 environment ministers from the federal, provincial, and territorial governments (2009a). The CCME convenes once per year and serves as a forum to assist its members to fulfill their mandate of protecting Canada's environment and to develop national strategies, norms, and guidelines that each environment ministry across the country can use (CCME 2009a). Since the environment is, constitutionally speaking, a shared jurisdiction among the provinces and the federal government, the CCME members work together to promote effective results (CCME 2009a). In 2009, the Canadian Council of Ministers of the Environment produced a document entitled *Canada-wide Action Plan for Extended Producer Responsibility* (Canadian Council of Ministers of the Environment [CCME] 2009b). The *Plan* outlines a shift in Canadian policy from product stewardship to extended producer responsibility (CCME 2009b). Product stewardship programs are programs that place some of the financial burden of the post-consumer stage of a product's lifecycle onto the producer of the product (Nicol and Thompson 2007). On the other hand, extended producer responsibility (EPR) programs place *all* of the responsibility of the post-consumer stage of a product's lifecycle onto the producer of the product, therefore shifting the burden of the product's waste disposal from taxpayers to the producer and consumer of the product (CCME 2009b). Once a jurisdiction has adopted the *Plan*, it is committed to working toward developing EPR programs toward certain kinds waste, including packaging, printed materials, and mercury containing lamps, within six years (CCME 2009b).

In the past, the Government of Canada has been mainly involved in waste management issues concerning hazardous materials and their interprovincial or

international transportation, air emissions, and federal funding programs (Environment Canada 2009b). The Government of Canada has provided funding to the Federation of Canadian Municipalities (FCM), which represents the interests of over 1,900 municipalities concerning policies and programming that fall within federal jurisdiction (Federation of Canadian Municipalities n.d.). With the funding provided by the Government of Canada, the FCM produced a guide to municipal solid waste management in 2004: *Solid Waste as a Resource: Guide for Sustainable Communities* (Federation of Canadian Municipalities [FCM] 2004). The Guide is a tool for municipal governments to reduce waste and maximize the use of resources (FCM 2004). In particular, the Guide was designed for smaller communities where scarce resources might prohibit the study of waste management options and for the consultants hired by communities to better understand their waste management goals (FCM 2004). The Guide takes a step-by-step approach to designing a holistic waste management program (FCM 2004). The Guide moves from the planning and goal setting stage, to understanding community needs, policy and legislative considerations, partnership considerations, technology considerations, energy and greenhouse gas effects, financial and economic considerations, end-use market considerations, promotion and education, and evaluation (FCM 2004). Therefore, the Guide produced by FCM provides municipal leaders with the knowledge necessary to plan a waste management strategy for their respective community.

5.3.2 Manitoba, Canada

Manitoba is the easternmost of Canada's three Prairie Provinces, situated between the provinces of Saskatchewan and Ontario. The total area of Manitoba is about 647,797 km^2, which is about 6.49% of Canada's total land area (Statistics Canada 2005b). In 2006, the population of Manitoba was 1.148 million, which was about 3.52% of Canada's total population of 32.576 million (Statistics Canada 2009). In 2006, 0.327 million (28.48%) Manitobans lived in rural areas and about 0.821 million (71.52%) lived in urban areas (Statistics Canada 2008a). Of the approximately 283 communities in Manitoba, in 2006, eight had populations greater than 10,000 people, containing 65.17% of Manitoba's population (Statistics Canada 2008b). The City of Winnipeg is the capital of Manitoba and contained 55.16% of Manitoba's population in 2006 (Statistics Canada 2008b).

5.3.2.2 Manitoba's Waste Management Program Achievements

Although Manitoba has no published waste management strategy, per se, it has had a plan in the past and currently has numerous programs that encourage waste diversion from landfills. Circa 1990, a target of 50% reduction in waste disposal compared to 1988 levels was set, and a Recycling Action Committee was established to develop a means by which to achieve that target (Haque and Hamberg 1996, Recycling Action Committee 1990). The Recycling Action Committee made many recommendations to the Government of Manitoba, including identifying priority substances to target for waste management programs, setting an interim target (20% reduction by 1995), providing public education and communication, reducing the number

of landfills to consolidate sites into larger, upgraded ones, and implementing a user pay system of waste management (Recycling Action Committee 1990). In 1990, the Government of Manitoba passed the *Waste Reduction and Prevention Act*, through which regulations were developed concerning multi-material recycling, tire recycling, and used oil management (Manitoba Conservation n.d.b). The Act also includes provisions for industry stakeholder consultations, reporting, establishing waste reduction targets, and establishing financial mechanisms, including deposits, handling fees, and pre-disposal fees (Manitoba Environment 1991). As well, the Act provides the power to license distributors or prohibit the sales of products or materials in Manitoba (Manitoba Environment 1991). In 1991, a WRAP Report was prepared to comply with the WRAP Act (Manitoba Environment 1991). Although much of the report dealt specifically with the recommendation provided by the Recycling Action Committee, few definite actions were taken by Manitoba Environment as a result of the recommendations: for instance, Manitoba Environment did not acknowledge the need to provide targets for major subcategories of waste, the formation of a composting committee was delayed, and many other recommendations were simply under review. By 1996, Manitoba had experienced substantial progress in terms of its waste management system: the Manitoba Product Stewardship Corporation was formed, funded by a two cent levy on all non-deposit, non-dairy beverage containers; waste disposed at landfill per capita had decreased by 21% since 1988. Between 1991 and 1995, 10% of active municipal waste disposal sites had closed, with 57 scheduled for closure; recycling services were available to over 85% of Manitoba households; and the recognition that only with the diversion of organic waste could Manitoba achieve its waste disposal target by the year 2000 (Manitoba

Environment 1996). Other stewardship programs were also established, including Tire Stewardship Manitoba and Manitoba Association for Resource Recovery Corporation (MARRC) (Manitoba Conservation n.d.b).

In 1999, a document called the *Final Report of the Manitoba Regional Waste Management Task Force: Regional Solid Waste Management Action Plan and Recommendations* was developed in consultation with stakeholders (Manitoba Conservation 1999). The purpose of the *Report* was to better understand Manitoba's waste management system in comparison to other jurisdictions and to propose a regional solid waste management plan (Manitoba Conservation 1999). The *Report* included recommendations to the Government of Manitoba to improve its waste management system (Manitoba Conservation 1999).

In 2008, the document *Beyond Kyoto: Manitoba's Green Future*, produced by the Government of Manitoba, included some highlights of Manitoba's waste management strategy (Manitoba Science, Technology, Energy and Mines [MSTEM] 2008). These highlights included the following: new legislation requiring the capture or flaring of methane from large landfills to reduce methane emissions; the acknowledgement that changes to waste management in Manitoba would be beneficial to reach its greenhouse gas emission goal; and a retail sales tax exemption for manure treatment equipment, including lagoon liners, biodigesters, and composters (MSTEM 2008). In 2005, greenhouse gas emissions from Manitoba's waste management system were about 1.0 Mt (MSTEM 2008). Finally, Manitoba will meet its Kyoto GHG reduction target of 6% below 1990 levels by 2012: in fact, according to *Beyond Kyoto*, Manitoba will be the first

jurisdiction in Canada and the first regional jurisdiction in North America to legislate the 6% below 1990 level emissions target (MSTEM 2008).

In 2010, there are voluntary drop-off programs for electronic waste and household hazardous waste operated by the Government of Manitoba. There will be 29 electronic waste collection depots, including 19 temporary depots operating May 1 – October 30 and 10 year-round depots in Manitoba in 2010 (Green Manitoba n.d.b). There will also be a number of events for voluntary drop-off of household hazardous waste in major communities in Manitoba (Green Manitoba 2010).

In 2009, the Waste Reduction and Recycling Support (WRARS) Fund was created (Green Manitoba 2009). Beginning on July 1, 2009, a WRARS levy of $10 per tonne of waste disposed at landfills was imposed on waste entering landfills receiving more than 30,000 tonnes of waste annually (Green Manitoba 2009). By January 1, 2011, all landfilled waste in Manitoba will be subject to the levy (Green Manitoba 2009). The purpose of the levy is to increase the financial assistance to communities for recycling and composting programs: 80% of the revenue collected by the levy will be rebated to communities to promote diversion programs (Green Manitoba 2009). The remainder of the revenue of the levy will be used to increase the financial support of the electronic waste and household hazardous waste programs (Green Manitoba 2009). This levy will provide a strong financial disincentive to landfill waste in Manitoba and, thereby, improve Manitoba's diversion rate (Green Manitoba 2009).

Previously, funding for recycling programs was mainly provided to communities in Manitoba through the Manitoba Product Stewardship Corporation (MPSC). The MPSC received revenue through a 2 cent deposit/levy on beverage containers in Manitoba. The

money raised by the levy was then returned to communities based on their diversion performance: that is, the greater a community's diversion rate, the greater the sum of money it received from MPSC. However, the functions of the MPSC have now been turned over to Multi Material Stewardship Manitoba (MMSM) (B. Duggirala, personal communication, June 30, 2010).

Communities can also receive supplemental funding through the Waste Reduction and Pollution Prevention (WRAPP) fund (Manitoba Conservation n.d.a). The WRAPP fund supports projects that reduce or prevent waste generation, promote sustainable practices, or demonstrate innovative approaches to waste management (Manitoba Conservation n.d.a).

The City of Winnipeg first adopted a waste management strategy in 1996, which was updated in 2001 (City of Winnipeg 2010c). In 2010, the City of Winnipeg adopted a new waste management strategy based on Winnipeg City Council's determination that the perspective on waste management has changed dramatically since 2001: that is, the perspective has shifted from landfilling most of the waste stream to a resource recovery model that keeps valuable resources out of landfills (City of Winnipeg 2010c). Along with this strategy, the Winnipeg City Council also adopted an organic waste management strategy (City of Winnipeg 2010a). The new strategy will include the automated collection of about 19,000 tonnes of bagged yard waste in Winnipeg's north-west sector, using certified compostable bags (City of Winnipeg 2010a). Winnipeg will contract the collection of yard waste, and yard waste processing to produce compost, at a cost of approximately $232,000 (City of Winnipeg 2010a).

5.3.2.2 Manitoba's Waste Diversion Achievements

Between 2004 and 2006, Manitoba's waste diversion rate fell from 14.5% to 13.0% (Table 5.1). On average in 2006, Canadians disposed of 835 kg of waste per person per year in landfills (Statistics Canada 2008c), which was about 4.1% lower than Manitoba's waste disposal rate (Table 5.2). In addition, on average in 2006, Canadians diverted 237 kg of waste per person per year from landfills (Statistics Canada 2008c), which was about 82.3% greater than Manitoba's waste diversion rate (Table 5.2).

Table 5.1 Total waste generated, disposed, and diverted in, and % change between, 2004 and 2006 in Manitoba.

	2004	2006	% Change (2004 to 2006)
Waste Generated (Mt)	1.085	1.177	8.5
Waste Disposed (Mt)	0.928	1.024	10.3
Waste Diverted (Mt)	0.157	0.153	-2.6
Percent Diverted (%)	14.5	13.0	-11.5

Source: Statistics Canada 2008c

Table 5.2 Total waste generated, disposed, and diverted per capita in 2004 and 2006 in Manitoba.

	2004	2006
Waste Generated (kg/capita)	928	999
Waste Disposed (kg/capita)	793	869
Waste Diverted (kg/capita)	135	130

Source: modified from Statistics Canada 2008c

In 2009, through the Manitoba Association for Resource Recovery Corporation (MARRC), Manitobans recycled 70% of used motor oil, 77% of used oil filters, and 49% of used oil containers (MARRC 2010). Also in 2009, through Tire Stewardship Manitoba, Manitoba achieved a scrap tire diversion rate of 93% (Tire Stewardship Manitoba 2009). About 14,373 tonnes of scrap tires were diverted and used in the making of products such as aggregate, crumb rubber, and blast mats (Tire Stewardship Manitoba 2009). In 2009, through the Manitoba Product Stewardship Corporation, over 70,000 tonnes of materials, including newspapers, corrugated cardboard, plastics, glass,

aluminum, and metal cans, were recycled (Manitoba Product Stewardship Corporation 2009). Finally, in 2009, Manitobans diverted 1,500 tonnes of electronic waste and 750 tonnes of household hazardous waste (HHM) from landfills through the E-Waste and HHM programs, respectively (Manitoba Conservation 2010).

5.3.3 Nova Scotia, Canada

Nova Scotia is located on the east coast of Canada and consists of mainland Nova Scotia, which is almost entirely surrounded by water, and Cape Breton Island, located in the Cabot Straight (Google Maps 2010b). Nova Scotia is a relatively small province in Canada: it consists of a total area of about 55,284 km^2 and represents only 0.55% of Canada's total land area (Statistics Canada 2005b). In 2006, the population of Canada was estimated at about 32.576 million people, while the population of Nova Scotia was estimated at about 0.938 million people or about 2.88% of Canada's total population (Statistics Canada 2009). In 2006, about 0.507 million people (54.05%) lived in urban areas and about 0.407 million people (45.95%) lived in rural areas (Statistics Canada 2008a). There are 18 Counties in Nova Scotia and in 2006 their populations ranged from 7,941 (Victoria) to 382,203 (Halifax) people (Vital Statistics 2006). The capital of Nova Scotia is Halifax (Government of Canada 2010).

5.3.3.1 Nova Scotia's Waste Management Plan

In 1995, Nova Scotia Environment, a department of the Government of Nova Scotia, produced an extensive solid waste management strategy, called the Solid Waste-Resource Management Strategy, aimed primarily at environmental protection and

promoting ecological value, the efficient use of resources, and benefitting from the economic opportunities of developing the environmental industrial sector (Nova Scotia Environment 2009c). Major milestones of the solid waste management strategy included the following: formally adopting in the Environment Act the goal of achieving 50% diversion of solid waste by the year 2000, using 1989 as a base year; the conclusion, based on a series of studies of provincial waste management, that certain economies of scale could be realized by the collaboration of regions in Nova Scotia; and government recognition that its goals with respect to waste management could not be achieved without extensive public consultations (Nova Scotia Environment 2009c). Specifically, the accomplishments of the solid waste management strategy of Nova Scotia include bans on the disposal of many items in landfills, including compostable organic materials and beverage containers, a reduction in the number of landfills by 75% and the requirement of all landfills to adhere to strict guidelines, the establishment of seven solid waste management regions, the creation of job opportunities through the development of the value-added goods industry, and the marketing of environmental technologies developed in Nova Scotia to other regions (Nova Scotia Environment 2009c).

Possibly the largest change caused by Nova Scotia's waste management plan was the increase in landfill tipping fees: in 1989, there was no landfill tipping fee for waste in Halifax Regional Municipality; by 2001, the tipping fee reached $115 per tonne (Wagner and Arnold 2008). Other regions saw an average tipping fee of $80 per tonne (Wagner and Arnold 2008). The new tipping fees, combined with the landfill ban on certain materials, the open burning ban, and the closure of many landfills and Nova Scotia's one incinerator due to the strict new landfill and emissions regulations, has led to a strong

financial incentive to divert materials rather than dispose of them (Wagner and Arnold 2008). A strong financial incentive to divert materials is crucial for centralized composting since these facilities need to charge a tipping fee of between $30 and $77 per tonne of waste to cover their operational costs (Wagner and Arnold 2008). Importantly, this strategy has led to the internalization of waste management costs for households and the ICI sector (Wagner and Arnold 2008).

In 2007, the Nova Scotia government set a new target of reducing the amount of waste disposed of from about 430 kilograms per person per year to 300 kilograms per person per year by 2015 (Nova Scotia Environment 2009a). This disposal target is legislated by the Environmental Goals and Sustainable Prosperity Act (Nova Scotia Environment 2009a). To help reach this target, Nova Scotia Environment initiated a renewal process to update its Solid Waste Resource Management Strategy (Nova Scotia Environment 2009a).

Nova Scotia reaffirmed its commitment to its Solid Waste-Resource Management Strategy in 2009 by consulting with stakeholders across the province to determine how the Strategy might be improved (Nova Scotia Environment 2009b). After analyzing the concerns and opinions of the stakeholders taking part in the consultation process, seven broad goals were developed (Nova Scotia Environment 2009b). These goals include, developing and expanding waste reduction and diversion practices and programs that are sustainable, increasing residential, commercial, institutional, and industrial participation in waste prevention and diversion initiatives, and minimizing waste disposal by using financial incentives and disincentives (Nova Scotia Environment 2009b). An updated

Strategy, based upon the findings of the consultation process, will be recommended to government by spring 2010 (Nova Scotia Environment 2009b).

5.3.3.2 Program Achievement of the Nova Scotia Waste Management Plan

In order for Nova Scotia to reach its impressive waste management goals, the Government of Nova Scotia established several programs. The Resource Recovery Fund Board Inc. (RRFB) is a private, not-for-profit organization created to direct a significant part of the Solid Waste-Resource Management Strategy (Nova Scotia Environment and Labour 2004). The RRFB is mandated by the Government of Nova Scotia to fund municipal and regional waste diversion programs, create and manage a deposit/refund system for beverage containers, develop and execute industry stewardship programs, raise awareness of waste reduction, reuse, recycling, and composting, and promote the development of value-added manufacturing in Nova Scotia (Nova Scotia Environment and Labour 2004). The RRFB is responsible for opening Enviro-Depots and Regional Processing Facilities, introducing the deposit/refund system for beverage containers and the Used Tire Management Program, and establishing a paint recycling program (Nova Scotia Environment and Labour 2004). The RRFB, in conjunction with local municipalities, provides province-wide education programs for reducing, reusing, recycling, and composting waste, operates a recycling and composting hotline, and produces booklets and brochures promoting recycling and composting (Nova Scotia Environment and Labour 2004).

In Nova Scotia, consumers pay a $0.10 charge per beverage container and receive $0.05 back for bringing the container to an Enviro-Depot (Wagner and Arnold 2008). Of

the $0.05 that remain, $0.0356 is given to the Enviro-Depots and $0.0144 is used to fund municipal solid waste management programs, material processing centres, the transportation of diverted materials, and the administration of the fund (Wagner and Arnold 2008). Public acceptance of the beverage container charge is largely due to the knowledge that the money is returned to the community in order to fund waste management programs (Wagner and Arnold 2008). Other municipal funding systems for waste management include a reward system that provides a monetary incentive for municipalities to increase their diversion rates and environmental levies on tires, paint, and milk containers (Wagner and Arnold 2008).

The RRFB Nova Scotia is also responsible for assisting in the funding and marketing of new and innovative products, services, and technologies related to resource recovery (Wagner and Arnold 2008). The assistance of the RRFB on this matter is critical, since the creation of local markets reduces transportation costs, which are often the greatest barrier to the marketing of recovered materials, increases market stability by diversifying demand, and creates local jobs (Wagner and Arnold 2008). In fact, between 1996 and 2004, more than 1000 jobs relating to waste management were created in Nova Scotia (Nova Scotia Environment and Labour 2004).

In 2004, 99% of the population of Nova Scotia had access to curb-side recycling programs (Nova Scotia Environment and Labour 2004). In terms of food waste recycling, 77% of the population of Nova Scotia had access to curb-side collection and centralized composting of food waste and 53 out of 55 municipalities provided centralized composting to their business sector (Nova Scotia Environment and Labour 2004). In 2002, the average cost of operating a two-stream waste pickup program (waste plus

recyclables) was $50 per household per year; the average cost of operating a three-stream waste pickup program (waste plus recyclables plus organics) was $56 per household per year.

5.3.3.3 Diversion Achievement in Nova Scotia

Tables 5.3 and 5.4 demonstrate the diversion achievements of Nova Scotia. In 2006, Nova Scotia had the lowest per capita waste generation and waste disposal rates in Canada and diverted about 24.5% more waste per capita than the Canadian average (Statistics Canada 2008c). Table 5.4 also shows the waste disposal rate of Nova Scotians in 1989, which is considered the base year rate in Nova Scotia: that is, present-day waste disposal rates are compared against the 1989 waste disposal rate.

Table 5.3 Total waste generated, disposed, and diverted in, and % change between, 2002, 2004, and 2006 in Nova Scotia.

	2002 (Mt)	**2004 (Mt)**	**2006 (Mt)**	**% Change (2002 to 2004)**	**% Change (2004 to 2006)**	**% Change (2002 to 2006)**
Waste Generated	0.559	0.640	0.678	14.5	5.9	21.3
Waste Disposed	0.389	0.400	0.402	2.8	0.5	3.3
Waste Diverted	0.170	0.240	0.276	41.2	15.0	62.4
Percent Diverted (%)	30.4	37.5	40.7	23.4	8.5	33.9

Source: modified from Statistics Canada 2005a, Statistics Canada 2008c, Statistics Canada 2010b

Table 5.4 Total waste generated, disposed, and diverted per capita in, and % change between, 2002, 2004, and 2006 in Nova Scotia.

	1989	**2002**	**2004**	**2006**	**% Change of Per Capita Waste Disposed Compared to 1989**		
					2002	2004	2006
Population		934,507	937,993	934,405			
Waste Generated per capita (kg)		598	682	726			
Waste Disposed per capita (kg)	747	416	426	430	-44.3	-43.0	-42.4
Waste Diverted (per capita)		182	256	295			

Source: modified from Government of Nova Scotia 2008, Statistics Canada 2005a, Statistics Canada 2008c, Statistics Canada 2010b

By 2006-07, Nova Scotia's per capita waste disposal rate had risen to 477 kg per year (Nova Scotia Environment 2008). In 2006, the Government of Nova Scotia introduced new legislation that added a new waste disposal goal of 300 kg/person/year by 2015 (Nova Scotia Environment 2008). The new waste disposal target aims to reduce the waste disposal rate in Nova Scotia by about 37.1%.

Table 5.5 Organic waste recycled as a proportion of total waste recycled and generated in Nova Scotia in 2002, 2004, and 2006.

	Total Waste Generated (Mt)	Total Materials Prepared for Recycling (Mt)	Total Organic Waste Prepared for Recycling (Mt)	% Organic Waste of Total Waste Recycled	% Organic Waste Recycled of Total Waste Generated
2002	0.559	0.170	0.062	36.5	11.1
2004	0.640	0.240	0.093	38.8	14.5
2006	0.678	0.276	0.134	48.6	19.8

Source: Statistics Canada 2008c, Statistics Canada 2005a

The amount of organic waste from residential and institutional and commercial sources has increased dramatically in recent years (Table 5.5). The total tonnage of organic waste received at composting facilities (excluding organic material from industrial sources, such as pulp and paper sludge and wood fibre) in Nova Scotia has increased from less than 5,000 tonnes in 1994 to nearly 100,000 tonnes in 2006 due to the launch of the curb-side collection of organics in Halifax Regional Municipality and other communities (Nova Scotia Environment 2008).

5.3.4 New South Wales, Australia

New South Wales (NSW) is one of Australia's six states (Australian Government n.d.). NSW is located on the east cost of Australia, south of the state of Queensland and north of the state of Victoria (Google Maps 2010a). The total area of NSW is 800,642

km^2 (Encyclopedia Britannica n.d.). In 2009, 7.1 million people lived in NSW, representing about 32.5% of the total Australian population of 21.9 million people (Australian Bureau of Statistics 2009). There are 152 councils in NSW; in 2007, the population of the councils ranged from 1,286 (Urana) to 284,692 (Blacktown) people (Department of Local Government 2009). The capital of NSW is Sydney, which in 2008 had a population of about 172,685 people (The City of Sydney 2010).

There are three key regions in NSW: the Sydney Metropolitan Area (SMA), the Extended Regulated Area (ERA), comprising the Hunter, Central Cost, and Illawarra regions, and the Non-Regulated Area (NRA). In 2006-07, NSW has a population of about 6.82 million people (DECCW 2009c). In 2006-07, of the total NSW population, about 55.9% (3.81 million people) lived in the SMA, about 18.5% (1.26 million people) lived in the ERA, and about 25.1% (1.71 million people) lived in the NRA (Adapted from DECCW 2009c).

The federal Parliament of Australia is located in Canberra in the Australian Capital Territory (Parliamentary Education Office [PEO] 2009). The Australian Capital Region is situated within the State of NSW (Google Maps 2010). The limit of the power of the federal Parliament to make laws is defined by the Australian Constitution (PEO 2009). The federal Parliament is entitled to legislate in 39 areas of national interest listed in section 51 of chapter 1 of the Australian Constitution, which include trade and commerce, foreign relations, taxation, fisheries, immigration, and defense (PEO 2003, Parliament of Australia 2003). Section 52 defines the areas about which states are prohibited from legislating (PEO 2009). Importantly, the Australian Constitution provides

for the independent legislation by states of waste management issues (Parliament of Australia 2003).

5.3.4.1 Australia's National Strategy for Ecologically Sustainable Development

All levels of Australian government adopted the National Strategy for Ecologically Sustainable Development (NSESD) in 1992 (Department of the Environment, Water, Heritage, and the Arts [DEWHA] 2007a). The NSESD was developed with the consultation of communities, industries, interest groups, scientific organizations, governments, and individuals in order for the objectives and guiding principles of the NSESD to represent the diverse regions, peoples, and interests of Australia (DEWHA 2007a). The core objectives of the NSESD encourage economic development that improves individual, community, and intergenerational welfare and equity, while maintaining essential environmental diversity, processes, and life-support systems (DEWHA 2007b). The guiding principles of the NSESD include, long and short-term economic, environmental, social, and equity considerations should be integrated into all decision making processes, use of the precautionary principle, recognition and consideration of global environmental issues, use of cost effective and flexible policy instruments, and community involvement in decisions and actions directly affecting them (DEWHA 2007b).

With regards to non-hazardous waste management, the objective of the NSESD is to improve resource use, while minimizing the effect of waste disposal on the environment (DEWHA 2007c). According to the NSESD, governments will develop an improved means of support for local councils in order for them to increase recycling,

provide curb-side recycling, and better plan and manage landfill sites (DEWHA 2007c). Governments will also develop pricing and charging schemes that reflect the full economic and environmental cost of waste management, ensure that the cost of implementing waste management strategies does not fall disproportionately on industries or local authorities, provide support for developing a methodology for full-cost accounting of waste management strategies, and develop targets for waste reduction (DEWHA 2007c).

The increased focus on sustainable development policy since the implementation of NSESD in 1992 resulted in the Australian Government's Environmental Protection and Biodiversity Conservation Act, 1999 (DEWHA 2007a). This Act provides for a national scheme of environmental protection and biodiversity conservation (DEWHA 2009a). However, only actions that have, or are likely to have, national environmental significance require approval under the Act (DEWHA 2009c). Therefore, in matters of waste management, states have the authority to pursue the objectives of NSESD in any way they see fit.

The National Environmental Protection Council (NEPC) arose as a result of an Intergovernmental Agreement on the Environment in 1990, and came into effect in May 1992 (DEWHA 2009b). The NEPC is composed of ministers from the Australian Government and from each state and territory (DEWHA 2009b). The purpose of the NEPC is as follows: 1) to provide equivalent protection against air, water, and soil pollution and from noise to all Australians, and 2) to ensure consistency in environmental protection initiatives among member governments, such that business decisions are not distorted nor markets fragmented by different policies in different regions (DEWHA

2009b). The NEPC has the power to create National Environmental Protection Measures (NEPMs), which can be goals, guidelines, standards, or protocols, concerning environmental issues, such as ambient air quality and the re-use and recycling of used materials (DEWHA 2009b). The NEPC, therefore, is critical for establishing a national waste management strategy.

5.3.4.2 NSW Waste Management Plan

The policy framework for environmental protection, waste reduction, and resource recovery in New South Wales (NSW) is overseen by the NSW Department of Environment, Climate Change, and Water (DECCW), which operates under the legislation of the Protection of the Environment Operations (POEO) Act, 1997 and the Waste Avoidance and Resource Recovery (WARR) Act, 2001 (Hyder Consulting 2008). In short, the POEO Act, 1997 provides the NSW government the authority to enact legislation relating directly to *protection of the environment policies* and is a means of adopting nation-wide environmental policies (NEPMs) established by the National Environmental Protection Council (NSW Legislation 2010). Before any *protection of the environment policy* can be implemented, the POEO Act, 1997 requires public consultation and an economic and social impact analysis (NSW Legislation 2010). The WARR Act, 2001 supports waste reduction and resource recovery, extended producer responsibility, and continues a Waste Fund for funding waste management projects (DECCW 2009b). The POEO Act, 1997 and the WARR Act 2001, along with the national NSESD program, have formed the foundation of the waste management strategy for NSW.

The Government of NSW developed the Waste Avoidance and Resource Recovery Strategy in 2003 (revised in 2007) in order to establish targets for waste management (Hyder Consulting 2008). The Strategy includes four key result areas and broad targets. The first key result area is preventing and avoiding waste, with the broad target of holding the level of waste generation in NSW for 5 years since the Strategy's implementation in 2003 (DECCW 2007). The second key result area is increasing recovery and use of secondary materials; the broad targets for NSW is by 2014 to increase recovery and use of materials from the MSW stream from 26% (in 2000) to 66%, from the C&I waste stream from 28% (in 2000) to 63%, and from the C&D stream from 65% (in 2000) to 76% (DECCW 2007). The third key result area is reducing toxicity in products and materials, with the broad target of phasing out priority toxins or, where impossible, achieving maximum recovery for reuse (DECCW 2007). The final key result area is to reduce litter and illegal dumping (DECCW 2007).

The Local Government Act, 1993, gives the 152 local councils of NSW significant authority over their communities (Department of Local Government 2009). Local councils are responsible for the efficient, effective, and equitable allocation of services (Department of Local Government 2009).

5.3.4.3 Program Achievements of the NSW Waste Management Plan

With the Waste Avoidance and Resource Recovery Strategy in place, NSW has been able to realize significant progress towards sustainable waste management. What follows are some of the relevant programs developed through the NSW strategy. In 2004, Greengoods, a website designed to assist in the purchasing of environmentally preferred

goods, was launched (Hyder Consulting 2008). Educational and support programs that explain the relevance of sustainable practices are provided to school children, communities, councils, and industry (Hyder Consulting 2008). In July 2006, scheduled increases to the levy for the disposal of waste in landfills were introduced (DECCW 2007); in 2009, as a result of the success of the levy to divert waste from landfills, larger scheduled increases were introduced (DECCW 2010). In 2006, the levy in the Sydney Metropolitan Area was less than $30 per tonne; in July 2009, the levy in the SMA was $58.10 per tonne and scheduled to increase by $10 per tonne per year until 2015-16 (DECCW 2010, DECCW 2009c). The levy in the Extended Regulated Area (ERA) in 2009 was $52.40 and is scheduled to increase by $10 per tonne per year until 2015-16 (DECCW 2010, DECCW 2009c). The aim of the levy is to increase the economic incentive to avoid the disposal of waste in landfills, thereby increasing the relative attractiveness of more sustainable, but relatively more expensive, waste management options (DECCW 2007). The Waste Avoidance and Resource Recovery Act, 2001 allows the set-up of an Extended Producer Responsibility (EPR) scheme in NSW (Hyder Consulting 2008).

Other programs initiated in NSW include the following: reward payments to councils in the SMA and ERA that meet certain waste management standards; regional waste management groups covering 90% of rural and regional NSW; incentives for smaller landfills sites to implement landfill gas capture for energy generation; industrial licensing to encourage recycling, reuse, and best practice; and a Waste Reduction and Purchasing Policy for NSW government agencies and state owned corporations that aims

at reducing waste and increasing the purchase of recycled materials (Hyder Consulting 2008).

5.3.4.4 Diversion Achievements of the NSW Waste Management Program

Tables 5.6, 5.7, 5.8, and 5.9 illustrate waste management in NSW between 2002 and 2007 for all waste, for municipal solid waste (MSW), commercial and institutional waste (C&I), and construction and demolition waste (C&D), respectively.

Table 5.6 Total waste generated, disposed, and diverted in NSW and % change.

	2002-03 (Mt)	2004-05 (Mt)	2006-07 (Mt)	% Change (2002-03 to 2004-05)	% Change (2004-05 to 2006-07)	% Change (2002-03 to 2006-07)
Waste Generated	11.804	13.118	15.359	11.1	17.1	30.1
Waste Disposed	6.506	7.100	7.365	9.1	3.7	13.2
Waste Diverted	5.297	6.019	7.995	13.6	32.8	50.9
Percent Waste Diverted (%)	44.9	45.9	52.1	2.3	13.5	16.0

Source: Department of Environment, Climate Change, and Water 2009c

Table 5.7 Residential waste generated, disposed, and diverted in NSW and % change.

	2002-03 (Mt)	2004-05 (Mt)	2006-07 (Mt)	% Change (2002-03 to 2004-05)	% Change (2004-05 to 2006-07)	% Change (2002-03 to 2006-07)
Waste Generated	3.100	3.181	3.891	2.61	22.32	25.52
Waste Disposed	2.155	2.144	2.408	-0.01	12.31	11.74
Waste Diverted	0.945	1.037	1.483	9.74	43.01	56.93
Percent Waste Diverted (%)	30.48	32.60	38.11	6.96	16.90	25.03

Source: Department of Environment, Climate Change, and Water 2009c

Table 5.8 C&I waste generated, disposed, and diverted in NSW and % change.

	2002-03 (Mt)	2004-05 (Mt)	2006-07 (Mt)	% Change (2002-03 to 2004-05)	% Change (2004-05 to 2006-07)	% Change (2002-03 to 2006-07)
Waste Generated	4.015	4.820	5.218	20.05	8.26	29.96
Waste Disposed	2.644	2.985	2.921	12.90	-2.14	10.48
Waste Diverted	1.372	1.835	2.297	33.75	25.18	67.42
Percent Waste Diverted (%)	34.17	38.07	44.02	11.41	15.63	28.83

Source: Department of Environment, Climate Change, and Water 2009c

Table 5.9 C&D waste generated, disposed, and diverted in NSW and % change.

	2002-03 (Mt)	2004-05 (Mt)	2006-07 (Mt)	% Change (2002-03 to 2004-05)	% Change (2004-05 to 2006-07)	% Change (2002-03 to 2006-07)
Waste Generated	4.689	5.118	6.251	9.15	22.14	33.31
Waste Disposed	1.708	1.972	2.036	15.46	3.25	19.20
Waste Diverted	2.981	3.147	4.216	5.57	33.97	41.43
Percent Waste Diverted (%)	63.57	61.49	67.45	-3.27	9.69	6.10

Source: Department of Environment, Climate Change, and Water 2009c

While no coordinated organics recycling existed in NSW in 1990, by 2005 there were 61 licensed composting facilities and 87 local Councils provided regular garden organics recycling services in 2004-05, up from 71 in 2002-03. NSW is now leading the nation in organics recycling (DECCW 2007). Garden organics recycling in the Greater Sydney Region (SMA + ERA) has increased from 40% of the total generated in 1998 to more than 68% in 2004-05 (Table 5.11). Tables 5.7 and 5.12 indicate that about 10.5% of the total waste generated is diverted through organic waste processing. Organic waste processing increased significantly between 2005-06 and 2006-07 (Table 5.12).

Table 5.10 Garden organic waste generated and diverted in the Greater Sydney Region.

	Total Waste Generated (Mt)	Total Garden Organic Waste Generated (Mt)	% Garden Organic Waste of Total Waste Generated	Total Recycled (Mt)	% Recycled
1998		0.680		0.269	40
2002-03	10.483	1.140	10.87	0.550	48
2004-05	11.170	0.866	7.75	0.482	56
2006-07	12.549	0.821	6.54	0.562	68

Source: Department of Environment, Climate Change, and Water 2009c

Table 5.11 Total organic waste reprocessed by type in, and percent change between, 2005-06 and 2006-07 in NSW.

Type of Organic Waste	Quantity of Raw Material Reprocessed (Mt) 2005-06	Quantity of Raw Material Reprocessed (Mt) 2006-07	% Change from 2005-06 to 2006-07
Garden organics	0.530	0.551	3.96
Manure	0.340	0.315	-7.35
Biosolids/grit/screenings	0.086	0.196	127.91
Barks (from forestry	0.115	0.142	23.48

residuals)			
Sawdust (from forestry residuals)	0.096	0.110	14.58
Other - MSW organics fraction	0.079	0.109	37.97
Wood/timber/sawdust (C&I sources)	0.062	0.067	8.06
Food organics (food waste)	0.049	0.049	< -0.30[2]
Other[1]	0.086	0.067	-22.09
Total[2]	1.441	1.609	11.66

Source: Department of Environment, Climate Change, and Water [DECCW] 2008

Notes:

1. Includes Oils, grease trap, sludges, straw, animal bedding, miscellaneous agricultural organics, paunch, animal mortalities, paper pulp/sludge, and biowaste.
2. Results affected by rounding.

5.3.5 Denmark

Denmark is located in northern Europe and consists of the Jutland peninsula and 407 named islands (Visit Denmark 2009). The total land area of Denmark is about 43,098 km^2 (Statistics Denmark 2009) and, in the fourth quarter of 2009, Denmark had a population of about 5.5 million people (Statistics Denmark 2010b). Denmark's only land border is with Germany, which is about 68 km long (Visit Denmark 2009). Denmark is divided into 98 municipalities and 5 regions (Danish Parliament 2009). The capital of Denmark is Copenhagen with a combined city and suburban population of about 1.2 million people (Statistics Denmark 2009). Denmark is one of the 27 member states of the European Union (Europa n.d.).

The legislative powers are divided among state, regional, and municipal governments as established by the Constitutional Act of Denmark, 1953, Section 82; however, regional and municipal governments are watched over by the state (Danish Parliament 2009). Regional and municipal governments are entitled to make decisions affecting local matters (Danish Parliament 2009). Therefore, waste management is

primarily under the control of regional and municipal governments (Danish Environmental Protection Agency 1999a).

5.3.5.1 European Union Waste Management Strategy

The main purpose of the European Union (EU) is to integrate the economic and political systems of the Member States, such that a single market, based on the free movement of people, money, goods, and services, is established (European Commission 2009d). Through treaties, Member States have relinquished part of their power to create laws (European Commission 2009d). As a result of this process, in 2005, the EU created an integrated strategy for the prevention and recycling of waste (Europa 2006). The overall objective of the strategy is to reduce the negative environmental impact of waste; however, the strategy contains no specific target for waste prevention, as the strategy recognizes that some measures that greatly reduce the volume of waste have undesirable environmental consequences (Europa 2006). As such, the strategy declares that the environmental impact of waste must be minimized at every stage of a resource's lifespan (Europa 2006). An important factor in achieving maximum waste reduction with minimum environmental damage is the sharing of best available techniques among Member States (Europa 2006). Nations are required under this strategy to develop their own programs and targets for waste prevention by using life-cycle assessment (Europa 2006). The strategy also aims to improve recycling rates and the economic incentives to recycle in Member States: in particular, two-thirds of biodegradable waste is mandated to be diverted from landfills by EU law (Europa 2006).

EU law, established through treaties, grants EU institutions the authority to adopt regulations, directives, and decisions that are binding on, and override the laws of, Member States (European Commission 2009d). In terms of EU law, *regulations* are the most direct, since they come into force, on par with national laws, as soon as they are passed and Member States do not have to take steps to implement them (European Commission 2009c). *Directives* establish targets or goals that all or specific member states must attain by a certain date; however, member states are free to determine their own strategy for reaching those targets or goals (European Commission 2009b). Finally, *decisions* are EU laws that pertain to specific cases and parties that compel the parties to do something, stop doing something, or grant rights (European Commission 2009a). The Directive on Waste is an example of EU law that establishes targets and goals that must be attained by Member States.

The Directive on Waste established a legal framework for the management of waste among the Member States of the EU (Europa 2009a). The updated Directive on Waste came into force on December 12, 2008 and the deadline for its transposition in the Member States is December 12, 2010 (Europa 2009a). The Directive on Waste created what is called a waste management hierarchy, which lists broad waste management measures in order of their importance (Europa 2009a). The measures from greatest to least importance are waste prevention, preparing waste for reuse, recycling/composting, other recovery (such as energy recovery from waste), and disposal in landfill (Europa 2009a). The Directive on Waste stipulates that the following of the hierarchy should avoid human health hazards and environmental damage (Europa 2009a). Member States

are also required to monitor and control waste treatment and to ensure energy capture from waste incineration takes place only at a high level of efficiency (Europa 2009a).

An EU Directive on the incineration of waste came into force on December 28, 2000 (Europa 2008b). The objective of the Directive is to reduce, to the greatest extent possible, water, air, and soil pollution resulting from incineration and co-incineration plants (Europa 2008b). This objective is accomplished through extensive requirements, such as the monitoring of the characteristics of the waste entering the plants and the residues leaving the plants, specific incineration procedures, limit values for particular air emissions, the reduction and recycling of incineration residues, and the release of annual reports to the competent authority and public (Europa 2008b).

5.3.5.2 Denmark's Waste Management Strategy

As evidenced by Section 4.3.3.1 above, the interplay between the EU and Denmark with regard to waste management is extensive. While the EU determines the principles and overall framework for the management of waste, the Government of Denmark deals with the specific details of legislating in matters of national waste management (Danish Environmental Protection Agency 1999a). In fact, Denmark has published detailed waste management plans since at least 1993 (Danish Environmental Protection Agency 1999a).

In its *Waste 21: Waste Management Plan 1998-2004*, the Danish government name improving the quality of waste treatment (i.e., reducing waste's environmental impact and ensuring better resource recovery) and the stabilization of waste generation as the primary challenges facing Denmark's waste management sector (Danish

Environmental Protection Agency 1999a). To this end, eight types of waste must be sources separated in Denmark: organic waste, paper and cardboard, cardboard packaging, polyvinyl chloride (PVC), impregnated wood, electrical and electronic equipment, end-of-life vehicles, and batteries (Danish Environmental Protection Agency 1999a). To accomplish such sophisticated source separation, the *Plan* suggests building regional and international cooperation such that treatment plants have sufficient supply and financial resources; therefore, the citing of these plants must be consistent with its supply base and logistics to be feasible (Danish Environmental Protection Agency 1999a). The publication also notes the importance of implementing producer responsibility, which promotes the design of recyclable products: however, to have a great impact on waste, it must be implemented internationally (Danish Environmental Protection Agency 1999a).

Denmark has chosen a slightly different route than the other jurisdictions to accomplish its waste management targets in that it incinerates a large portion of its waste (Danish Environmental Protection Agency 1999a). In fact, all waste that can be incinerated has been banned from landfills (Danish Environmental Protection Agency 1999a). Since incineration with energy recovery is seen as a better option than landfilling in Denmark (and by the EU), a large portion of waste is incinerated (Danish Environmental Protection Agency 1999a). The targets for waste management in Denmark by 2004 were 64% recycling, 24% incineration, and 12% landfilling (Danish Environmental Protection Agency 1999a). Other goals for 2004 are found on the Table 5.14. Interestingly, some of the recycling targets for 2004 were lower than what existed in 1997 (Table 5.14). The reason for this is that recycling goals in Denmark are not just measured in terms of absolute percent recycled, but, rather, with environmental

protection and economic prosperity also in mind (Danish Environmental Protection Agency 1999a). Therefore, it is clear that Denmark is constantly reviewing whether its achievements are consistent with its overall goals for waste management.

Table 5.12 Denmark's waste management targets for 2004.

Type of waste	Reduction target (2004)	Actual 1997
Waste incineration plant residues	70% recycling	77% recycling
Construction and demolition waste	90% recycling	92% recycling
Domestic waste	30% recycling	15% recycling
Bulky waste (i.e., cardboard, etc)	25% recycling	17% recycling
Industry waste	65% recycling	58% recycling
Institutions, trade, and offices	50% recycling	38% recycling
Wastewater treatment plants	50% recycling	70% recycling
Coal-fired plant residues	90% recycling of bottom/fly ash	70% recycling of bottom/fly ash
Electrical/electronic waste	40% copper recycling	n/a
End-of-life vehicle waste	25 tonnes of lead recycled	n/a
NiCd batteries	6 tonnes of Cadmium	n/a
Impregnated wood	25 tonnes of Arsenic, 75 tonnes of Chromium	n/a

Source: Danish Environmental Protection Agency 1999a

In its *Waste Strategy 2004-08* (Danish Government 2004), the Danish Government adds on to what it had built in its previous waste management strategy. In the revised strategy, the Danish Government asserts that its broad aims are to prevent resource loss and environmental degradation due to waste, decouple economic growth and waste generation, and ensure the cost-effectiveness of environmental policies by improving waste treatment methods and ensuring the efficiency of the waste management sector (Danish Government 2004). In order to achieve a decrease in resource consumption, an initiative under the *Strategy* is to provide a basis for evaluating combinations of instruments that ensure the efficient use of resources and waste prevention (Danish Government 2004). To this end, the Danish Government has decided that market-based instruments will take precedence over prohibitions and orders (Danish Government 2004). To facilitate the decoupling of economic growth and waste

generation, the Danish Government suggests that it is first essential to determine the factors that lead to waste generation. The *Strategy* suggests building upon enterprises and people that have a willingness to contribute to the production and consumption of less resource-intensive goods, an increase in market share for environmentally friendly products, and assisting the growth of consumption patterns that are less harmful to the environment (Danish Government 2004). Finally, to ensure the cost-effectiveness of its environmental policies, the Danish Government suggests improving the quality of their waste management system. The *Strategy* suggests that the waste hierarchy established by the EU continue to be followed, but only where it is environmentally and economically justifiable (Danish Government 2004). Unfortunately, the waste hierarchy is an imprecise tool; therefore, the *Strategy* calls for an updated tool that takes into consideration environmental and economics issues (Danish Government 2004). In order to promote better waste management, the *Strategy* suggests three broad goals: first, develop a method that makes it possible to assess the quality of a waste treatment option and determine whether waste is being treated at the right cost; second, create more stringent requirements for the treatment of waste; and, finally, produce less hazardous waste (Danish Government 2004).

The *Waste Strategy 2004-08* (Danish Government 2004) describes in detail waste diversion goals and strategies for each sector, including building and construction, households, industry, institutions, trade, offices, retail trade, landfill sites, and waste incinerations plants. It also names several Directives set out by the EU by which Denmark must abide (Danish Government 2004).

5.3.5.3 Denmark's Waste Diversion Initiatives

Denmark's waste management strategy is characterized by instruments such as Acts, Statutory Orders, taxes and charges, and subsidy schemes (Danish Government 2004). There are many regulations delineating what a local municipal council can and cannot do with regard to its waste management. The Danish Environmental Protection Act states that local municipal councils are in charge of managing the waste produced within their jurisdictional boundaries (Danish Government 2004). Under the Act, each local municipal council every four years must produce a short-term waste management strategy for the following four years and a long-term strategy for the following 12 years (Danish Government 2004). Municipalities must ensure that their waste management scheme is consistent with the waste management hierarchy established by the EU and is environmentally friendly (Danish Government 2004). In general, it is the responsibility of the local municipal councils to make certain their waste management scheme is consistent with regulations established by the EU and the Danish Government (Danish Government 2004). However, it is recognized that too many regulations exist and that the waste management sector in Denmark needs to be deregulated to a certain extent (Danish Government 2004).

Another instrument used in Denmark's waste management is a waste tax, which came into effect on January 1, 1987 (Danish Government 2004). The waste tax places a charge on the disposal of non-hazardous waste according to its weight: i.e., sending waste to landfill or incinerating waste (Danish Government 2004). The waste tax was set up in order provide the strongest financial disincentive to landfill waste and a weaker financial disincentive to incinerate waste, while not taxing waste that is recycled (Danish

Government 2004). In 2001, Denmark's waste tax was 50 euro/tonne (CAD$65.00-71.50 in 2001); in 2005, Denmark's waste tax was 75 euro/tonne (CAD$102.75-121.50 in 2006) (Economic Instruments in Environmental Policy 2010; X-Rates 2010). In this way, there is a financial incentive to follow the waste hierarchy. A packaging tax has also existed in Denmark since 1978 (Danish Government 2004). The tax applies to new packaging, therefore providing a financial incentive to reuse old packaging (Danish Government 2004). Since the tax was implemented, increasingly more kinds of packaging have fallen under the tax, including non-carbonated soft-drinks, vinegar, plastic foil foodstuff packaging made from soft PVC, and disposable tableware (Danish Government 2004). As of April 1, 2001, the tax on each material was adjusted to reflect its environmental impact, based on "cradle-to-grave" assessments (Danish Government 2004).

The Danish Government, through the Danish Environmental Protection Agency and the Environmental Council for Cleaner Products, operates a subsidy program that funds waste management projects that promote either cleaner products or recycling (Danish Government 2004). Funds can be received for demonstrations, surveying, and information projects relating to waste management or for the development of novel waste management techniques (Danish Government 2004).

In Denmark's *Waste Strategy 2005-2008* (Danish Government 2004), it refers to over 100 initiatives that are planned to be commenced between 2005 and 2008. Many of these proposed initiatives involve EU and Danish regulations and public education programs (Danish Government 2004). Specifically, the Danish Government will continue to collect and express data on waste management and treatment that can be practically

used by private enterprises and national and local governments (Danish Government 2004). Further refinement to life-cycle assessment (LCA) techniques is required in order to determine the best waste management options (Danish Government 2004). Waste Centre Denmark will continue knowledge-sharing initiatives in order for relevant information to be made available to the various players implementing the *Strategy* (Danish Government 2004). Initiatives will be undertaken where barriers are small and where results can be achieved in the short-term; the four sectors where these initiatives will be commenced are households, the service sector, industry, and building and construction (Danish Government 2004). Support for the development of new waste management technologies will continue, while helping to overcome the barrier that there is no security in the volume of waste coming to a treatment plant (Danish Government 2004). Transparency in waste management fees is a goal of this strategy, with the aim of making the polluter pay and achieving environmental, economic, and legal efficiency (Danish Government 2004). Existing waste management regimes in Denmark will continue to be evaluated, which will likely lead to the creation of new initiatives in the future (Danish Government 2004). The harmonization of regulations in the waste management industry across Denmark will continue and an examination of waste taxes will occur, along with the development of a strategy for dealing with hazardous waste (Danish Government 2004). Finally, the capacity of waste management facilities will be analyzed to ensure that capacity for existing and future waste is available (Danish Government 2004).

5.3.5.4 Denmark's Waste Diversion Achievements

Tables 5.13, 5.14, and 5.15 illustrate Denmark's waste diversion achievements. In 2001, Denmark's waste generation by sector was divided as follows: 26% building and construction, 24% households, 21% manufacturing, 10% institutions/trade and offices, 10% slag, fly, ash, etc. (due to coal), and 9% wastewater treatment plants (Danish Government 2004).

Table 5.13 Total waste generated, disposed, recycled, and incinerated in, and % change between, 2002, 2004, and 2006 in Denmark.

	2002 (Mt)	2004 (Mt)	2005 (Mt)	% Change (2002 to 2004)	% Change (2004 to 2005)	% Change (2002 to 2005)
Waste Generated[1]	13.105	13.359	14.210	1.9	6.4	8.4
Waste Disposed	1.194	1.024	0.983	-14.2	-4.0	-17.7
Waste Recycled	8.382	8.746	9.545	4.3	9.1	13.9
Waste Incinerated	3.344	3.437	3.473	2.8	1.0	3.9
Percent Waste Disposed (%)	9.1	7.7	6.9			
Percent Waste Recycled (%)	64.0	65.5	67.2			
Percent Waste Incinerated (%)	25.5	25.7	24.4			

Source: Danish Ministry of the Environment 2007

1. Total waste generated is the sum of waste disposed (landfilled), waste recycled (includes waste recycled and waste composted), waste incinerated, specially treated waste, and stored waste (specially treated waste and stored waste amounts not shown).

Table 5.14 Total waste generated, disposed, recycled, and incinerated per capita in, and % change between, 2002, 2004, and 2006 in Denmark.

	2002	2004	2005	% Change (2002 to 2004)	% Change (2004 to 2005)	% Change (2002 to 2005)
Population (millions)	5.374	5.401	5.416	0.5	0.3	0.8
Waste Generated per capita (kg)[1]	2439	2473	2623	1.4	6.1	7.5
Waste Disposed per capita (kg)	222	190	181	-14.4	-4.7	-18.5
Waste Recycled per capita (kg)	1560	1619	1762	3.8	8.8	12.9
Waste Incinerated per capita (kg)	622	636	641	2.3	0.8	3.1

Source: modified from Statistics Denmark 2009, Danish Ministry of the Environment 2007

1. Total waste generated per capita is the sum of waste disposed (landfilled), waste recycled, waste incinerated, specially treated waste, and stored waste: specially treated waste and stored waste amounts not shown.

Table 5.15 Organic waste materials and their respective treatment in, and % change between, 2002, 2004, and 2006 in Denmark.

	2002 (Mt)	2004 (Mt)	2005 (Mt)	% Change (2002 to 2005)
Branches, leaves, etc. led to plants for composting/wood chipping	0.685	0.682	0.737	7.6
Organic domestic waste led to plants for composting	0.018	0.047	0.038	111.1
Organic domestic waste led to plants for biogasification	0.019	0.001	0.001	-94.7
Other organic waste led to plants for composting	0.045	0.006	0.007	-84.4
Other organic waste led to plants for biogasification	0.065	0.114	0.106	63.1
Other organic waste led to plants for animal fodder	0.018	0.004	0.004	-77.8
Sludge led to plants for composting	0.348	0.053	0.050	85.6
Sludge led to plants for biogasification	0.086	0.091	0.087	1.2
Sludge led to plants, applied to farmland	0.000	0.006	0.005	n/a
Sludge led to plants for incineration	0.000	0.054	0.043	n/a
Sludge led to plants, used for carbogrit	0.000	0.172	0.179	n/a
Total	1.284	1.229	1.257	

Source: Danish Ministry of the Environment 2007

In 2005, about 99% of household garden waste was recycled; that is, 0.557 Mt of garden waste was recycled and 0.005 Mt was landfilled (Danish Ministry of the Environment 2007). By 2008, the target is to recycle 0.535 Mt and incinerate 0.028 Mt of garden waste (Danish Ministry of the Environment 2007).

5.4 Discussion/Conclusion

This section compares the various jurisdictions in terms of their political climates, demography, waste management strategies, program achievements, and waste diversion achievements.

5.4.1 Political Climate of Jurisdictions

Despite Canada having various Acts aimed at protecting environmental and human health and safety, these Acts have not led to a national waste management strategy for non-hazardous waste. This is unlike Australia and Denmark, which both have national strategies for waste management. The leadership demonstrated by these governments concerning waste management has likely played a large role in shaping their extensive waste management systems. Although neither Manitoba nor Nova Scotia have the support of a federal waste management strategy, they are members of the Canadian Council of Ministers of the Environment (CCME), which provides a forum where environmental issues can be discussed and strategies can be formulated. In fact, it is through the CCME that the *Canada-wide Action Plan for Extended Producer Responsibility* was produced. If the *Action Plan* is successful, the Government of Canada may take this as justification for not taking a lead on this issue. In the meantime, Federal monetary support, like the funding of the Federation of Canadian Municipalities' guide to municipal solid waste management, will likely continue.

All levels of Australian government adopted the National Strategy for Ecologically Sustainable Development (NSESD) in 1992. The NSESD sets out broad principles and goals for, among other environmental issues, waste management in Australia, although individual states have the authority to pursue these in any way they see fit. The National Environmental Protection Council (NEPC) plays a significant role in terms of cooperation among Australian states and the Australian Government, while providing a platform from which significant national change can occur. Interestingly, the

NEPC is not unlike the CCME. Therefore, New South Wales is provided with significant guidance in terms of the implementation of its waste management strategy from both the Australian Government and other state governments.

As a part of the European Union (EU), Denmark is obligated to follow the EU created strategy for the prevention and recycling of waste. As with the Australian strategy, the EU strategy outlines principles that should be followed by member states with respect to waste management. Therefore, Denmark is provided with significant, on-going guidance from, and cooperation between, nations concerning waste management.

It is strikingly clear that Manitoba and Nova Scotia are situated in a much different political climate than New South Wales and Denmark. Indeed, Manitoba and Nova Scotia have had little historic Federal assistance in terms of guidance in developing their waste management systems. However, it is interesting that Nova Scotia has managed to develop a provincial waste management plan despite the lack of leadership on the part of the Canadian Government. Therefore, while New South Wales and Denmark have certainly gained a great deal by operating within a political system that supports the development of waste management strategies, the Nova Scotia Government has demonstrated that this is not a necessary condition for the development of a waste management strategy. One aspect of all four jurisdictions that is similar, however, is that the responsibility to provide waste management services ultimately falls onto local governments.

While international and national support structures can play an important role in shaping policy, it should be noted that other drivers for implementing waste management

strategies exist. One driver, in particular, that can influence waste management strategies is population density.

5.4.2 Demography

In Manitoba, there has been a wide-spread belief that because Manitoba is so large and sparsely populated, there is abundant land suitable for waste disposal (Haque and Hamberg 1996), which has likely made it difficult to implement changes to Manitoba's waste management system. This belief might make policy-makers skeptical that an economically viable waste management strategy would be successful in Manitoba. However, the practical difference between the geographic population distribution of Manitoba compared to the three other jurisdictions is not as great as might be expected.

In 2006, about 1,148,000 people lived in Manitoba (Statistics Canada 2008b). With a total area of about 647,797 km^2, the population density of Manitoba was about 1.77 people per square kilometre. Also, in 2006, 0.327 million (28.5%) people lived in rural areas and about 0.821 million (71.5%) people lived in urban areas (Statistics Canada 2008a). Of the approximately 284 communities in Manitoba eight had populations greater than 10,000 people and, together, contained about 65.2% of Manitoba's population; the City of Winnipeg alone contained about 55.2% of Manitoba's population (Statistics Canada 2008b).

In 2006, about 914,000 people lived in Nova Scotia (Statistics Canada 2008a). With a total area of about 55,284 km^2 (Statistics Canada 2005b), the population density of Nova Scotia was about 16.53 people per square kilometre. Also, in 2006, about 0.507 million people (54.1%) lived in urban areas and about 0.407 million people (46.0%) lived

in rural areas (Statistics Canada 2008a). In 2006, there were 18 Counties in Nova Scotia and their populations ranged from 7,941 (Victoria) to 382,203 (Halifax) people (Vital Statistics 2006). In 2006, Halifax contained about 40.7% of the population of the Province.

In 2006-07, about 6,800,000 people lived in New South Wales (DECCW 2009c). With a total area of about 800,642 km^2 (Encyclopedia Britannica n.d.), the population density of New South Wales was about 8.87 people per square kilometre. In New South Wales, there were 152 councils, with populations ranging from 1,286 (Urana) to 284,692 (Blacktown) people in 2006 (Department of Local Government 2009). Also at that time, the Sydney Metropolitan Area (SMA) contained about 55.9% of the population of the State.

In 2005, about 5,411,000 people lives in Denmark. With a total area of about 43,098 km2, the population density of Denmark was about 127.62 people per square kilometre. Denmark is divided into 98 municipalities and 5 regions (Danish Parliament 2009), with a projected 35 municipalities having populations greater than 50,000 people in 2010 (Statistics Denmark 2010a). In 2009, Copenhagen contained about 21.8% of the total population of Denmark.

By strictly comparing population densities among the four jurisdictions, it becomes evident that Manitoba is in the unique position of having an extremely low population density. Indeed, the population density in Denmark is about 72 times the population density in Manitoba, while the population densities of Nova Scotia and New South Wales are about 9 and 5 times larger, respectively, than Manitoba's. It could be argued, therefore, that the implementation of an integrated waste management strategy in

Manitoba would not be able to achieve the economies of scale that the other jurisdictions could attain. However, the practical population density in Manitoba might be understated: in 1996, about 90% of Manitoba's population lived within 200 km of the 497 km long border with the United States (Haque and Hamberg 1996; International Boundary Commission n.d.). Assuming that Manitoba's population distribution has remained relatively constant since 1996 and that Manitoba's eastern and western borders are approximately perpendicular to the border with the United States, 90% of Manitoba's population lives in an area of 99,400 km^2. Since 90% of Manitoba population in 2006 is about 1.033 million people, the population density of Manitoba within 200 km of the border with the United States is about 10.36 people per square kilometre, which is a greater population density than New South Wales.

The four jurisdictions also have large relatively dispersed populations, with significant proportions of their populations living in rural communities or in many smaller cities, although Denmark's population density is much higher than the other three jurisdictions. The comparison between Manitoba and Nova Scotia changes importantly when Manitoba's population is considered in terms of portions of Manitoba's total land area, rather than its total land area. Since the vast majority of the population of Manitoba lives within 200 km of the border, it makes sense to focus on this area, rather than the province as a whole. It may be that it is not possible for an integrated waste management strategy in Manitoba to reach all corners of the province; but, if the strategy reaches 90% of the population, it could be considered successful. It might even be useful for a strategy to focus, at first, in the Winnipeg Census Metropolitan Area, which, in 2009, is estimated to have contained 60.8% of Manitoba's population (City of Winnipeg 2010b). In 2009,

the population density of the Winnipeg CMA was approximately 95.37 people per square kilometre[3] (Wikipedia 2010), about 75% of the population density in Denmark in 2005. Therefore, a waste management strategy should take advantage of the large population (compared to Manitoba as a whole) and the high population density in and around the City of Winnipeg.

5.4.3 Waste Management in the Four Jurisdictions

Table 5.18 demonstrates the considerable difference between the waste management systems of the jurisdictions described. In Particular, Manitoba's waste management system appears to be missing many aspects that are included in the waste management systems of Nova Scotia, New South Wales, and Denmark. The following section will discuss the four jurisdictions in terms of waste management strategies, waste management programs, and waste management diversion achievements.

5.4.3.1 Waste Management Strategies

The Government of Manitoba has no recently published, publicly accessible, holistic waste management strategy, unlike the other three jurisdictions. Although the Government of Manitoba has commissioned the creation of waste management strategies for Manitoba (the Recycling Action Committee in 1990; the Manitoba Regional Waste Management Task Force in 1999) and has produced reports concerning waste management in Manitoba (e.g., the WRAP Strategy Reports), the Government of Manitoba has not successfully implemented a publicly accessible, integrated waste

[3] The population density of the Winnipeg CMA was calculated using the area for the Winnipeg Capital Region, which, according to Wikipedia (2010), is larger than the Winnipeg CMA. Therefore, the population density might be understated.

management strategy (Manitoba Conservation 1999; Manitoba Environment 1991, 1996; Recycling Action Committee 1990). While the development of an integrated waste management strategy is probably not a necessary condition for a successful waste management system, given that Nova Scotia, New South Wales, and Denmark have strategies and systems in place that have been successful, it would be difficult to argue that a strategy would not benefit Manitoba.

Probably a result of having no integrated waste management strategy, Manitoba lacks waste diversion targets, while the other jurisdictions do not. Establishing publicly accessible targets makes the associated ministry or department accountable for attaining those targets. For instance, through Nova Scotia's *Environment Act* and the *Environmental Goals and Sustainable Prosperity Act*, the Government of Nova Scotia has committed itself to reducing waste disposal: recently, the Government of Nova Scotia set a target for waste disposal of 300 kg per person by 2015 (Nova Scotia Environment 2009a). Establishing targets that are sector- or waste category- specific might also be beneficial: for instance, New South Wales and Denmark have established diversion goals with respect to specific sectors and strategies for dealing with organic waste (Table 5.16). Like establishing an integrated strategy, publicly setting a target would not, per se, improve waste diversion in Manitoba; however, the public nature of the commitment might pressure the Government of Manitoba into action. Strong political will would be required within the Government of Manitoba to self-impose this kind of commitment.

Another result of Manitoba lacking an integrated waste management strategy is the lack of any mandatory regional cooperation. As such, it is unlikely that the existing regional cooperation attains the economies of scale that are possible in Manitoba. For

example, the Government of Nova Scotia commissioned studies concerning achieving economies of scale in waste management through regional cooperation; as a result of these studies, the Government of Nova Scotia established seven waste management regions (Table 5.16). If the Government of Manitoba commissioned such studies and made regional cooperation mandatory among relevant communities, it is possible that this would make Manitoba's waste management system more economically viable.

5.4.3.2 Waste Management Programs

In terms of funding to support municipalities' waste management systems, all jurisdictions have a means by which funds are delivered to municipalities: for instance, through performance-related payments and proposed waste management projects related to recycling and cleaner projects (Table 5.16). A large difference, here, between Manitoba and Nova Scotia is the level of funding. As we have seen, Manitoba has a two cent levy on some beverage containers, while Nova Scotia has a ten or twenty cent levy (depending on size). The system operated in Nova Scotia is a deposit-refund system, which returns half of the levy upon receipt of the container at a designated depot. The funds generated by these levies are used to fund waste management projects in Manitoba and Nova Scotia, respectively. Therefore, Nova Scotia, having a levy 2.5 times greater than Manitoba's, generates more money for funding waste management programs. Manitoba's waste management system might gain from an increase in the levy on beverage containers.

Local Councils in Nova Scotia, New South Wales, and Denmark appear to have more support from higher levels of government compared to Manitoba (Table 5.16).

Although there is waste management collaboration in Manitoba, in the other jurisdictions, the local councils appear to collaborate with higher levels of government than local councils in Manitoba. It might be useful, therefore, for the Government of Manitoba to actively engage communities in developing their waste management system.

Landfill bans exist in Nova Scotia and Denmark, but not in New South Wales or Manitoba (Table 5.16). Specifically, Nova Scotia and Denmark both have landfill bans on organics, although Denmark also bans other waste from landfills. A landfill ban could be successful in Manitoba, but probably not at the current level of funding, without compost quality control regulations, without the curb-side pickup of organic waste, or higher tipping fees. Manitoba is the only jurisdiction out of the four that does not have regulated compost quality control guidelines and has a very low population with access to the curb-side pickup of organic waste, especially compared to Nova Scotia (Table 5.16). As has been shown, Nova Scotia had a tipping fee of $110/tonne in 2006 and Denmark had a waste tax of about $110/tonne in 2005, both of which are much higher than Manitoba's tipping fees ($43.50/tonne in Winnipeg in 2010, which includes the $10/tonne levy).

5.4.3.3 Waste Diversion Achievements

Perhaps as a result of the number of issues previously discussed, Manitoba's diversion rates are much lower than the other three jurisdictions'. In fact, Manitoba's waste diversion rate is three to seven times less than those of the other jurisdictions examined (Table 5.16). In terms of organic waste recycling, in 2006, Manitoba also diverted far less organic waste than the other three jurisdictions: per capita, Manitobans diverted between 13 and 22 times less organic waste than the other three jurisdictions

(Table 5.16). Manitoba's low per capita organic waste diversion rate is most likely the results of few residents having access to convenient means of diverting food waste (e.g., curb-side pickup of food waste) in Manitoba (see Chapter 4). However, it should be noted that it was estimated that Manitoba diverted at least 35,000 tonnes of organic waste in 2009, which is nearly a three-fold increase over 2006 (see Chapter 4). This is a promising result, especially since no organized organic waste management strategy exists in Manitoba.

Compared to Manitoba, in 2006, Nova Scotia generated 29.2% less waste and disposed of 51.8% less waste, while diverting 221.8% more waste (Table 5.16). However, compared to New South Wales and Denmark, Manitoba generated much less waste per capita (Table 5.16). The reason why New South Wales and Denmark generated more than double the amount of waste per capita generated in Manitoba is unclear.

Table 5.16 Waste management characteristics of Manitoba, Canada, Nova Scotia, Canada, New South Wales, Australia, and Denmark.

Characteristic	Manitoba, Canada	Nova Scotia, Canada	New South Wales, Australia	Denmark
Population (millions)	1.148 (2006)	0.913 (2006)	6.888 (2006-07)	5.411 (2005)
Waste Management Strategies				
Publicly accessible, integrated waste management strategy	No	Yes –Solid Waste Resources Management Strategy	Yes – NSW Waste Avoidance and Resource Recovery Strategy	Yes – extensive waste and recycling national plan since 1993
Diversion targets	By 2000, reduce 1989 per capita disposal rate by 50%	By 2000, reduce 1989 per capita disposal rate by 50%; by 2015, attain solid waste per capita disposal rate of 300 kg	MSW 2014: 66% (38%, 2006-07); C&I 2014: 63% (44%, 2006-07); C&D 2014: 76% (67%, 2006-07)	Recycling rate 2008: 65% Incineration rate 2008: 26% Landfilling rate 2008: 9%
Publicly accessible, sector-specific waste management strategies (e.g., residential; commercial, industrial, and institutional; construction and demolition)	No	Limited – government buildings are now to be built to LEED standards	Yes – specific strategies for MSW, C&I, and C&D and for urban and rural areas	Yes – including waste from construction, packaging, households, industries, institutions, trade, and offices, and power, treatment, and incineration plants
Provincial organic waste management strategy	No	No	Yes – including trials and cost-benefit analysis for recycling household food waste	Yes
Mandatory regional cooperation	No	Yes – established 7 waste management regions, which is autonomous in determining its priorities	Yes – waste and recycling program cooperation among councils occurs with government funding and support	Yes – EU Member States are to construct a network of disposal installations; information exchange on BATs
Market development/support for recycled goods	No	Yes – development of local markets for reprocessed goods	Yes – WRAPP and Council Sustainable Choice programs	Yes – in National waste strategy
Product Stewardship or Extended Producer Responsibility	Yes – e.g., electrical and electronic waste; household hazardous waste; tire waste; used oil, oil filter, and container waste	Yes – e.g., electrical and electronic waste; tire waste; oil waste; paint waste	Yes – to some extent – to phase out or maximize recovery of priority substances	Yes
Waste Management Programs				
Program funding	Yes – WRARS performance fund, WRAPP	Yes – Provincial funding programs (RRFB tire and container fund, performance fund)	Yes – knowledge and planning tools are supplied to Councils by Government; government agencies purchase recycled goods; Council performance payments	Yes – knowledge sharing program; funding for waste management projects relating to recycling and cleaner products.
Education of public/business/industry	Some	Yes – RRFB Nova Scotia partners with regional and municipal educators	Yes – collaborative Government-Council approaches; government programs developed specifically for business/industry	Yes – in National waste strategy.
Waste management regional collaboration	Yes – in 1999, there were ten regional waste management systems that included three or more community partners	Yes – provincial, regional, municipal, stakeholder, and public collaboration	Yes – collaboration between Government, Councils, and industry collectors	Yes – local council, national, and international cooperation;

Characteristic	Manitoba, Canada	Nova Scotia, Canada	New South Wales, Australia	Denmark
Landfill bans	No	Yes	No	Landfill ban on waste suitable for incineration (1997); mandatory organics source separation
Best available technology (BAT)	No (issues identified by the Office of the Auditor General – see Chapter 2)	Somewhat – incinerators must capture energy and landfills require soil and plastic liners and the capture and treatment of leachate	Yes – proposed waste management projects are assessed and determined by Minister of Planning in NSW; advice for councils given by DECC; small-scale landfill incentive for LFG capture	Yes – required under EU law
Compost quality control	No provincial regulation	Yes – provincial standards regarding maturity period, but may not be stringent enough	Yes – national standard for contaminant limit, stability and maturity criteria, and physical properties	Yes – national standards for quality control with respect to heavy metals and xenobiotic substances.
Curb-side pickup of source-separated food waste	In June 2010, less than 1% of the population had access (see Chapter 6)	In 2008, 90% of residents had curb-side organics pickup	Some – 31 out of 38 councils in Sydney provided curb-side organics pickup in 2006-07	Yes
Landfill tipping fee, levy, tax (per tonne)	Yes – WRARS tipping fee levy of $10/tonne beginning in 2009 and coming into effect for all landfills in 2011 (see Chapter 4).	Yes – tipping fee increased to $110 in HRM and an average of $80 elsewhere	Yes – $58.80 in SMA, $52.40 in ERA, increasing by $10 per tonne per year until 2015-16.	Waste tax, packaging tax
Link waste management to GHG emissions and energy and water conservation	Limited (in Government of Manitoba's "Beyond Kyoto" document waste management is only briefly mentioned)	Yes	Yes	Yes
Waste Management Diversion Achievements				
Total waste generated (Mt)	1.177 (2006)	0.678 (2006)	15.359 (2006-07)	14.210 (2005)
Total waste disposed / recycled / incinerated (Mt)	1.024 / 0.153 / 0 (2006)	0.402 / 0.276 / 0 (2006)	7.370 / 7.989 / 0 (2006-07)	1.194 / 9.549 / 3.467 (2005)
Per capita waste generated / disposed / recycled / incinerated (kg)	1025 / 892 / 133 / 0 (2006)	726 / 430 / 295 / 0 (2006)	2230 / 1070 / 1160 / 0 (2006-07)	2623 / 181 / 1762 / 641 (2005)
Recycling rate[1] (%) **Diversion rate[1](%)**	13.0 (2006) 13.0 (2006)	40.7 (2006) 40.7 (2006)	52.1 (2006-07) 52.1 (2006-07)	67.2 (2005) 91.6 (2005)
Quantity of organics recycled	12,490 tonnes (2006)	134,000 tonnes, comprised of about 100,000 tonnes of garden organics and food waste (2006)	1,609,000 tonnes, comprised of 770,000 tonnes food, garden, and wood waste (2006)	1,257,000 tonnes, comprised of 737,000 tonnes of garden organics (2005)
Per capita organic waste recycled (kg)	11 (2006)	147	234	232

Source: Danish Government 2007, DECCW 2009c, DECCW 2008, Danish Environmental Protection Agency 1999b, Danish Government 2004, Environment Protection and Heritage Council 2009, Europa 2009b, Europa 2008a, Nova Scotia Environment 2009a, Nova Scotia Environment 2008, Organic Waste Recycling Unit 2002, RRFB Nova Scotia 2008, RRFB Nova Scotia 2003, Statistics Canada 2010a, Wagner and Arnold 2008.

Notes:

1. "Recycling rate" includes recycling and composting; "Diversion rate" is the sum of recycling rate and incineration rate.

5.4.6 Conclusion

The province of Manitoba's waste management system lags far behind those found in Nova Scotia, New South Wales, and Denmark. However, policy-makers in Manitoba can learn much from those other jurisdictions.

As Nova Scotia has demonstrated, the fact that the Government of Canada is not taking a leadership role in terms of waste management is not a sufficient condition for Manitoba to be unable to develop an integrated waste management strategy. Therefore, it might benefit the Government of Manitoba to look to Nova Scotia's strategy to determine how to implement a successful integrated waste management strategy.

A significant problem in Manitoba is that the province has an extremely low population density, especially compared to the other jurisdictions. Therefore, as with Nova Scotia, the Government of Manitoba should commission studies that determine opportunities to achieve economies of scale in terms of waste management. As we have seen, the vast majority of Manitoba's population (about 90%) lives within 200 km of the border. Furthermore, about 60% of the population of Manitoba lives in the Winnipeg Census Metropolitan Area, where the population density reaches over 95 people per square kilometre. These kinds of details would be fleshed out in the commissioned studies, which would hopefully propose waste management regions in Manitoba. Once these waste management regions have been established, Manitoba would be more amenable to an integrated waste management strategy.

In terms of a waste management strategy, what is needed is a publicly accessible document containing waste diversion and disposal targets. In fact, the Government of

Manitoba might consider legislating targets in a provincial Act, as was done in Nova Scotia. If the Government of Manitoba is accountable for achieving waste diversion and disposal goals, it may be more motivated to implement options to achieve them.

The other jurisdictions have found that mandatory regional and inter-regional cooperation has been helpful; therefore, this should also be included in a strategy for Manitoba. However, collaboration with, and support by, the Government of Manitoba should not be understated: the Government of Manitoba should be involved in the development of every regions' waste management system. In addition, the Government of Manitoba should be open to altering the boundaries of these regions should it become clear that the change could promote greater economies of scale or environmental protection.

Finally, in order to be able to fund an integrated waste management system, it might be prudent to increase funding through "environmental fees", like the two cent levy on beverage containers that currently exists. As a reference point, the levy in Nova Scotia is about five cents on each beverage container and funds recycling and composting initiatives in Nova Scotia. Therefore, policy-makers in Manitoba would be justified in imposing a new levy to fund more expensive waste management options, like a large-scale, centralized composting facility. In Nova Scotia in 2006, centralized composting facilities charged tipping fees of $33-$77 per tonne to cover their operational costs (it is unclear whether this includes pickup of organic waste); in 2002, the cost of picking up source separated organic waste was an additional $6 per household (compared to waste and recyclable pickup). Therefore, the overall cost of a centralized composting facility in

Manitoba could be $39-$83 per tonne, which is probably an underestimate given that those costs will have at least risen with inflation.

Other tools by which policy-makers in Manitoba could include in an integrated waste management strategy are increasing the WRARS landfill levy steadily over time, landfill bans, and making a compost quality regulation. These options might not only help to increase organic waste diversion, but also overall diversion.

If the Government of Manitoba has the objective of increasing its waste diversion rate and decreasing its waste disposal rate, it should consider the options presented. The options come well-tested by the other jurisdictions and have proven effective at increasing waste diversion rates. Although Manitoba's situation remains unique, and studies may be required to determine how best to proceed, the other jurisdictions have set a firm foundation upon which Manitoban policy-makers can construct an effective integrated waste management strategy.

REFERENCES

Australian Bureau of Statistics. 2009. Australian Demographic Statistics, Jun 2009. *Australian Government*. Retrieved Feb 24, 2010 from <http://www.abs.gov.au/ausstats/abs@.nsf/mf/3101.0>.

Australian Government. n.d. State and Territory Government. Retrieved Feb 24, 2010 from <http://www.australia.gov.au/about-australia/our-government/state-and-territory-government>.

Bogner, J., M. Abdelrafie Ahmed, C. Diaz, A. Faaij, Q. Gao, S. Hashimoto, K. Mareckova, R. Pipatti, T. Zhang. 2007. Waste Management. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Retrieved October 24, 2010 from <http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter10.pdf>.

Canadian Council of Ministers of the Environment [CCME]. 2009a. About CCME. Retrieved November 17, 2010 from <http://www.ccme.ca/about/>.

Canadian Council of Ministers of the Environment [CCME]. 2009b. Canada-wide action plan for extended producer responsibility. Retrieved June 29, 2010 from <http://www.ccme.ca/assets/pdf/epr_cap.pdf>.

City of Winnipeg. 2010a. Organic Collection Options. Report – Standing Policy Committee on Infrastructure Renewal and Public Works – February 9, 2010. Minute No. 232.

City of Winnipeg. 2010b. Population of Winnipeg. Retrieved November 6, 2010 from <www.winnipeg.ca/cao/pdfs/population.pdf>.

City of Winnipeg. 2010c. Preparation of a Comprehensive Waste Management Strategy. Report – Standing Policy Committee on Infrastructure Renewal and Public Works – May 25, 2010. Minute No. 442.

Danish Environmental Protection Agency. 1999a. Waste 21: Waste Management Plan 1998-2004. Government of Denmark. Retrieved May 13, 2010 from <http://www2.mst.dk/Udgiv/publications/1999/87-7909-571-2/pdf/87-7909-570-4.pdf>.

Danish Environmental Protection Agency. 1999b. Waste in Denmark. Government of Denmark. Retrieved Mar 30, 2010 from <http://www.google.ca/url?sa=t&source=web&ct=res&cd=1&ved=0CAYQFjAA&url=http%3A%2F%2Fwww.seas.columbia.edu%2Fearth%2Fwtert%2Fsofos%2FDenmark_Waste.pdf&rct=j&q=denmark+waste+management&ei=zXSyS-SWIpC2NtfftfwD&usg=AFQjCNHKgKlOA0mpIBTZWPwP8PvCjjKu8Q>.

Danish Government. 2007. Greenhouse gas emissions trends and projections in Europe 2007: Denmark – Country profile 2007. European Environment Agency. Retrieved June 10, 2010 from <http://www.eea.europa.eu/publications/eea_report_2007_5/Denmark.pdf>.

Danish Government. 2004. Waste Strategy 2005-08. Retrieved June 7, 2010 from <http://www2.mst.dk/udgiv/Publications/2004/87-7614-249-3/pdf/87-7614-250-7.pdf>.

Danish Ministry of the Environment. 2007. Waste Statistics 2005. *Government of Denmark*. Retrieved Mar 24, 2010 from <http://www2.mst.dk/Udgiv/publications/2007/978-87-7052-581-7/pdf/978-87-7052-581-7.pdf>.

Danish Parliament. 2009. My Constitutional Act with explanations (5th edition, 1st impression). Government of Denmark. Retrieved Mar 23 from <http://www.ft.dk/English/~/media/Pdf_materiale/Pdf_publikationer/English/My%20Constitutional%20Act_samlet_web%20pdf.ashx>.

David, A. 2007. Overview of municipal solid waste (MSW) management in Canada. Environment Canada. *Government of Canada*. In proceedings "Municipal Waste Management Workshop: Different Approaches and Solutions." Retrieved January 16, 2009 from <http://www.awma-ovc.ca/AWMA_OVC_WMWorkshop_Alain_David.pdf>.

Department of Environment, Climate Change, and Water [DECCW]. 2010. The Waste and Environment Levy. *NSW Government*. Retrieved Mar 3, 2010 from <http://www.environment.nsw.gov.au/wr/index.htm>.

Department of Environment, Climate Change, and Water [DECCW]. 2009a. About POEO Legislation. *NSW Government*. Retrieved Feb 25, 2010 from <http://www.environment.nsw.gov.au/legislation/aboutpoeo.htm#major>.

Department of Environment, Climate Change, and Water [DECCW]. 2009b. DECCW Act Summaries. *NSW Government*. Retrieved Feb 25, 2010 from <http://www.environment.nsw.gov.au/legislation/DECCActsummaries.htm#waarra>.

Department of Environment, Climate Change, and Water [DECCW]. 2009c. NSW Waste Avoidance and Resource Recovery Progress Report 2008. *NSW Government*. Retrieved Feb 26, 2010 from <http://www.environment.nsw.gov.au/resources/warr/09155WARRreport08.pdf>.

Department of Environment, Climate Change, and Water [DECCW]. 2008. NSW Resource Recovery Industries Survey 2006-07: Organics Reprocessing. *NSW Government*. Retrieved Mar 1, 2010 from <http://www.environment.nsw.gov.au/resources/sustainbus/08584organicsRecovery.pdf>.

Department of Environment, Climate Change, and Water [DECCW]. 2007. NSW Waste Avoidance and Resource Recovery Strategy 2007. *NSW Government*. Retrieved Feb 25, 2010 from <http://www.environment.nsw.gov.au/resources/warr/07226_WARRreport07.pdf>.

Department of Local Government. 2009. Comparative Information on NSW Local Government Councils 2007/08. Retrieved Mar 2, 2010 from <http://www.dlg.nsw.gov.au/dlg/dlghome/documents/Comparatives/Comparatives_2007_08.pdf>.

Department of Justice. 2010. Constitution Acts, 1867 to 1982. *Government of Canada*. Retrieved Mar 5, 2010 from <http://laws-lois.justice.gc.ca/eng/Const/Const_index.html>.

Department of the Environment, Water, Heritage, and the Arts [DEWHA]. 2009a. About the EPBA Act. *NSW Government*. Retrieved Feb 24, 2010 from <http://www.environment.gov.au/epbc/about/index.html>.

Department of the Environment, Water, Heritage, and the Arts [DEWHA]. 2009b. National Environmental Protection Council. *NSW Government*. Retrieved June 9, 2010 from <http://www.environment.gov.au/about/councils/nepc/index.html>.

Department of the Environment, Water, Heritage, and the Arts [DEWHA]. 2009c. What is protected under the EPBA Act? *Australian Government*. Retrieved Feb 24, 2010 from <http://www.environment.gov.au/epbc/protect/index.html>.

Department of the Environment, Water, Heritage, and the Arts [DEWHA]. 2007a. National Strategy for Ecologically Sustainable Development. *Australian Government*. Retrieved Feb 24, 2010 from <http://www.environment.gov.au/esd/national/nsesd/index.html>.

Department of the Environment, Water, Heritage, and the Arts [DEWHA]. 2007b. National Strategy for Ecologically Sustainable Development. *Australian Government*. Retrieved Feb 24, 2010 from <http://www.environment.gov.au/esd/national/nsesd/strategy/intro.html#GoalsEtc>.

Department of the Environment, Water, Heritage, and the Arts [DEWHA]. 2007c. National Strategy for Ecologically Sustainable Development. *Australian*

Government. Retrieved February 24, 2010 from <http://www.environment.gov.au/esd/national/nsesd/strategy/wastes.html>.

Economic Instruments in Environmental Policy. 2010. Landfill Tax (EU). University College Dublin. Retrieved November 21, 2010 from <http://economicinstruments.com/index.php/solid-waste/charges-and-taxes-/article/280->.

Encyclopedia Britannica. N.d. New South Wales. Retrieved September 2, 2010 from <http://www.britannica.com/EBchecked/topic/412057/New-South-Wales>.

Environment Canada. 2009a. Canada's 2006 Greenhouse Gas Inventory. *Government of Canada*. Retrieved February 11, 2009 from http://www.ec.gc.ca/pdb/ghg/inventory_report/2006/tab_eng.cfm

Environment Canada. 2009b. Municipal Solid Waste (MSW). *Government of Canada*. Retrieved March 9, 2010 from <http://www.ec.gc.ca/drgd-wrmd/default.asp?lang=En&n=7623F633-1>.

Environment Canada. 2005a. A Guide to Understanding the Canadian Environmental Protection Act, 1999: Section 1: Introduction. *Government of Canada*. Retrieved March 5, 2010 from <http://www.ec.gc.ca/CEPARegistry/the_act/guide04/s1.cfm>.

Environment Canada. 2005b. A Guide to Understanding the Canadian Environmental Protection Act, 1999: Section 2: Environmental Management in Canada. *Government of Canada*. Retrieved March 5, 2010 from <http://www.ec.gc.ca/CEPARegistry/the_act/guide04/s2.cfm>.

Environment Canada. 2005c. A Guide to Understanding the Canadian Environmental Protection Act, 1999: Section 3: CEPA 1999 Guiding Principles. *Government of Canada*. Retrieved March 5, 2010 from <http://www.ec.gc.ca/CEPARegistry/the_act/guide04/s3.cfm>.

Environment Protection and Heritage Council. 2009. National Waste Overview 2009. *Australian Government*. Retrieved March 2, 2010 from <http://www.ephc.gov.au/sites/default/files/WasteMgt_Nat_Waste_Overview_PRINT_ver_200911.pdf>.

Europa. 2009a. Directive on waste. Retrieved Mar 26, 2010 from <http://europa.eu/legislation_summaries/environment/waste_management/ev0010_en.htm#KEY>.

Europa. 2009b. Waste disposal (until the end of 2010). Retrieved March 30 from <http://europa.eu/legislation_summaries/environment/waste_management/l21197_en.htm>.

Europa. 2008a. Integrated pollution prevention and control: IPPC Directive. Retrieved March 30, 2010 from <http://europa.eu/legislation_summaries/environment/waste_management/l28045_en.htm>.

Europa. 2008b. Waste incineration. Retrieved March 29, 2010 from <http://europa.eu/legislation_summaries/environment/waste_management/l28072_en.htm>.

Europa. 2006. Strategy on the prevention and recycling of waste. Retrieved March 29, 2010 from

<http://europa.eu/legislation_summaries/environment/waste_management/l28168_en.htm>.

Europa. N.d. The 27 member countries of the European Union. Retrieved March 22, 2010 from <http://europa.eu/about-eu/27-member-countries/index_en.htm>.

European Commission. 2009a. What are EU decisions? Retrieved March 26, 2010 from <http://ec.europa.eu/community_law/introduction/what_decision_en.htm>.

European Commission. 2009b. What are EU directives? Retrieved March 26, 2010 from <http://ec.europa.eu/community_law/introduction/what_directive_en.htm>.

European Commission. 2009c. What are EU regulations? Retrieved March 26, 2010 from <http://ec.europa.eu/community_law/introduction/what_regulation_en.htm>.

European Commission. 2009d. What is EU law? Retrieved March 26, 2010 from <http://ec.europa.eu/community_law/introduction/treaty_en.htm>.

Federation of Canadian Municipalities [FCM]. 2004. Solid Waste as a Resource: Guide for Sustainable Communities. Retrieved March 9, 2010 from <http://www.sustainablecommunities.ca/files/Capacity_Building_-_Waste/SW_Guide_Overview.pdf>.

Federation of Canadian Municipalities. N.d. Introduction. Retrieved November 17, 2010 from <http://www.fcm.ca/english/view.asp?x=450>.

Forster, P., V. Ramaswamy, P. Artaxo, T. Berntsen, R. Betts, D. W. Fahey, J. Haywood, J. Lean, D. C. Lowe, G. Myhre, J. Nganga, R. Prinn, G. Raga, M. Schulz, and R. Van Dorland. 2007. Changes in Atmospheric Constituents and in Radiative Forcing. *In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel*

on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor and H. L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Google Maps. 2010a. Retrieved Feb 24, 2010 from <http://maps.google.com.au/>.

Google Maps. 2010b. Retrieved March 4, 2010 from <http://maps.google.ca/>.

Government of Canada. 2010. Provinces and Territories. *Government of Canada*. Retrieved March 4, 2010 from <http://www.canada.gc.ca/othergov-autregouv/prov-eng.html>.

Government of Nova Scotia. 2008. Nova Scotia Population by County. *Government of Nova Scotia*. Retrieved March 16, 2010 from http://www.gov.ns.ca/finance/statistics/agency/common/default.asp?p=1&s=1c.

Green Manitoba. 2010. HHW events calendar for 2010. *Government of Manitoba*. Retrieved June 29, 2010 from <http://www.greenmanitoba.ca/cim/dbf/2010_hhw_events.pdf?im_id=411&si_id=1001>.

Green Manitoba. 2009. Waste reduction and recycling support (WRARS) program guide. *Government of Manitoba*. Retrieved June 29, 2010 from <http://www.greenmanitoba.ca/cim/dbf/wrars_guide_december_09_(v1.1).pdf?im_id=392&si_id=1001>.

Green Manitoba. N.d. E-waste roundup. *Government of Manitoba*. Retrieved June 29, 2010 from <http://www.greenmanitoba.ca/cim/1001.dhtm>.

Haque, C. E., and K. T. Hamberg. 1996. The challenge of waste stewardship and sustainable development: A study of municipal waste management in rural Manitoba. *Great Plains Research* 6: 245-268.

Hyder Consulting. 2008. Waste and Recycling in Australia: Final Report. Retrieved February 25, 2010 from <http://www.environment.gov.au/settlements/waste/publications/pubs/waste-recycling2008.pdf>.

Manitoba Association for Resource Recovery Corporation [MARRC]. 2010. On drop of used oil makes a difference. Retrieved June 29, 2010 from <http://www.usedoilrecycling.com/en/mb>.

Manitoba Environment. 1991. Waste reduction and prevention: 1991 strategy report. *Government of Manitoba*.

Manitoba Environment. 1996. Waste reduction and prevention: Waste reduction and prevention strategy report 1996. *Government of Manitoba*.

Manitoba Conservation. 1999. Final report of the Manitoba regional waste management task force: Regional integrated waste management action plan and recommendations. *Government of Manitoba*.

Manitoba Conservation. 2010. News release. *Government of Manitoba*. Retrieved June 29, 2010 from <http://news.gov.mb.ca/news/index.html?archive=&item=8282>.

Manitoba Conservation. N.d.b. Waste reduction and pollution prevention (WRAPP) fund. Government of Manitoba. Retrieved June 29, 2010 from <http://www.gov.mb.ca/conservation/pollutionprevention/wrapp/wrappfund.html>.

Manitoba Conservation. N.d.b. Waste reduction and prevention. *Government of Manitoba*. Retrieved June 29, 2010 from <http://www.gov.mb.ca/conservation/pollutionprevention/waste/index.html>.

Manitoba Environment. 1991. Waste reduction and prevention: 1991 strategy report. *Government of Manitoba*.

Manitoba Environment. 1996. Waste reduction and prevention: Waste reduction and prevention strategy report 1996. *Government of Manitoba*.

National Capital Commission. 2008. About Canada's Capital. *Government of Canada*. Retrieved Mar 5, 2010 from <http://www.capcan.ca/bins/ncc_web_content_page.asp?cid=16297-24515&lang=1&bhcp=1>.

Nevens, F., and D. Reheul. 2003. The application of vegetable, fruit and garden waste (VFG) compost in addition to cattle slurry in a silage maize monoculture: nitrogen availability and use. European Journal of Agronomy 19:189–203.

Nicol, S., and S. Thompson. 2007. Policy options to reduce consumer waste to zero: Comparing product stewardship and extended producer responsibility for refrigerator waste. *Waste Management and Research* 25(3): 227-233.

Nova Scotia Environment. 2009a. Environmental Goals and Sustainable Prosperity Act: Progress Report 2009. *Government of Nova Scotia*. Retrieved Mar 11, 2010 from <http://www.gov.ns.ca/nse/egspa/docs/EGSPA.2009.Annual.Report.pdf>.

Nova Scotia Environment. 2009b. Renewal of Nova Scotia's Solid Waste Resource Management Strategy: Consultation Summary Report 2009. *Government of Nova*

Scotia. Retrieved Mar 10, 2010 from <http://www.gov.ns.ca/nse/waste/docs/SolidWasteStrategy.2009.Renewal.pdf>.

Nova Scotia Environment. 2009c. Solid Waste-Resource Management Strategy. *Government of Nova Scotia*. Retrieved Mar 10, 2009 from <http://www.gov.ns.ca/nse/waste/swrmstrategy.asp>.

Nova Scotia Environment. 2008. Final Report on Nova Scotia's 1995 Solid Waste Resource Management Strategy: Not Going to Waste. *Government of Nova Scotia*. Retrieved Mar 10, 1995 from <http://www.gov.ns.ca/nse/waste/docs/SolidWasteStrategyFinalReport1995.pdf>.

Nova Scotia Environment and Labour. 2004. Status Report 2004 of Solid Waste-Resource Management in Nova Scotia. *Government of Nova Scotia*. Retrieved Mar 11, 2010 from <http://www.gov.ns.ca/nse/waste/docs/WasteResourceStatus2004.pdf>.

NSW Legislation. 2010. Protection of the Environment Operations Act 1997 No. 156. *New South Wales Government*.

Organic Waste Recycling Unit. 2002. Soil Carbon Sequestration Utilising Recycled Organics: A Review of the Scientific Literature. *NSW Agriculture*. Retrieved Mar 2, 2010 from <http://www.environment.nsw.gov.au/resources/warr/SPD_ORG_0208SoilCarbonSeq.pdf>.

Otten, L. 2001. Wet-dry composting of organic municipal solid waste: current status in Canada. Canadian Journal of Civil Engineering 28:124–130.

Parliamentary Education Office [PEO]. 2009. A Multi-tiered System: Governing Australia. *Australian Government*. Retrieved Feb 24, 2010 from <http://www.peo.gov.au/students/cl/multi.html>.

Parliament of Australia. 2003. Commonwealth of Australia Constitution Act. *Australian Government*. Retrieved Feb 24, 2010 from <http://www.aph.gov.au/SEnate/general/constitution/par5cha1.htm>.

Recycling Action Committee. 1990. Action plan: A waste minimization strategy for Manitoba in the 1990s. *Prepared for Manitoba Environment, Government of Manitoba*.

RRFB Nova Scotia. 2008. Annual Report 2008. Government of Nova Scotia. Retrieved Mar 16, 2010 from <http://www.rrfb.com/pdfs/RRFB_AR_2008.pdf>.

RRFB Nova Scotia. 2003. An Assessment of the State of Provincial Compost Processing Facilities. Government of Nova Scotia. Retrieved Mar 16, 2010 from <http://www.rrfb.com/pdfs/An%20Assessment%20of%20the%20State%20of%20Provincial%20Compost%20Processing%20Facilities.pdf>.

Statistics Canada. 2010a. 2006 Community Profiles. *Government of Canada*. Retrieved June 25, 2010 from <http://www12.statcan.ca/census-recensement/2006/dp-pd/prof/92-591/index.cfm?Lang=E>.

Statistics Canada. 2010b. Waste disposal, by source, by province. *Government of Canada*. Retrieved Mar 12, 2010 from <http://www40.statcan.gc.ca/l01/cst01/envir25a-eng.htm>.

Statistics Canada. 2009. Population by year, by province and territory. *Government of Canada*. Retrieved Mar 4, 2010 from <http://www40.statcan.ca/l01/cst01/demo02a-eng.htm>.

Statistics Canada. 2008a. Farm population and total population by rural and urban populations, by province (2001 and 2006 Census of Agriculture and Census of Population). *Government of Canada*. Retrieved Mar 4, 2010 from <http://www40.statcan.ca/l01/cst01/agrc42a-eng.htm>.

Statistics Canada. 2008b. Population and dwelling counts, for Canada, provinces and territories, and census subdivisions (municipalities), 2006 and 2001 censuses – 100% data. *Government of Canada*. Retrieved June 25, 2010 from <http://www12.statcan.ca/english/census06/data/popdwell/Table.cfm?T=302&SR=1&S=3&O=D&RPP=25&PR=46&CMA=0>

Statistics Canada. 2008c. Waste management industry survey: Business and government sectors. *Government of Canada*. Catalogue no. 16F0023X. Retrieved Mar 12, 2010 from <http://www.statcan.gc.ca/pub/16f0023x/16f0023x2006001-eng.pdf>.

Statistics Canada. 2005a. Human Activity and the Environment: Solid Waste in Canada. *Government of Canada*. Catalogue no. 16-201-XIE. Retrieved Mar 15, 2010 from <http://www.statcan.gc.ca/pub/16-201-x/16-201-x2005000-eng.pdf>.

Statistics Canada. 2005b. Land and freshwater area, by province and territory. *Government of Canada*. Retrieved Mar 4, 2010 from <http://www40.statcan.ca/l01/cst01/phys01-eng.htm>.

Statistics Denmark. 2010a. Population projections by municipality, age and sex. *Government of Denmark*. Retrieved Mar 22, 2010 from <http://www.statbank.dk/statbank5a/default.asp?w=1680>.

Statistics Denmark. 2010b. Quarterly Population (ultimo). *Government of Denmark*. Retrieved Mar 22, 2010 from <http://www.dst.dk/HomeUK/Statistics/Key_indicators/Population/pop_quarterly.aspx>.

Statistics Denmark. 2009. Statistical Yearbook 2009. *Government of Denmark*. Retrieved Mar 22, 2010 from <http://www.dst.dk/pubpdf/14468/sy2009>.

The City of Sydney. 2010. Estimated Resident Population (ERP). Retrieved Feb 24, 2010 from <http://profile.id.com.au/Default.aspx?id=148&pg=210>.

Tire Stewardship Manitoba. 2009. 2009 Annual Report. Retrieved June 29, 2010 from <http://www.tirestewardshipmb.ca/cim/dbf/tsm-2009annualreport_web_s.pdf?im_id=54&si_id=1005>.

US EPA. 2010a. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2008. US Government. EPA 430-R-10-006. Retrieved May 10, 2010 from <http://www.epa.gov/climatechange/emissions/downloads10/US-GHG-Inventory-2010_ExecutiveSummary.pdf>.

US EPA. 2010b. Methane. US Government. Retrieved May 10, 2010 from <http://www.epa.gov/methane/sources.html>.

US EPA. 2009. Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2008. EPA 530-F-009-021. US Government.

Retrieved May 10, 2010 from <http://www.epa.gov/osw/nonhaz/municipal/pubs/msw2008rpt.pdf>.

Visit Denmark. 2009. Geography. *Government of Denmark*. Retrieved Mar 22, 2010 from <http://www.visitdenmark.com/usa/en-us/menu/turist/turistinformation/fakta-az/geography.htm>.

Vital Statistics. 2006. Annual Report. *Nova Scotia Government*. Retrieved Mar 4, 2010 from <http://www.gov.ns.ca/snsmr/pdf/ans-vstat-2006-annual-report.pdf>.

Wagner, T., and P. Arnold. 2008. A new model for solid waste management: an analysis of the Nova Scotia MSW Strategy. *Journal of Cleaner Production* 16: 410-421.

Wikipedia. 2010. Winnipeg Capital Region. Retrieved November 24, 2010 from <http://en.wikipedia.org/wiki/Winnipeg_Capital_Region>.

X-Rates. 2010. Canadian Dollars to 1 EUR. Retrieved November 21, 2010 from <http://www.x-rates.com/>.

CHAPTER 6: ESTIMATING ORGANIC WASTE ENTERING AND METHANE EMITTING FROM LANDFILLS IN MANITOBA, CANADA

6.1 Introduction

In 2005, about 4.9% of Manitoba's greenhouse gas emissions were due to the waste management sector (Manitoba Science, Technology, Energy and Mines 2008). Methane is generated at landfills as a result of the decomposition of organic waste under anaerobic conditions (Ackerman, 2000). Methane is of concern because it has a global warming potential of about 25 times that of carbon dioxide over a 100-year time horizon (Forster et al 2007). For the methane from the waste management sector to be reduced, options for the management of organic waste are required, in addition to access to a sanitary landfill. To build the desire and momentum to initiate these options, it would be helpful for policy-makers and the public to be aware that these options can reduce greenhouse gas emissions. It is therefore useful to determine both the quantity of organic waste going into landfills and the amount of methane that results from its decomposition.

The province of Manitoba in Canada has some organic waste diversion programs (see Chapter 4). However, the vast majority of these programs are voluntary, with very limited curb-side pickup, and do not track the amount of organic waste that is diverted from landfills (see Chapter 4). In addition, few waste composition studies have ever been performed. One waste composition study was conducted on the City of Winnipeg's residential waste stream in the year 2000 (Earthbound Environmental 2000). Waste generated by Winnipeg is disposed of at the Brady Road Landfill, which services about 60% of the population of Manitoba (see Chapter 4). In 2008, the Brady Road Landfill

was the third largest point source of greenhouse gas emissions in Manitoba (Environment Canada 2010b). In addition, although methane emissions from landfills are reported to Environment Canada from two landfills (Brady Road and Summit Road landfills) in Winnipeg, the other landfills in Manitoba do not report their methane emissions (Environment Canada 2010b). The lack of knowledge with regard to the amount of organic waste sent to landfills and the methane that results is likely a key inhibitor to the implementation of organic waste management options in Manitoba.

This study estimates the quantity of organic waste entering landfills in Manitoba and the quantity of methane released by these landfills as a result of its anaerobic decomposition.

6.2 Method

To estimate landfill gas emissions in Manitoba, waste composition data is needed. However, waste composition data is not available for the vast majority of landfills in Manitoba. There is limited data available concerning waste composition in Manitoba, which can be extrapolated to other landfill sites. This waste composition data was used to predict the amount of organic waste going to landfills and the greenhouse gas emissions due to organic waste.

6.2.1 Estimating the quantity of organic waste entering landfills in Manitoba

An estimation of the amount of organic waste going into landfills was derived using the following method:

1. For simplicity, a waste composition study of residential waste from the City of Winnipeg in 2000 (Earthbound Environmental 2000**)** was used to estimate organic waste disposal for the City of Winnipeg in 2006 (Table 6.1). The waste composition data used for this analysis are supported by a waste composition study conducted in Vancouver, British Columbia in 2008 and 2010 (Table 6.2).
2. Two waste composition studies (City of Yellowknife 2007, Pennsylvania Department of Environmental Protection 2003) were used to estimate a low and high organic waste disposal for communities other than Winnipeg in 2006.
3. The waste disposal rate of the Brandon Landfill in 2006 was used to check the accuracy of the waste disposal rate for communities in Manitoba other than Winnipeg.
4. Data on population and waste generation, disposal, and diversion in Manitoba were retrieved from Statistics Canada.
5. Data on diversion rates from communities other than Winnipeg were retrieved from Manitoba Product Stewardship Corporation (MPSC) (2010).

Table 6.1 The fractions of the residential waste stream entering Brady Road Landfill in Manitoba that are organic.

Category	Percent of residential MSW (by weight)
Paper and textiles	31.0%
Food waste	26.1%
Garden, park waste and other organics	6.6%
Wood and straw waste	2.3%
Total	66.0%

Source: Earthbound Environmental 2000

Table 6.2 The fractions of the waste stream in Vancouver, British Columbia that are organic.

Category	Percent of MSW (by weight)
Organic (food, yard, and clean wood waste)	32.2% - 38.4%
Paper (tissue, toweling, cardboard, boxboard, newsprint, and office paper waste)	21.7% - 27.1%
Total	53.9% - 65.5%

Source: Technology Resources Inc. 2008, 2010

6.2.2 Estimating methane emissions from organic waste

An estimation of the methane from landfills in Manitoba was derived using the following method:

1. Both the RETScreen Clean Energy Project Analysis Software and Scholl Canyon Model were used to estimate methane emissions from landfills in Manitoba.
2. Inputs into the models were based on estimates at the Brady Road Landfill (Table 6.3). The methane generation constant (k) was calculated by using an equation from Thompson et al. (2009) and the average rainfall pattern at the Winnipeg Richardson International Airport between 1971 and 2000 (Environment Canada Weather Office Environment Canada 2006). The percent of landfill gas that is methane at Brady Road Landfill was based on a study by Tanapat (2004). The methane generation rate from waste (Lo) at Brady Road Landfill was taken from Thompson et al. (2009). All waste in Manitoban landfills was assumed to be under these conditions.
3. To check the accuracy of RETScreen, an estimate of methane emissions was made for the Brady Road Landfill in Winnipeg, from which 10 years of waste quantities had been received. Brady Road Landfill reports its methane emissions to Environment Canada.
4. As waste data was unavailable for every landfill in Manitoba, methane was calculated by developing a model for one large landfill that excluded waste entering the Brady Road and Summit Road landfills. There are well over 200 landfills operating in Manitoba (Green Manitoba n.d.).

5. Waste data in Manitoba between 1990 and 2006 were used (Green Manitoba n.d., Statistics Canada 2008a); an estimate of the waste landfilled in Manitoba in 2009 was acquired by using a Growth Trend and Linear Trend analysis in Microsoft Excel 2003. Waste entering either the Brady Road or Summit Road landfills was subtracted from the total value. Summit Road landfill data was estimated in 1990 by assuming that Winnipeg has had a consistent 38% contribution to the total waste disposed in Manitoba (average between 2000 and 2009).

Table 6.3 Inputs into RETScreen and Scholl Canyon Model.

Input	Value
Methane generation constant (k)	0.023
Methane by volume of landfill gas (%)	56
Methane generation from waste (Lo) (m^3/tonne)	136

6.3 Results

6.3.1. Estimate of organic waste entering landfills

Table 6.4 describes the result of the estimated amount of organic waste entering the Brady Road Landfill based on the waste composition data (Table 6.1) and other data from the year 2000. It is assumed that in 2000 and 2006 the percent of the total waste generated that is organic waste remains constant and that the organic waste is sent to the landfill.

Table 6.4 Waste disposed, diverted, and generated in total (tonnes) and per capita (kg) in Winnipeg in 2000 and 2006.

Population of Winnipeg in 2000	634,500	
Population of Winnipeg in 2006	653,500	
Waste categories for Winnipeg	**2000**	**2006**
Waste disposed (t)	377,179	382,042
Waste disposed per capita (kg)	594	585
Waste diverted (t)	23,995	42,205
Waste diverted per capita (kg)	38	65
Waste generated (t)	401,174	424,247

Waste generated per capita (kg)	632	649
Organic waste disposed in 2000 (66.0% of waste disposed) (t)	248,938	
Percent organic waste of waste generated in 2000 (kg)	62.1%	
Organic waste disposed in 2006 (62.1% of waste generated) (t)		263,457
Organic waste disposed per capita in 2006 (kg)		402

Source: City of Winnipeg 2010, Office of the CFO 2010, T. Kuluk personal communication April 9, 2010

Table 6.5 describes the result of the estimated amount of organic waste entering all landfills other than the Brady Road Landfill. Table 6.5 provides an estimate of the waste disposal rate of communities other than Winnipeg in Manitoba in 2006. Interestingly, the waste disposal per capita rate for the Brandon Landfill in 2006 (Table 6.6) is only 3.8% greater than the estimated waste disposal per capita rate for all non-Winnipeg communities in Manitoba in 2006 (Table 6.3): this suggests that non-Winnipeg communities have a similar waste disposal rate.

Table 6.5 Waste and population data in Manitoba in 2006.

Population of Manitoba in 2006	1,148,401
Population of Winnipeg in 2006	653,500
Population of non-Winnipeg communities in 2006	494,901
Manitoba Statistics	**Waste**
Total waste generated in Manitoba in 2006 (t)	1,177,071
Total waste generated in Winnipeg in 2006 (t)	424,247
Total waste generated by non-Winnipeg communities in 2006 (t)	752,824[1]
Waste generated per capita by non-Winnipeg communities in 2006 (average) (kg)	1,521[2]
Waste recycled per capita by non-Winnipeg communities in 2006 (weighted average) (kg)	57
Waste disposed per capita by non-Winnipeg communities in 2006 (average) (kg)	1,464[3]
Total waste disposed by non-Winnipeg sources in 2006 (t)	724,535[4]

Source: MPSC 2010, Office of the CFO 2010, Statistics Canada 2010, Statistics Canada 2008b, Statistics Canada 2008e, T. Kuluk personal communication April 9, 2010

Notes:

1. 752,824 = 1,177,071 tonnes generated in Manitoba – 424,247 tonnes generated by Winnipeg
2. 1,521 = 752,824 tonnes / 494,901 people) * 1000 kg / tonne
3. 1,464 = 1,521 kg generated per capita – 57 kg diverted per capita
4. 724,535 = 1,464 kg per capita * 494,901 people / 1000 kg/tonne

Table 6.6 Waste and population data for the Brandon landfill in 2006.

Population served by landfill in 2006	45,569
Waste characteristics for Brandon landfill	**2006**
Waste disposed (t)	69,248
Waste disposed per capita (kg)	1,520

Source: T. Mclaughlin personal communication April 9, 2010

Table 6.7 presents a low and a high value of total organic waste disposed of by non-Winnipeg communities in Manitoba in 2006.

Table 6.7 Low and high estimates of the disposal of organic waste by non-Winnipeg communities in Manitoba in 2006.

Low estimate of rural waste stream that is organic	64.8%
High estimate of rural waste stream that is organic	69.6%
Rural Manitoba Statistics	**Organic Waste (tonnes)**
Low estimate of organic waste disposed of by rural communities	469,499[1]
High estimate of organic waste disposed of by rural communities	504,276[2]

Source: City of Yellowknife 2007, Department of Environmental Protection 2003

Notes:

1. 469,499 tonnes organic waste = 726,515 tonnes * 0.648 low organic waste fraction
2. 504,276 tonnes organic waste = 726,515 tonnes * 0.696 high organic waste fraction

According to this analysis, the total amount of waste disposed in landfills in Manitoba in 2006 was 1,106,577 tonnes. Without considering any organic waste diversion programs, the total quantity of organic waste entering landfills in Manitoba in 2006 is estimated to range from 732,956 to 767,733 tonnes, which is 66.2 to 69.4% of the estimated total waste disposed in Manitoba.

Since Manitoba does have some organic waste diversion programs and only recyclable materials[4] were taken into account in this analysis, the above estimate of the amount of organic waste going to landfills is likely too high. In 2010, it was found that about 12.9% of Manitobans have access to either the curb-side pickup of organic waste or a compost pile at which they can voluntarily drop off their organic waste (see Chapter 4). However, since most communities do not yet keep track of the amount of organic waste

[4] It should be noted that Manitoba Tire Stewardship and Manitoba Association for Resource Recovery Corp. divert tires and used oil and used oil products, respectively, from landfill. The quantity diverted by these groups was not taken into account, although it is estimated that, combined, they divert at least 30,000 tonnes of waste from landfill (about 2.6% of total waste generated).

they divert, accurately estimating the amount of organic waste diverted in Manitoba was not possible (see Chapter 4). In 2009, at the very least, 35,270 tonnes of organic waste was diverted (see Chapter 4). According to Statistics Canada (2008f), about 12,480 tonnes of organic waste was diverted from landfills in Manitoba in 2006. It seems unlikely that organic waste diversion in Manitoba increased by at least 283% between 2006 and 2009; therefore, the Statistics Canada result for 2006 is probably too low. Taking into account the Statistics Canada (2008f) data for organic waste diversion, the total amount of organic waste entering landfills in Manitoba in 2006 ranges from 720,476-755,253 tonnes. Of this quantity of organic waste, about 49.5% is easily compostable: that is, food, garden, or park waste. Therefore, between 356,636-373,850 tonnes of waste disposed in Manitoba could be composted.

6.3.2 Estimate of methane emissions from landfills in Manitoba

Table 6.8 describes the results of the estimated methane emissions from Brady Road Landfill from the RETScreen and Scholl Canyon models. The 2008 methane emission data was taken from Environment Canada (Environment Canada 2010b). The 2009 and 2010 results under the Environment Canada column (Table 6.8) were estimated by applying the Growth and Linear Trend functions in Microsoft Excel 2003 to estimated emissions data from 2005-2008 (Environment Canada 2010b).

Overall, the results estimated by RETScreen were very similar to, but consistently greater than, the Environment Canada data and estimates. The difference between the two estimates was 0.2% in 2008, 1.0% in 2009, and 2.1% in 2010.

The Scholl Canyon Model consistently produced lower results than the Environment Canada data and estimates. The difference between the two estimates was 7.1% in 2008, 6.9% in 2009, and 4.1% in 2010.

Given the consistency of the results for the Brady Road Landfill among the models, it is expected that using RETScreen will fairly accurately predict Manitoba's total methane emissions from landfills.

Table 6.8 Actual and estimated methane emissions (tonnes) from Brady Road Landfill.

	Environment Canada	RETScreen	Scholl Canyon Model
2008	14,265	14,289	13,319
2009	15,243[1]	15,398	14,259
2010	16,139[1]	16,471	15,505

Source: Environment Canada 2010b

Notes:

1. Values were estimated by applying the Growth and Linear Trend functions in Microsoft Excel 2003 to estimated emissions data from 2005-2008 and taking the average (Environment Canada 2010b).

Table 6.9 Estimated methane emissions (tonnes) from Summit Road Landfill.

	Environment Canada
2008	5,071
2009	4,756[1]
2010	4,504[1]

Source: Environment Canada 2010b

Notes:

1. Values were estimated by applying the Growth and Linear Trend functions in Microsoft Excel 2003 to estimated emissions data from 2005-2008 and taking the average (Environment Canada 2010b).

Since methane emissions estimates from Brady Road Landfill and Summit Road Landfill already exist (Table 6.8 and Table 6.9), RETScreen was used to calculate the methane emissions from the remaining landfills in Manitoba (Table 6.10).

Table 6.10 Estimated methane emissions (tonnes) from landfills other than Brady Road and Summit Road landfills.

	RETScreen
2008	30,062
2009	31,627
2010	33,259

Table 6.11 describes the total estimated methane emissions from landfills in Manitoba. According to the IPCC, methane has a global warming potential of about 25 times that of carbon dioxide over a 100-year time horizon (Forster et al, 2007). Therefore, the estimated methane emissions in Manitoba in 2010 represent emissions of between 1,331,700 and 1,355,850 tonnes CO_2e. The average of the low and high estimate is 1,343,775 tonnes CO_2e.

Table 6.11 Total estimated methane emissions (tonnes) from landfills in Manitoba.

	Low estimate	High estimate	Average estimate
2008	48,452	49,422	48,937
2009	50,642	51,781	51,212
2010	53,268	54,234	53,751

6.4 Discussion/Conclusion

The analysis provided in this Chapter points to some interesting conclusions concerning waste management on land in Manitoba. First, although estimates of the greenhouse gas emissions due to waste management on land have been made by the Government of Manitoba (MSTEM 2008) and the Government of Canada (Environment Canada 2010a), this analysis demonstrates that those estimates may be too low. It was estimated by Manitoba Science, Technology, Energy and Mines (2008) that Manitoba greenhouse gas emissions due to the waste management sector were about 1,000,000 tonnes CO_2e in 2005. Environment Canada (2010a) estimated that, in 2008, Manitoba greenhouse gas emissions due to the waste management sector were about 860,000 tonnes CO_2e. In the period 2005-2008, Manitoba's total greenhouse gas emissions increased, on average, about 1.41% per year (Environment Canada 2010a). In Table 6.12, this rate of emissions growth is applied to both the Government of Manitoba and Government of Canada emissions estimates for the waste management sector in Manitoba

to acquire 2010 estimates. Both estimates presented in Table 6.12 are much lower than the average estimate produced by this analysis (1,343,775 tonnes CO_2e): in fact, the Government of Canada result is about 66% and the Government of Manitoba is about 80% of the average estimate produced by this analysis. Given that this analysis predicted the emissions of Brady Road Landfill within 1% of the actual emissions published by Environment Canada (2010b), the actual greenhouse gas emissions from Manitoba's waste management sector may be closer to the estimate in this analysis than either estimates provided by the Government of Manitoba or the Government of Canada. It should also be noted that greenhouse gas emissions from the waste management sector arise from three distinct processes: solid waste disposal on land, wastewater handling, and waste incineration (Environment Canada 2010a). This analysis only considered solid waste disposal on land, while the estimate by the provincial and federal governments also included wastewater handling (there is no incineration in Manitoba). If this analysis included activities related to wastewater handling, the estimate would be greater, although not by much: Environment Canada (2010a) estimated that about 34,000 tonnes of CO_2e were due to wastewater handling in Manitoba in 2008.

Table 6.12 Total estimated greenhouse gas emissions in Manitoba (tonnes).

	Published Estimate (tonnes CO_2e)	**Estimate for 2010 (tonnes CO_2e)**
Government of Manitoba	1,000,000	1,072,516
Government of Canada	860,000	884,000

Source: Environment Canada 2010a, MSTEM 2008

Second, Manitoba's waste management sector may be contributing more per capita toward Canada's total greenhouse gas emissions than other provinces. In Canada in 2008, about 20.000 Mt of CO_2e were released due to waste management on land, which is equivalent to about 600 kg per person (Environment Canada 2010a, Statistics Canada

2009). Assuming that Canada's CO_2e emissions from waste management on land are growing at a rate similar to Canada's population, and assuming that Canada's population will grow 1.2% per year from 2008 to 2010 (Canada's population in 2010 estimated from Statistics Canada 2009), in 2010, Canada will have per capita CO_2e emissions from waste management on land of 610 kg. The average estimate of greenhouse gas emissions due to Manitoba's waste management on land in Manitoba in 2010 was 1,343,775 tonnes CO_2e. Therefore, in 2010, it is estimated that Manitoba will have a per capita greenhouse gas emission due to waste management on land of about 1,088 kg CO_2e (Statistics Canada 2009), which is about 78% greater than the Canadian average. In addition, the 2010 estimate produced from the Government of Manitoba's estimate for 2005 (Table 6.12) would result in a per capita greenhouse gas emission of about 868 kg CO_2e (Statistics Canada 2009). This is about 42% greater than the Canadian average. These results appear to suggest that Manitobans are contributing more, per capita, to Canada's greenhouse gas emissions due to the waste management sector than the average Canadian.

It must be noted, however, that Environment Canada (2009) assumes a 100-year global-warming potential for methane of 21. In this analysis, methane was assumed to have a global warming potential of 25 over a 100-year time horizon, in congruence with the Intergovernmental Panel on Climate Change (IPCC 2007). Therefore, the carbon dioxide equivalent released by waste management on land in Canada might be higher than predicted by Environment Canada (2009): in fact, emissions may have been as high as 23.810 Mt CO_2e[5] in 2008. In this scenario, on average, Canadians would generate 744 kg CO_2e per capita in 2010.

[5] 23.810 Mt CO_2e = 20 Mt CO_2e * 25 / 21.

This analysis shows that a large portion of Manitoba's waste stream is organic waste that is compostable. However, the paper and textiles and, perhaps, the wood and straw waste portions of the waste stream would probably not be composted. About 32.7% of Manitoba's waste stream, then, is compostable: including food, yard, and garden waste. Currently, most organic diversion programs in Manitoba are voluntary (i.e., drop-off at compost piles), with only one community in Manitoba providing the weekly curb-side pickup of food waste (see Chapter 4). Voluntary diversion programs that are not curb-side pickup generally do not achieve a very high level of waste diversion (Nicol and Thompson 2007). To divert a significant amount of organic waste, the curb-side pickup of organic waste is required in larger urban centres in Manitoba, like Winnipeg.

With compostable organic waste making up a large portion of Manitoba's waste stream and contributing toward a disproportionately large portion of Canada's total methane emissions from waste management, it is important for Manitoba to begin diverting organic waste away from landfills. If food, yard, and garden waste produce the same quantity of methane per tonne as paper, textiles, and wood, significant reductions in greenhouse gases could be realized by focusing on the diversion of this portion of the waste stream. Potentially, Manitoba could reduce its total greenhouse emissions by greater than 500,000 tonnes of CO_2e (about 2.3%) by composting the food, yard, and garden waste portion of the waste stream. In addition, by implementing organic waste diversion programs, Manitoba could significantly increase its diversion rate from landfill, which is one of the lowest in the country (Statistics Canada 2008b).

REFERENCES

Ackerman, F. 2000. Waste Management and Climate Change. Local Environment 5(2): 223-229.

Air Liquide. 2009. Gas Encyclopaedia. Retrieved May 21, 2010 from <http://encyclopedia.airliquide.com/encyclopedia.asp>.

City of Winnipeg. 2010. Residential recycling report. Retrieved July 1, 2010 from <http://www.winnipeg.ca/waterandwaste/recycle/recyclingReport.stm>.

City of Yellowknife. 2007. City of Yellowknife waste composition study & waste reduction recommendations. Retrieved July 1, 2010 from <http://www.yellowknife.ca/AssetFactory.aspx?did=6158>

Environment Canada. 2010a. National Inventory Report 1990-2008: Greenhouse Gas Sources and Sinks in Canada. *Government of Canada*. Retrieved July 2, 2010 from <http://www.ec.gc.ca/Publications/default.asp?lang=En&xml=492D914C-2EAB-47AB-A045-C62B2CDACC29>.

Environment Canada. 2010b. Search data. *Government of Canada*. Retrieved June 30, 2010 from <http://www.ec.gc.ca/pdb/ghg/onlinedata/dataSearch_e.cfm>.

Environment Canada Weather Office Environment Canada. 2006. Canadian climate normals or averages 1971-2000. Retrieved July, 2007. <http://www.climate.weatheroffice.ec.gc.ca/climate_normals/index_e.html>.

Forster, P., V. Ramaswamy, P. Artaxo, T. Berntsen, R. Betts, D. W. Fahey, J. Haywood, J. Lean, D. C. Lowe, G. Myhre, J. Nganga, R. Prinn, G. Raga, M. Schulz, and R. Van Dorland. 2007. Changes in Atmospheric Constituents and in Radiative

Forcing. *In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor and H. L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Green Manitoba. N.d. History of waste minimization in Manitoba. *Government of Manitoba*. Retrieved June 23, 2010 from <http://www.greenmanitoba.ca/cim/dbf/history.pdf?im_id=150&si_id=1001>.

Manitoba Science, Technology, Energy and Mines. 2008. Beyond Kyoto: Manitoba's green future. *Government of Manitoba*.

Manitoba Product Stewardship Corporation [MPSC]. 2009. 2008/2009 annual report: Fourteen years of recycling success, performance and results.

Nicol, S., and S. Thompson. 2007. Policy options to reduce consumer waste to zero: Comparing product stewardship and extended producer responsibility for refrigerator waste. *Waste Management and Research* 25(3): 227-233.

Office of the CFO. 2010. Population of Winnipeg. *City of Winnipeg*. Retrieved July 1, 2010 from <http://www.winnipeg.ca/cao/pdfs/population.pdf>.

Pennsylvania Department of Environmental Protection. 2003. Statewide waste composition study. *State of Pennsylvania*. Retrieved July 1, 2010 from <http://www.dep.state.pa.us/dep/deputate/airwaste/wm/recycle/waste_comp/study.htm>.

Statistics Canada. 2010. Waste disposal, by source, by province. *Government of Canada*. Retrieved June 23, 2010 from <http://www40.statcan.ca/l01/cst01/envir25b-eng.htm>.

Statistics Canada. 2009. Population by year, by province and territory. *Government of Canada*. Retrieved July 4, 2010 from <http://www40.statcan.gc.ca/l01/cst01/demo02a-eng.htm>.

Statistics Canada. 2008a. Disposal and diversion of waste, by province and territory, 2004 and 2006 (Diverted materials per capita). *Government of Canada*. Retrieved May 4, 2010 from <http://www40.statcan.ca/l01/cst01/envir32d-eng.htm>.

Statistics Canada. 2008b. Disposal and diversion of waste, by province and territory, 2004 and 2006 (Total waste disposed). *Government of Canada*. Retrieved July 1, 2010 from <http://www40.statcan.ca/l01/cst01/envir32a-eng.htm>.

Statistics Canada. 2008c. Disposal and diversion of waste, by province and territory, 2004 and 2006 (Waste disposed per capita). *Government of Canada*. Retrieved May 4, 2010 from <http://www40.statcan.ca/l01/cst01/envir32b-eng.htm>.

Statistics Canada. 2008d. EnviroStats. *Government of Canada*. Retrieved June 21, 2010 from <http://www.statcan.gc.ca/pub/16-002-x/16-002-x2008001-eng.pdf>.

Statistics Canada. 2008e. Population and dwelling counts, for Canada, provinces and territories, 2006 and 2001 censuses - 100% data. *Government of Canada*. Retrieved June 21, 2010 from <http://www12.statcan.ca/english/census06/data/popdwell/Table.cfm?T=101>.

Statistics Canada. 2008f. Waste management industry survey: Business and government sectors. *Government of Canada*. Catalogue no. 16F0023X. Retrieved Mar 12, 2010 from <http://www.statcan.gc.ca/pub/16f0023x/16f0023x2006001-eng.pdf>.

Tanapat, S. 2004. A feasibility study of municipal waste-to-energy management: Measurement of landfill gas quality at Brady Road Landfill in Canada. Unpublished Master's thesis, University of Manitoba, Winnipeg, Canada.

Technology Resource Inc. 2008. Solid waste composition study. *Prepared for* Metro Vancouver. Retrieved November 29, 2010 from <http://www.metrovancouver.org/about/publications/Publications/SolidWasteCompositionStudyFinal-2007.pdf>.

Technology Resource Inc. 2010. Metro Vancouver - Solid waste composition study 2009. *Prepared for* Metro Vancouver. Retrieved November 29, 2010 from <http://www.metrovancouver.org/about/publications/Publications/2009_Waste_Composition_Report.pdf>.

Thompson, S., J. Sawyer, and J. E. Valdivia. 2009. Building a better methane generation model: Validating models with methane recovery rates from 35 Canadian landfills. *Waste Management* 29(7): 2085-2091.

Travel Manitoba. 2010. Manitoba Population. Retrieved June 23, 2010 from <http://www.travelmanitoba.com/PlanYourVisit/QuickFacts/ManitobaPopulation/>.

CHAPTER 7: CONCLUSION

With Manitoba having one of the lowest waste diversion rates out of all the provinces in Canada, a strategy to increase diversion is needed. Since Manitoba has a low organic waste diversion rate, yet a large portion of its total waste stream is organic waste, targeting organic waste for diversion would likely be a successful way of increasing Manitoba's overall diversion rate. Furthermore, the analysis in Chapter 6 indicated that Manitobans contribute more per capita than the Canadian average toward greenhouse gas emissions due to waste management on land. This finding stands as an excellent justification for implementing organic waste management options, since it is the decomposition of organic waste that is the cause of those greenhouse gas emissions. In addition, connecting waste management with greenhouse gas emissions and climate change may increase public awareness of the issue of waste management and, thereby, increase public support for waste diversion initiatives.

The findings from the survey and meeting participants (Chapter 4) also support increasing the organic waste management options available in Manitoba. However, participants viewed organic waste management as being situated within the context of waste management, in general. Participants stated that an organic waste management strategy is required in the context of an integrated waste management strategy. An integrated waste management strategy would focus scattered energies in the waste management sector and provide direction to policy-makers at all levels of government. Looking to other jurisdiction, like those examined in Chapter 5, to provide examples of

how to implement an integrated waste management strategy would also be useful for policy-makers.

7.1 Creating an Integrated Waste Management Strategy in Manitoba

Chapter 5 described the successful waste management systems of three jurisdictions: Nova Scotia, Canada; New South Wales, Australia; and Denmark. The successful strategies implemented by these jurisdictions provide important lessons concerning how to create a successful waste management system. Nova Scotia, being another province in Canada, is probably the most relatable to Manitoba.

Chapter 4 presented the perspectives of Manitobans working in, or connected with, the waste management sector (i.e., experts in the field of waste management). In general, these perspectives described the policies and programs that could be put in place to improve the waste management system that currently exists in Manitoba. In fact, the participants were largely aware of many of the policies and programs that have been implemented by the other jurisdiction described in Chapter 5 and understood, in a broad sense, how these policies and programs would work in Manitoba. This is an important finding, since a strong barrier to implementing new waste management options is a lack of knowledge, particularly a lack of knowledge in those who are supposed to implement those options. As a result, the participants recommended implementing an integrated waste management strategy in much the same way as was done in Nova Scotia in the mid-1990s. The following outlines the steps participants stated the Government of Manitoba should take to implement such a strategy.

The participants stressed the importance of leadership from the Government of Manitoba in developing an integrated waste management strategy. This leadership would extend from determining how economies of scale can be realized through regional cooperation to providing technical support to municipalities or regions wishing to implement waste management options. The participants also stated the Government of Manitoba should request the advice and involvement of stakeholders throughout Manitoba in creating an integrated strategy. The Government of Manitoba, according to the participants, also has the responsibility of educating the public concerning the importance of waste, including connecting waste management to climate change and greenhouse gas emissions.

In terms of other specific strategies the participants stated the Government of Manitoba should implement, participant opinions were somewhat varied, which most likely reinforces the importance of an integrated approach to waste management. Those options stated by participants include backyard composting, large-scale centralized composting, pay-as-you-throw or unit pricing, eliminating Class 2 and Class 3 landfills, increasing tipping fees, and banning organic waste from landfills. Participants also stated that the curb-side pickup of organic waste, including food waste, in large urban centres was necessary for achieving a high level of organic waste diversion. Finally, participants agreed that policies and programs should be implemented in a scheduled manner over time to give citizens and businesses time to adapt to the changes.

The participants have suggested a way forward for Manitoba that is very similar to the approach actually taken in Nova Scotia. Considering the success of Nova Scotia's

waste management strategy, Manitobans certainly have the knowledge to create a successful waste management strategy.

7.2 Barriers and Opportunities in Manitoba

This section provides a list of barriers to positive change within the waste management sector and opportunities that exist to overcome these barriers. Table 7.1 is not meant to provide an exhaustive list of barriers and opportunities, but is meant to address many of the issues that arose in the preceding chapters.

Table 7.1 Barriers and opportunities to change within Manitoba's waste management sector.

No.	Barrier	Opportunity
1	Government of Canada lacks an integrated waste management strategy, which is unlike Australia and Denmark.	Nova Scotia has demonstrated that implementing a successful integrated waste management strategy in Canada is possible. The Canadian Council of Ministers of the Environment (CCME) also provides a forum for discussion among provinces concerning how to implement an integrated strategy.
2	Government of Manitoba lacks an integrated solid waste management strategy, unlike Nova Scotia, New South Wales, and Denmark.	Support for the development of an integrated waste management strategy exists, as demonstrated in Chapter 4. Nova Scotia presents an excellent example of how a strategy of this sort should be implemented. An integrated strategy is likely necessary if Manitoba is to realize significant waste diversion.
3	Lack of political will to implement an integrated waste management strategy or a more sophisticated organic waste management system.	The Government of Manitoba has legislated the target of meeting the Kyoto goal of 6% below 1990 levels by 2012. Ten percent of the difference between 2008 emissions and the Kyoto goal could be reduced through composting food, yard, and garden waste in Manitoba.
4	Manitoba lacks a formal system of regional cooperation.	Many municipalities in Manitoba collaborate to the extent that they share landfills. However, Chapter 2 identified waste management collaboration as difficult in Manitoba. The Government of Manitoba can build on regional cooperation by encouraging this cooperation and providing technical assistance to achieve greater economies of scale. The Government of Manitoba could also commission studies to determine the most cost-effective regional boundaries for cooperation.
5	Manitoba is a large province in terms of land area and has a low population density.	About 90% of Manitobans live within 200 km of the border, which is an area about 15% of the total land area in Manitoba. Also, about 60% of Manitobans live in Winnipeg's Capital Region. An integrated strategy could begin by focusing on waste management improvements in Winnipeg's Capital Region, since options in this area would make the most economic sense (due to the high population density).

6	Northern and remote communities cannot support programs that more densely populated communities can support.	By establishing waste regions, local characteristics come into play when determining how best to achieve waste diversion targets in those area. An integrated waste management strategy should allow northern and remote communities to implement unique waste management options, while having the technical support of the Government of Manitoba.
7	The public perception that Manitoba is so large that waste management options are unnecessary; lack of public support for waste management options.	By connecting waste management with climate change, public perception of waste may change over time. Chapter 6 demonstrated the extent to which waste management in Manitoba affects Manitoba's greenhouse gas emissions. In addition, Manitobans have been diverting recyclable waste for about 15 years, which suggests an acceptance of waste diversion activities.
8	The methane being release from landfills is from the decomposition of historic waste; organic waste diversion options will not stop these emissions.	The Brandon landfill will soon be flaring methane emitted from the landfill. This may prompt Winnipeg's Brady Road Landfill to flare its methane or, if feasible, collect the methane to be used to offset the use of natural gas. Brady Road Landfill is a huge point source of greenhouse gas emissions in Manitoba: this is motivation for the Government of Manitoba to implement landfill gas capture.
9	The huge number of landfills in Manitoba is a problem for achieving economies of scale, encouraging waste diversion, and environmental monitoring.	In reality, although more than 200 landfills are operational in Manitoba, the vast majority of waste produced by Manitobans ends up in one of the province's twelve Class 1 landfills (e.g., about 60% of Manitoba's waste goes to Winnipeg's Brady Road Landfill). In addition, in 2007, the Manitoba Auditor General provided recommendation on landfill permitting and operations concerning how to ensure environmental protection.
10	Most Manitobans have not source separated food waste before; voluntary drop-off programs have not proven to be successful.	Chapter 4 demonstrated that organic waste management options exist throughout Manitoba. These options should be built upon to educate Manitobans concerning the significance of organic waste. In addition, most Manitobans are already familiar with the Blue Box system for recyclables; therefore, getting people to separate organic waste into a "Green Box" may not be overly difficult.
11	The cost of operating a centralized composting facility is high: $30-$77 per tonne. In addition, the cost of picking up organic waste (three-steam system) was $6 more than a two-stream system (in 2002).	The levy system in Nova Scotia that funds waste management activities in the province is about 2.5 times greater than Manitoba's levy. Therefore, Manitoba would be justified in creating additional levies that could finance organic waste management options. In addition, the WRARS landfill levy could increase over time (currently at $10 per tonne) to pay for organic waste management options.
12	The usefulness of compost is not realized without standards for its production.	The CCME has a guide for the production of compost that the Government of Manitoba could use as a guideline for a compost quality regulation.
13	Residential waste accounts for only about 40% of the total waste stream in Manitoba.	Blue bin recycling for residents has existed for about 15 years. The success of this program suggests that the commercial, industrial, and institutional and construction and demolition sectors may be amenable to complying with waste diversion initiatives.
14	The commercial, industrial, and institutional and construction and demolition sectors may provide resistance to source separating its waste.	The implementation of scheduled landfill bans (and fines for non-compliance) after a certain amount of time has passed since the program was implemented, would give this sector time to adapt.

15	The City of Winnipeg recently decided that its organic waste management strategy will be to use an automated cart collection system to collect bagged yard waste in the North-West part of the city during the peak spring and fall period.	This is a step in the right direction. Extra funding (from increasing the levy on beverage containers or the landfill levy) from the Government of Manitoba or regulations, including a landfill ban on organics, might convince Winnipeg's City Council to implement a more sophisticated strategy, which could include the curb-side pickup of food waste for the entire city.

7.3 Recommendations for waste management in Manitoba

The findings of this study suggest steps to take with respect to the waste management sector. What follows are specific recommendations concerning how Manitoba's waste management sector should be amended; the justification for these recommendations will be presented and are based on the findings of this study.

Table 7.2 Recommendations for waste management in Manitoba.

No.	Recommendation	Justification
1	Implement landfill gas capture at the Brady Road Landfill and other large landfills.	In 2008, the Brady Road Landfill was the third largest point source of GHG emissions in the province of Manitoba. Landfill gas, which is about 50% methane, can be captured and sold to displace the use of natural gas.
2	Develop waste management options in Winnipeg's Census Metropolitan Area (CMA), Brandon, and other large urban centres.	In 2009, nearly 61% of Manitoba's population resided in the CMA, which is the most densely populated area of the province. Implementing new waste management options in the CMA "picks the low-hanging fruit": new options would be most cost-effective in this area, but also reach a significant portion of Manitoba's population and act as a first step to implementing options in other areas of the province. Other large urban centres, like Brandon, would also benefit from the development of waste management options.
3	Create a publicly accessible waste management strategy.	The general public and businesses need to be aware of the implementation of new waste management options that will require them to change their behaviour. A publicly accessible strategy will indicate the schedule for the implementation of such options and offer advice to the public and businesses concerning how to adapt to these changes.
4	Public education, communication, and consultations are required.	On-going public education, communication, and consultations are required to keep the public informed concerning changes to the waste management system. The public should be made aware of a timeline for the implementation of new waste management options and strategies.

5	A portion of the WRARS landfill levy should be used to pay for new waste management options. In addition, scheduled increases to the levy should occur over time to encourage waste diversion and pay for new waste management options.	Manitoba's low landfill tipping fees can act as a barrier to implementing new waste management options, especially for large-scale, centralized composting, which can have tipping fees nearly twice as high as the tipping fee at the Brady Road Landfill and higher than many other landfills in Manitoba. Implementing scheduled increases in the landfill levy would allow residents and businesses to adapt to these new fees and provide the funds necessary to implement more expensive organic waste management options.
6	Create regulation for compost quality control.	The product produced by composting organic waste is called "compost". Compost can be sold as a soil conditioner and, to some extent, replace the use of synthetic fertilizers and pesticides. To increase consumer confidence in the quality of this product, a regulation concerning the production process and final product should be implemented.
7	Construct large-scale, centralized composting facilities.	Easily compostable organic waste (food, yard, and garden waste) constitutes about 35% of the total waste stream in Manitoba. To increase Manitoba's waste diversion rate, organic waste should be targeted for diversion. A large-scale composting facility would be necessary to manage organic waste from the CMA and other large urban centres.
8	Implement the curb-side pickup of food, yard, and garden waste from the residential sector in the CMA, Brandon, and other large urban centres.	The residential sector in the CMA and Brandon have been source-separating their waste for about 15 years (Blue Box program); therefore, the residential sector would be the most amenable to the source-separation of organic waste.
9	Implement the curb-side pickup of food, yard, and garden waste from the commercial sector in the CMA, Brandon, and other large urban centres.	The commercial sector will not be as familiar with source-separation as the residential sector; therefore, more time should be given to this sector to adapt to this change.
10	Implement landfill ban on organic waste in the CMA and other urban centres, with fees for non-compliance.	To achieve high levels of organic waste diversion, a ban on organic waste from landfills is likely required. This ban, however, should be implemented in a manner that allows residents and businesses time to adapt to this change.

7.4 Final Thoughts

The findings of Chapter 4 and Chapter 5 suggest that the management of organic waste can really only be effectively addressed within the context of the entire waste management sector. In order to effectively manage the waste management sector, an integrated waste management strategy is required to focus scattered energies and direct all activities toward a common goal. On this point, the action of the Government of Manitoba is essential: only the Government of Manitoba can ensure mutually beneficial

cooperation among communities and create a fair and equal playing field for all actors in the sector. This study has attempted to determine the barriers and opportunities to implementing various policies and options concerning waste management in Manitoba and to show that organic waste management options can benefit the province. As it stands, Manitoba is in an excellent position to amend its waste management sector to increase its overall diversion rate and decrease greenhouse gas emissions.

APPENDIX A: MANITOBA WASTE MANAGEMENT SURVEY

Dear Participant,

Thank you for agreeing to be a part of my study. All of your responses will be kept confidential and anonymous and you can choose to withdraw from this study at any time.

This study, concerning organic waste management practices and greenhouse gas emissions, is being conducted with support from the Waste Reduction and Pollution Prevention (WRAPP) Fund. The purpose of this survey is to determine how organic waste management policies and practices can be improved in Manitoba.

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Please either e-mail your responses to me, Jeff Valdivia, at jevaldi@yahoo.ca or fax your responses to Dr. Shirley Thompson at (204) 261-0038.

ALL RESPONSES WILL BE KEPT CONFIDENTIAL. YOU CAN CHOOSE TO WITHDRAW FROM THIS STUDY AT ANY TIME.

Please answer the following questions to the best of your knowledge. If for whatever reason you do not answer a question (it may simply not be applicable to you), please indicate that you intentionally skipped the question or provide a reason for not answering.

1. In your opinion, how important is organic waste (food/kitchen waste, yard waste, wood, etc) management in the overall waste management sector?

1	2	3	4	5	6	7
Not important			Neutral			Very Important

2. Do you think Manitoba could better manage its organic waste? _____

3. Do you think your municipality of residence could better manage its organic waste? _____

4. Are you satisfied with the scope of discussion with regard to organic waste management at meetings, conferences, etc? _____
   a. Explain.

_____
_____
_____

5. Do you think that the implementation of wide-spread organic management policies and/or practices could benefit Manitoba (i.e., landfill ban on organic waste, increased tipping fees, backyard composting programs, centralized composting facilities, curb-side pick-up of organic waste, digesters, landfill gas capture, incineration, etc)?

_____

   a. Why?

_____
_____
_____

   b. Of all the policies and/or practices of which you are aware, which do you think would be best suited to Manitoba?

_____
_____
_____

   c. Why?

_____
_____
_____

   d. Do you think Manitoba should implement it…
      No matter what? _____
      Only if it is cost effective? _____
      Never? _____
      i. Why?

_____
_____
_____

      ii. What do you perceive as the barrier(s) to implementing this policy and/or practice?

_____
_____
_____

      iii. How do you think the barrier(s) could be overcome?

_____
_____
_____

6. In your municipality of residence…
   a. What organic waste management policies and/or practices currently exist?

_____
_____
_____

   b. Why were these options chosen as opposed to others?

c. Are you satisfied with the general level of involvement in the decision-making process with regard to choosing these options?

d. What did you perceive as the barriers to implementing these organic waste management options?

e. How were these barriers overcome?

f. If possible, please estimate the amount of greenhouse gases mitigated by each option.

7. Do you think that new organic waste management policies and/or practices will be implemented in your municipality in the near future? _____
   a. If so, which one(s)?

   b. What do you perceive to be the biggest hurdles preventing the implementation of new organic waste management policies and/or practices in your municipality?

   How do you think the hurdle(s) could be overcome?

   Are there any groups, initiatives, or people advocating for new organic waste management policies and/or practices in your municipality? Briefly explain.

8. Do you think that it is in the best interest of Manitoba, in general, to invest in finding a better solution to the management of organic waste than dumping it in landfills?

_____

a. Why?

_____
_____
_____

b. What percentage of your peers do you believe agree with your opinion?

_____
_____
_____

9. How would you describe the concept of "sustainability" or "sustainable development?"

_____
_____
_____

10. How important is it so you for waste management policies and/or practices to be sustainable?

1	2	3	4	5	6	7
Not important			Neutral			Very Important

11. Are you concerned with the predicted effects of global climate change due to greenhouse gas emissions? _____

12. What are the responsibilities in your current work position that relate to municipal solid waste (including all non-hazardous waste) management policies and/or practices?

_____
_____
_____

13. Could you recommend the name of one or two people who you know have expertise in this area and provide their contact information?

_____
_____
_____

14. Please provide the contact information for the landfill your municipal solid waste is sent to.

Landfill Name: _____
Landfill Operator: _____
Location of Landfill: _____
Landfill Contact Name: _____

Contact Phone Number: _____
Contact Email: _____

Please provide your own contact information:

Name: _____
Phone number or email (whichever is better for you):
_____

If necessary, may I contact you in the future regarding your responses? (YES / NO)

Thank you very much for your assistance.
This study has been approved by the Joint-Faculty Research Ethics Board of the University of Manitoba.

APPENDIX B: MANITOBA EXPERT STAKEHOLDER MEETING MINUTES

Summary Report of the Expert Stakeholder Workshop Concerning

Organic Waste Management in Manitoba

Presenter: Jeff Valdivia

Moderator: Dr. Shirley Thompson

Date: June 14, 2010

Time: 2:00pm

Number of expert stakeholders in attendance: 8

Highlights of Discussions

The participants explained that the most significant challenge facing the waste management sector in Manitoba is the public perception that waste should cost nothing: that is, that waste management is a service rather than a utility. Therefore, more public education and consultation is needed to help citizens understand the cost and environmental impact of waste. In fact, the participants agreed that waste management is more of a social issue than a technical issue because change in waste management seems to only ever occur when there is a change in public perception toward waste.

The participants agreed that waste diversion could improve in Manitoba.

It was noted, that about 12 years ago, there was a working group on waste management in Manitoba. This working group included good consultation with communities, including taking local circumstances into consideration. This kind of cooperation between all levels of government and all regions of Manitoba was praised by participants. They would like to see this occur again with a focus on waste diversion and regional landfills, with the closure of most Class 2 and Class 3 landfills.

Participants also agreed that although many communities have already implemented voluntary organic waste drop-off site programs, these compost piles will always have contamination issues because they are unsupervised. The participants therefore concluded that curb-side pickup is a better option. With the implementation of the WRARS landfill levy, communities will have more of a vested interest in organic waste management. With the levy, only waste that is sent to landfills is taxed the extra $10 per tonne; therefore, all waste that is recycled or composted is not taxed. Furthermore, the greater a community's diversion rate (i.e., the more waste that is recycled or composted) the more money it receives through the Manitoba Product Stewardship Corporation, a private, non-profit organization that is funded by the province-wide beverage container levy. Before the implementation of the levy, only recycled materials were counted toward a communities diversion score. Therefore, communities now have a financial incentive to monitor their organic waste diversion, which will result in more organic waste diversion and may result in less compost pile contamination.

Participants discussed that landfill gas capture is starting in Manitoba, with a project in the City of Brandon coming into operation in December 2010. Presently, the City of Brandon is intending to burn the landfill gas to reduce the methane to carbon dioxide. In the future, however, it is planning to harness the energy from the landfill gas in order to provide a nearby food processing plant with heat. Interestingly, participants pointed out that, as a deal with the City of Brandon for providing funding for the infrastructure of the landfill gas capture project, the greenhouse gas credits are going to the province rather than the City of Brandon. As participants pointed out, this was an

interesting choice for the province, since instead of selling the credits on the market, the province decided to retire the credits – a good option from an environmental standpoint, but a loss in potential revenue for the province. Winnipeg is currently considering options to harness landfill gas.

According to the participants, only Class 1 landfills should be required by Provincial legislation to capture their landfill gas. This is because Class 1 landfills are the largest landfills in Manitoba and are likely the only landfills where it makes economic sense to implement landfill gas capture. However, out of the approximately 245 landfills (consisting of Class 1, Class 2, and Class 3) in Manitoba, only 12 are designated as Class 1. Because of the large number of existing landfills, the participants believed that a reduction in the number of landfills had to occur before landfill gas capture is considered: in fact, the closure of all Class 2 and Class 3 landfill was suggested, since these landfills are, for the most part, poorly monitored with little or no environmental safe-guards. However, a significant challenge to reducing the number of landfills is that, in general, residents want to keep their local landfills because of the low cost of waste disposal (again, due to the idea that waste management is a service rather than a utility) and, according to some participants, it is a matter of local pride. The participants thought these residents would be against paying the large sum of money that would be required to close their local landfill that had existed for many years in order to either send their waste elsewhere or build a new, state-of-the-art landfill.

Another issue relating to landfills was that there are approximately three landfills in Manitoba that are not publicly owned. A participant brought up the point that if the City of Winnipeg were to increase its tipping fees or ban a substance to increase waste

diversion, the privately owned landfills would simply begin receiving more waste due to it either having lower tipping fees or accepting the banned substance. Therefore, the participants points out, only provincial regulations can bring about an equal playing field for all actors in the waste management sector.

In the City of Winnipeg, the cost of waste disposal and recycling per resident per year is about $70. This cost is funded through the tipping fees collected at Winnipeg's Brady Road Landfill. It was thought that organic waste curb-side pickup could be implemented in the City of Winnipeg with an increase in property taxes by 1% to 2%. Alternatively, a charge for waste management could appear on a regular utility bill, similar to a water bill, which would describe the cost of waste management per resident or household.

Next, participants next pointed out the need for a proper waste management plan with a waste tax that included scheduled increases. To this end, the participants praised the WRARS landfill levy, which comes into effect for all Manitobans next year. The participants thought the $10 per tonne levy would be an excellent financial incentive to encourage waste diversion. However, participants believed that the WRARS levy would be even more effective if, included in the legislation, were scheduled increases to the levy over time.

Another option for organic waste that participants supported was a landfill ban on organics. One participant explained that there would be a landfill ban for organics in Montreal coming into effect in 2015. The time delay between stating that a landfill ban will come into effect and actually implementing the ban will allow residents and businesses to adapt to the upcoming legislation and allow organic waste processing

facilities to meet the coming demand for their services. Participants largely believed this kind of strategy would be effective in Manitoba. One participant suggested a ban on landfilling cardboard would be an excellent place to start, as recycling systems are already in place and recovering more of this high-value commodity would help offset some costs of the recycling system.

One stakeholder from the City of Winnipeg noted that Calgary initiated a 50% increase in their waste tax a year ago, with a possible organics ban from landfills. On the other hand, Edmonton residents pay $292 per year for their waste management system, while residents of Winnipeg pay approximately $70 per year. He reiterated that in order to move forward with waste management options there has to be strong political will, a way for stakeholders to speak with one voice, and the establishment of a proper focus on waste.

Emerging Issues

- Public education and awareness campaigns are needed to change public perception of waste and waste management.
- Public consultations and planning at the provincial, regional, and community scale are needed to establish a provincial waste management strategy.
- Provincial regulations are needed to bring about an equal playing field for all actors in the waste management sector.
- WRARS landfill levy is a good start, but would benefit from having scheduled increases over time.

- Class 2 and Class 3 landfills should eventually close.
- Class 1 landfills should implement landfill gas capture. Brandon's Class 1 landfill will begin to reduce methane to carbon dioxide in December 2010. Landfill gas capture is also in the works for Brady Road Landfill in Winnipeg.
- Cost for waste management should appear to citizens in the form of a utility bill.
- A province-wide landfill ban on organics would be useful, if residents and businesses were given time to adapt to the legislation.

Implications for Moving Forward

On a national scale, the participants agreed that a holistic waste management strategy is needed, with working groups to help improve all provinces' waste management sectors. On a provincial scale, all participants agreed that provincial government leadership in waste management is necessary because only provincial legislation can bring about an equal playing field for all actors in the waste management sector. Therefore, participants called for the creation of provincial targets and goals for the waste management sector and a consistent, but flexible, provincial waste management strategy that will be useful in achieving those targets and goals.

According to the participants, a necessary part of any provincial waste management strategy would be the creation of province-wide and regional discussion groups, or think tanks, with provincial government representation to help set policy direction. At these discussions, there should be representation from all regions of Manitoba to discuss issues that are only seen at a local scale. Regional discussion groups that, ultimately, feed into a province-wide group would ensure that unique, local circumstances are taken into consideration when developing policy. Furthermore, a

strategy would need to recognize that time is needed for businesses and citizens to adapt to changes: that is, a waste management strategy should establish a time-line for the implementation of certain policies so that everyone has time to adapt to the new rules. The participants also mentioned life-cycle assessments as being necessary for determining which options would be best suited to Manitoba. The participants agreed that a successful strategy would require or encourage a regionalization of waste management options. The participants offered the following example of how a series of scheduled policy implementations over time might cause a regionalization of services to occur:

6) Create provincial guidelines for the construction and operation of landfills, which would include forcing Class 2 and Class 3 landfills to eventually close;
7) Ban the open burning of waste;
8) Employ scheduled increases in the WRARS landfill levy, with education on how the schedule would work;
9) Identify key waste items and create options for those items; and,
10) Ban key items from landfills;

With the implementation of these options, waste management would become too expensive for municipalities to work independently, thus encouraging the creation of regional partnerships. Hopefully, these regional partnerships would not be forged out of necessity, but through Government of Manitoba leadership and research.

As previously mentioned, participants believed that only a province-wide landfill levy or landfill ban would create an equal playing field for both the private and public landfills.

The participants also affirmed that public education on waste management must be continuous and on-going. For instance, with the WRARS landfill levy, the participants claimed that many communities are confused with where the money from the levy is going.

Interestingly, some participants were pushing for a user-pay system of waste management in the City of Winnipeg. In a user-pay system, residents would be charged for how much waste they produce, in the same way they are charged for other utilities, like water. A system that charged more for waste that is sent to landfill than for waste sent for recycling/composting would encourage diversion and provide residents with a greater awareness of the true cost of waste management. For example, in the City of Brandon, an additional waste cart must be paid for on an annual basis. One participant from the City of Brandon explained that karts with mechanized disposal by a garbage truck are more economical than bins or bags that must be manually thrown into the truck, since manual labour inevitably leads to injury. Meanwhile, participants thought that the curb-side pickup of organic waste is probably only economical in larger communities, but that smaller communities may be able to benefit from this kind of pickup in a regionalization scheme. Communities unable to participate in a curb-side pickup program for organic waste would benefit from a community-wide backyard composting initiative.

Conclusion

The stakeholder meeting brought to the table many important issues in the waste management sector in Manitoba. The stakeholders raised significant concerns in the existing waste management regime and presented reasonable and practical solutions to these concerns. In fact, stakeholders have created a rough sketch for what a provincial

strategy for waste management could look like. The stakeholders agreed to undertake a follow-up on the issues raised and to organize a meeting later this year. Clearly, the knowledge and desire to bring about positive change to the waste management sector in Manitoba exists.

APPENDIX C: RESIDENTIAL TIPPING FEES IN SELECT MANITOBAN COMMUNITIES

Municipality	Population	Approx. Residential Tipping Fee ($/tonne)
Winnipeg, City	633,451	43.5
Brandon, City	41,511	55
Thompson, City	13,446	10
Springfield, RM	12,990	0
Portage la Prairie, City	12,728	38
Hanover, RM	11,871	46.5
St. Andrews, RM	11,359	0
Steinbach, City	11,066	26
St. Clements, RM	9,706	0
Selkirk, City	9,515	80
Winkler, City	9,106	37
Tache, RM	9,083	0
East St. Paul, RM	8,733	44
Dauphin, City	7,906	121.95
Rockwood, RM	7,692	33
Portage la Prairie, RM	6,793	38
Morden, Town	6,571	37
Stanley, RM	6,367	37
Gimli, RM	5,797	33
Macdonald, RM	5,653	18.52
Flin Flon, City	5,594	0
The Pas, Town	5,589	0
Ritchot, RM	5,051	25
Ste. Anne, RM	4,509	46.5
Stonewall, Town	4,376	43.5
West St. Paul, RM	4,357	43.5
Rhineland, RM	4,125	34.1
Cornwallis, RM	4,058	55
Brokenhead, RM	3,940	43.5
Swan River, Town	3,859	0
Altona, Town	3,709	34.1
La Broquerie, RM	3,659	46.5
Woodlands, RM	3,562	0
De Salaberry, RM	3,349	20
Killarney - Turtle Mountain, Municipality	3,299	0
Neepawa, Town	3,298	62
Cartier, RM	3,162	0
Virden, Town	3,010	0
Alexander, RM	2,978	0
Bifrost, RM	2,972	0
Carman, Town	2,880	88
Beausejour, Town	2,823	43.5

Municipality	Population	Approx. Residential Tipping Fee ($/tonne)
Lac du Bonnet, RM	2,812	70
Swan River, RM	2,784	0
North Norfolk, RM	2,742	0
Headingley, RM	2,726	43.5
Morris, RM	2,662	11.55
Minnedosa, Town	2,474	0
Niverville, Town	2,464	11
Kelsey, RM	2,453	0
Dauphin, RM	2,326	146.34[6]
Dufferin, RM	2,199	88
Grey, RM	2,004	0
Lorne, RM	2,003	0
Fisher, RM	1,944	0
Armstrong, RM	1,919	0
Westbourne, RM	1,906	0
North Cypress, RM	1,902	0
Souris, Town	1,772	0
Franklin, RM	1,768	0
Piney, RM	1,755	0
Pembina, RM	1,712	0
Roblin, Town	1,672	0
Rosedale, RM	1,658	0
Morris, Town	1,643	11.55
Stuartburn, RM	1,629	0
Russell, Town	1,611	0
Ste. Anne, Town	1,534	46.5
Carberry, Town	1,502	0
Wallace, RM	1,501	
Boissevain, Town	1,497	0
Siglunes, RM	1,480	0
Whitemouth, RM	1,480	0
St. Laurent, RM	1,454	22
Pinawa, LGD	1,450	0
Alonsa, RM	1,446	0
Pipestone, RM	1,419	0
Grahamdale, RM	1,416	0
Reynolds, RM	1,410	0
Whitehead, RM	1,402	0
Rosser, RM	1,364	43.5
Coldwell, RM	1,339	11
Mountain, RM	1,336	0

[6] This value was calculated based on a conversion factor from volume to weight and extrapolated to a tonne; however, it is unlikely that residents of Dauphin pay this fee per tonne.

Municipality	Population	Approx. Residential Tipping Fee ($/tonne)
Montcalm, RM	1,317	0
Powerview - Pine Falls, Town	1,294	0
Elton, RM	1,285	0
Thompson, RM	1,259	0
Shell River, RM	1,219	0
Gillam, Town	1,209	0
Rivers, Town	1,193	0
South Norfolk, RM	1,170	0
Victoria, RM	1,149	0
Teulon, Town	1,124	16.5
Minitonas, RM	1,105	0
St. Francois Xavier, RM	1,087	0
Argyle, RM	1,073	0
Melita, Town	1,051	0
Oakland, RM	1,033	0
Arborg, Town	1,021	0
Winnipeg Beach, Town	1,017	0
Lac du Bonnet, Town	1,009	70
Park, RM	1,003	0
Roland, RM	1,002	0

Source: Survey of municipalities in Manitoba with population greater than 1,000, June 2010