An Evaluation of the Institutional Framework for the Organic Waste to Compost Process in Metro Vancouver

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Executive Summary

Within the regional district of Metro Vancouver, organic waste has been banned from disposal at landfills as of 2014 (Metro Vancouver, 2017). Organic waste produced by Metro Vancouver is source separated by residents and business owners, collected by haulers, processed by composting facilities and utilized by a variety of users. This system is defined as the institutional framework that supports the organic waste to compost process. Metro Vancouver relies on the efficient and sustainable operation of this framework as a regional waste management strategy for the organic waste stream of municipal solid waste.

It has been identified that throughout the framework, there are issues that are impacting efficiency and sustainability of the organic waste to compost process. The result is that compost produced from municipal organic waste has variable quality, affecting the utilization and perception of compost produced from municipal organic waste in the Metro Vancouver region. In addition, the inefficiencies result in the reduced capacity for organic waste processing in the region. This impacts the overall productivity of the regional organic waste to compost process.

To address the issues identified within the framework, strategies have been developed for the utilization of the following stakeholders: Metro Vancouver's Solid Waste Services, member municipalities, composting facilities, haulers and Metro Vancouver residents and businesses. The strategies recommended target specific issues occurring at each step in the institutional framework. The strategies aim to reduce contaminants from entering the system, to reduce costs for the private stakeholders of the system, and to improve educational resources for residents and businesses of Metro Vancouver.

By addressing institutional inefficiencies, the stakeholders can improve the regional organic waste to compost process in Metro Vancouver, resulting in a more efficient, productive and profitable system for all stakeholders.

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Acronyms, Abbreviations and Terminology

Acronyms/Abbreviations	Definition
DO	Drop-off, also referred to as self-haul
FW	Food waste
ICI	Industrial, commercial and institutional
MF	Multi-family residential
MOE	Ministry of Environment
MOW	Municipal organic waste
MSW	Municipal solid waste
MV	Metro Vancouver
SF	Single-family residential
SSO	Source separated organics
SWS	Solid Waste Services
YW	Yard waste

Terminology	Definition
Compost	A stabilized earthy matter having the properties and structure of humus, is beneficial to plant growth when used as a soil amendment, is produced by composting, and is only derived from organic matter.
Composting	The actively managed process of decomposition of organic matter.
Contaminant	Element, compound, substance, organism, or form of energy which through its presence or concentration causes adverse effect on the natural environment or impairs human use of the environment.
Food Waste	Municipal solid waste that comprised of food, including meat, fish, fat, dairy products, bread, baking products, fruits and vegetables, whether cooked or uncooked and packaged or unpackaged.
Foreign Matter	A contaminant that is not readily decomposed during the composting process, and includes plastic, glass, ceramic and metal.
Garbage	Materials that cannot be recycled or composted and are source separated and disposed of at a landfill, such as soft plastic.
Green bin	The large, green colored bin that remains outside one's home or place of business to collect food waste and/or yard waste.
Hauler	A waste disposal company that collects and transports municipal solid waste to a disposal facility with a vehicle.
Landfill	A waste disposal facility where waste that cannot be recycled or composted is diverted to and buried under the ground.
Load	Amount of waste contained in a hauler truck.
Mature	Designates a compost as not having phytotoxic effects when used as an organic soil conditioner.
Municipal Solid Waste	Solid, non-hazardous refuse originating from residential, industrial, commercial, institutional, and consumer drop-off/self-haul sources.
Municipal Organic Waste	The organic fraction of MSW consisting of food waste and yard waste.
Source separation	Separation of wastes into specific types of material at the point of generation.
Stable	Designates a compost as having a biological activity at a level that indicates the decomposition process is finished.
Tipping fee	The cost of disposal for organic waste at a composting facility or garbage at a landfill, typically charged per tonne with a minimum fee.
Trace element	Chemical element present in compost at a very low concentration, often used in reference to heavy metals.
Windrow	Elongated piles of triangular or trapezoidal cross-section that are turned in order to aerate and blend the material.
Yard Waste	Vegetative matter such as tree and shrub trimmings, plant remains, grass clippings, and chipped trees.

Introduction

Sustainable waste management is of increasing importance for regional governments, especially in urban areas where populations continue to grow. Strategies to support the recycling and reuse of resources are used by regional governments to address some of the challenges presented by waste management. Composting organic waste is a method that is used to reduce the impacts of organic waste on the environment as well as maximize the value of organic waste as a resource (Cooperband, 2000).

Metro Vancouver is an example of a regional government that is using policies to divert and process organic waste into compost. Metro Vancouver's Solid Waste Services is responsible for setting policies regarding municipal solid waste (MSW) such as facilitating the diversion of organic waste from landfills. It is the responsibility of Metro Vancouver's member municipalities to implement these policies through programs and services. In addition to setting policies, Metro Vancouver has developed a number of educational resources for municipalities, residents and businesses to utilize in order to improve organics diversion. A list of educational resources including those produced by Metro Vancouver are compiled in Appendix A.

The organic waste to compost process is supported by an institutional framework that has been developed over time in Metro Vancouver by both public and private stakeholders. The institutional framework can be defined as the processing and servicing steps that occur to source separate, collect, transport, process and utilize organic waste and the resultant compost. Figure 1 shows the organic waste to compost process and the alternative destination for organic waste if it were not source separated.

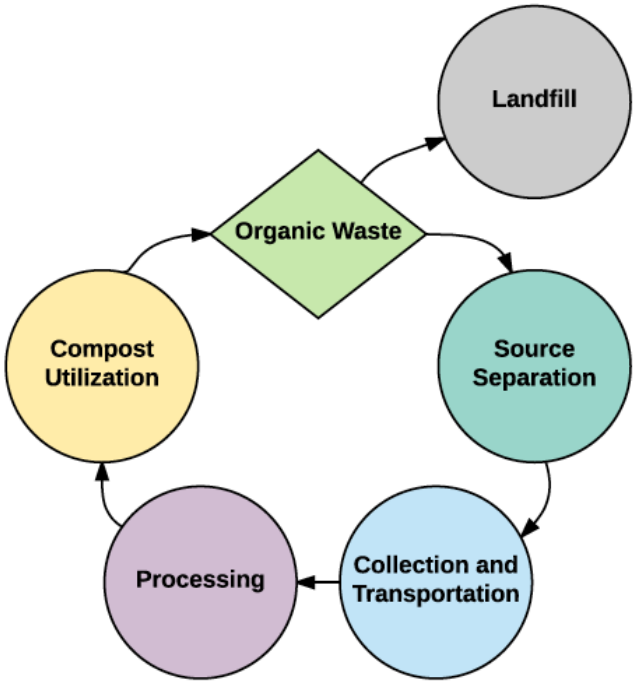


Figure 1: The institutional framework of services and processes that support the organic waste to compost process in Metro Vancouver.

Each phase of the institutional framework supporting the organic waste to compost process is facilitated by stakeholders. Figure 2 shows the framework in relationship to the stakeholders responsible for each step in the process.

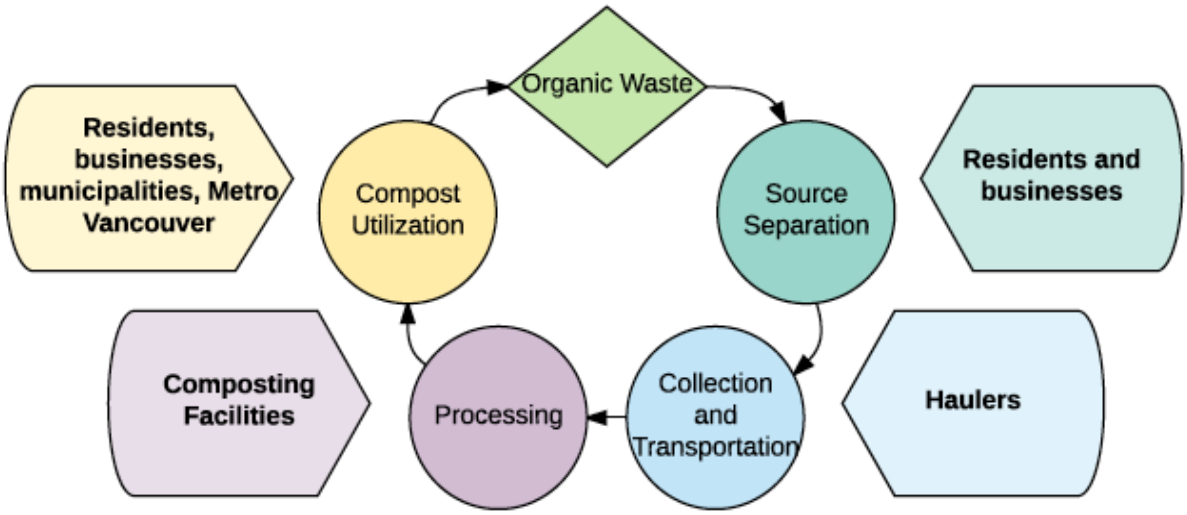


Figure 2: The stakeholders of the institutional framework supporting the organic waste to compost process.

The stakeholders of the institutional framework are the target audience of this evaluation; the results of the evaluation can be used to inform and improve their operations in order to reduce compost quality variability and improve its utilization within Metro Vancouver.

Within the institutional framework, there are points at each step where the process is occurring inefficiently. These inefficiencies are impacting the resultant compost quality, the volume of organic waste that can be processed regionally and the profitability for the private stakeholders involved. This impacts the sustainability of composting as a regional waste management strategy for public stakeholders, such as Metro Vancouver. By evaluating the framework, specific issues will be identified and strategies to address the issues will be recommended.

Objectives

The objectives of this study are to present and evaluate the institutional framework through which organic waste becomes compost and to identify factors that are contributing to inefficient processes; in addition, specific strategies are discussed to address factors that are affecting compost quality and the system's overall productivity. The recommendations made in this report are intended to be utilized by the stakeholders that are involved in the organic waste to compost framework.

Methods

This evaluation has been primarily informed through personal dialogue with stakeholders during May, June and July of 2017, including Metro Vancouver's Solid Waste Services employees, composting facility managers, municipal waste representatives and compost users in the region. Through personal communications and site visitations, the issues that are challenging stakeholders were identified and strategies to resolve these issues were discussed.

A literature review was conducted to assess the relevant processes and regulations regarding composting and organic waste management in British Columbia and Canada, as well as organic waste and compost characteristics. In addition, policies developed by Metro Vancouver's Solid Waste Services were reviewed to assess the current context under which organic waste is processed into compost in the region.

Organic Waste in Metro Vancouver

Organic Waste Diversion

In Metro Vancouver, organic waste has been diverted from landfills since the late 1980's and has been banned from landfills as of January 1st, 2014 (Metro Vancouver, 2017). Metro Vancouver's organics diversion policies have been successful in reducing the amount of waste entering landfills and has required the participation of municipalities as well as private stakeholders. Figure 3 shows the increase in organics diversion tonnage in Metro Vancouver since 2010.

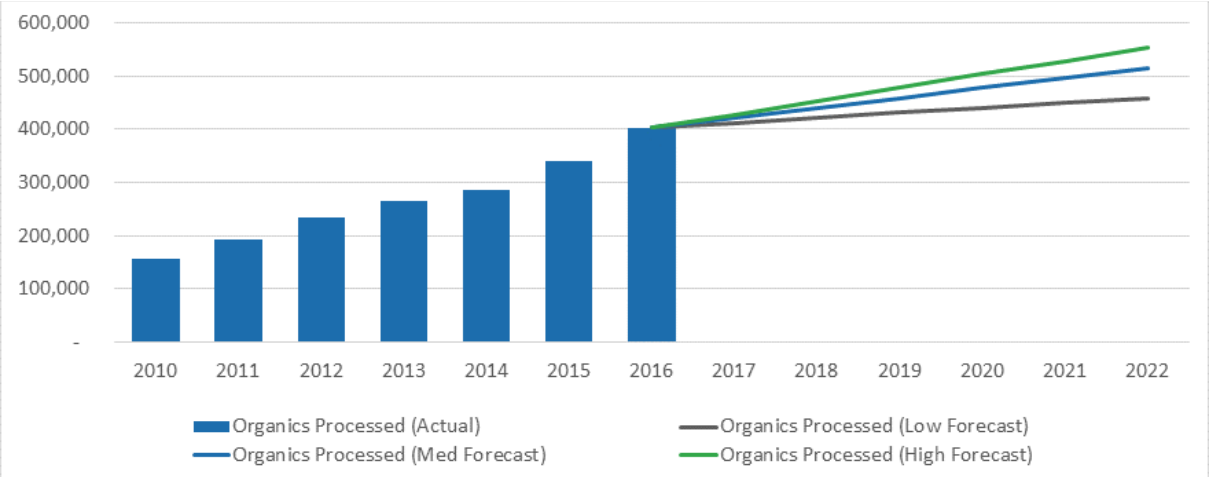


Figure 3: Actual organic waste diversion tonnage from 2010 to 2016 and forecasted diversion rates from 2016 to 2022 in Metro Vancouver (Metro Vancouver, 2017).

Organics diversion policies are beneficial for a variety of reasons. The diversion of organic waste reduces the volume of material entering landfills, extending the life of existing landfills; this is an important issue in urban areas such as Metro Vancouver where sites for landfilling are hard to obtain (Metro Vancouver, 2017).

When sent to landfills, organic waste exacerbates the environmental impacts that landfills commonly demonstrate. For example, due to the high moisture content of organic waste and the lack of oxygen in a landfill, organic waste will decompose anaerobically and produce methane, a greenhouse gas emission; leachate is also produced, a liquid that has extracted dissolved and suspended matter from materials in the landfill and risks polluting waterways and soils (Oliveira et al., 2017).

In addition, the diversion allows for the controlled processing of organic waste into compost, turning what would otherwise be garbage into a valuable resource. Composting also has some impact on the environment, but at much lower levels than when organic waste is landfilled. For example, both methane and leachate can be produced during composting; there are however opportunities to utilize these by-products such as collecting the methane for use as biogas and using compost leachate as a fertilizer, referred to as 'compost tea' (Oliveira et al., 2017).

Organic Waste Characteristics

Organic waste is a fraction of municipal solid waste (MSW); the other fraction of MSW is garbage (Figure 4). Garbage consists of materials that cannot be recycled or composted that are disposed of at a landfill. Organic waste consists of compostable, organic materials originating from food waste and yard waste. When organic waste is utilized for compost production, it is referred to as feedstock.

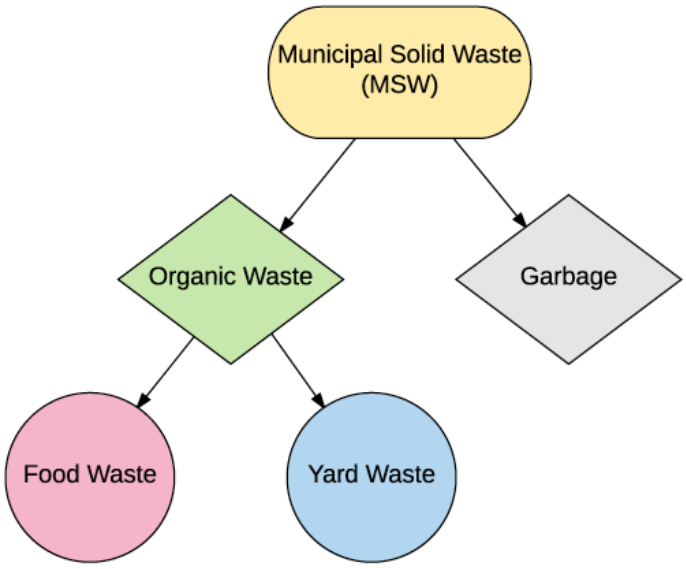


Figure 4: The fractions of MSW and sub-fractions of organic waste.

Food and yard wastes have different chemical and physical properties and because of this, composting facilities will manage the amounts of each they accept as a feedstock. Food waste can be post-consumer or pre-consumer; typical post-consumer sources are residences and commercial kitchens and pre-consumer sources are retail companies such as grocery stores (MOE, 2013). Food waste has been identified by stakeholders as having the potential to be a problematic feedstock. Because of the high moisture content, food waste can generate a high amount of leachate and odors (MOE, 2013). In addition, food waste has been shown to have a higher amount of contamination than yard waste, especially plastic bags (MOE, 2013; Metro Vancouver, 2017). According to composting facilities, plastics are the primary contaminant seen in food waste, including compostable/biodegradable plastics. Because of these characteristics, some facilities will only accept yard waste. The technology that a composting facility uses will reflect the type of feedstock they accept (Appendix B).

The generation of yard waste varies widely throughout seasons based on climatic factors; because of this, composting facilities must manage yard waste strategically and can sometimes store excess yard waste for use throughout the year (MOE, 2013). Yard waste has been reported as a relatively clean and contaminant-free feedstock; common contaminants of yard waste are plastic bags, pet wastes, dirt, rocks and fertilizer packaging (MOE, 2013).

Organic Waste Production

There are four sectors that produce organic waste in Metro Vancouver: Multi-Family Residential (MF), Single-Family Residential (SF), Industrial, Commercial and Institutional (ICI), and the Drop-Off sector (DO) (Figure 5). These sectors distinguish the sources of organic waste and allow for the analysis of waste content and consumer habits.

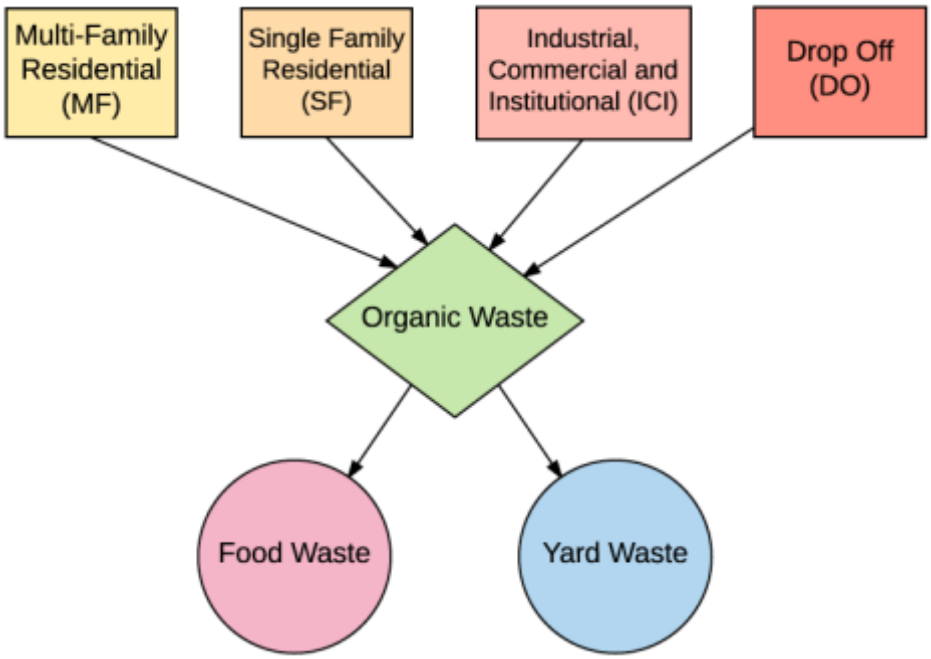


Figure 5: The sectors contributing to the production of organic waste in Metro Vancouver and the constituents of organic waste.

Each sector in Metro Vancouver produces different quantities of garbage, food waste and yard waste with varying characteristics. Metro Vancouver conducts annual waste composition studies to analyze components of the garbage and organic waste streams of MSW, which can be used to make conclusions on consumer habits and identify waste types and sectors that face challenges. In the 2016 study, MSW composition data was obtained for all sectors except for organic waste of the DO sector; pertinent data to this study is summarized in Table 1.

Table 1: Percentages of compostable organics found in garbage as well as percentages of food and yard waste found in diverted organic waste in Metro Vancouver in 2016.

	Compostable Organics found in Diverted Garbage	**Food Waste found in Diverted Organic Waste**	**Yard Waste found in Diverted Organic Waste**
Multi-family sector	37%	79%	17%
Single-family sector	29%	6%	88%
Industrial, commercial and institutional sector	25%	68%	10%
Drop-off	15%	N/A	N/A

(Metro Vancouver, 2016)

Analysis of diverted organic waste showed that, across all sectors, the MF sector demonstrated the highest percentage of compostable organics in its diverted garbage, indicating it has the poorest source separation techniques (Table 1). In addition, the MF sector produced the highest percentage of food waste across all sectors at 79% of organic waste (Figure 6) (Metro Vancouver, 2016). In contrast, the SF sector produced only 6% food waste and 88% yard waste (Figure 7). This distinction is important as food waste has been shown to be a challenging feedstock to manage and process at composting facilities in addition to demonstrating a higher presence of contaminants than yard waste (MOE, 2013).

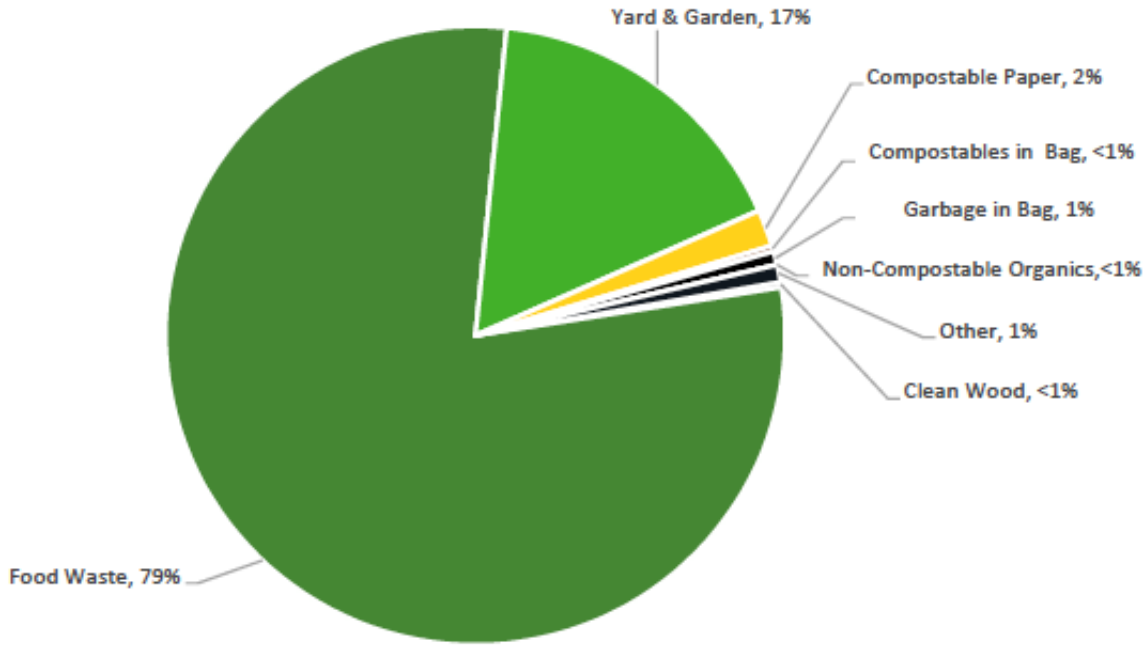


Figure 6: The composition of Multi-Family residential organic waste, 2016, Metro Vancouver (Metro Vancouver, 2016).

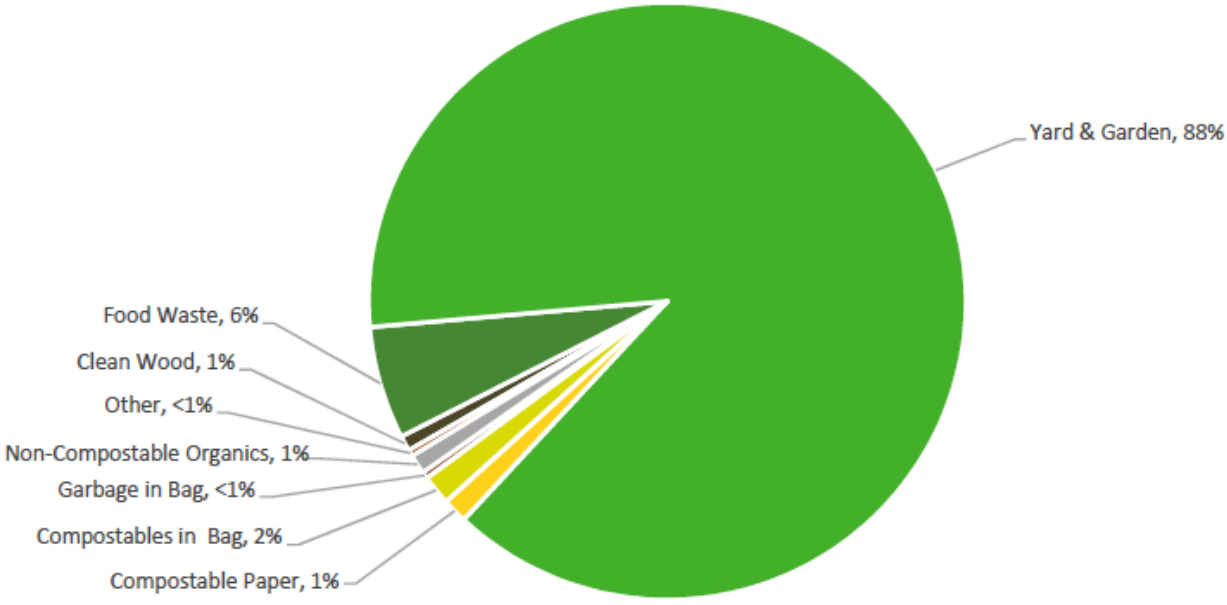


Figure 7: The composition of Single-Family residential organic waste, 2016, Metro Vancouver (Metro Vancouver, 2016).

The analysis of MSW constituents across sectors is important in order to target sectors and address their specific challenges. Through this study, the MF sector is identified as the target audience for both improving organics diversion as well as reducing contamination during source separation in order to improve the quality of food waste as a feedstock before it enters the compost system. In addition, organic waste produced by the SF sector may present challenges as yard waste production experiences seasonal highs and lows (MOE, 2013).

Metro Vancouver produced approximately 1.3 million tonnes of MSW in 2016; approximately 900 million tonnes were managed as garbage and approximately 400 million tonnes diverted as organics (Metro Vancouver, 2017). In 2016, compostable organics was identified as the largest component of garbage produced by the MF, SF and ICI sectors, indicating that there is a potential for the volume of diverted organics to be even higher. Figure 8 demonstrates the significant presence of compostable organics in diverted garbage on a per capita basis.

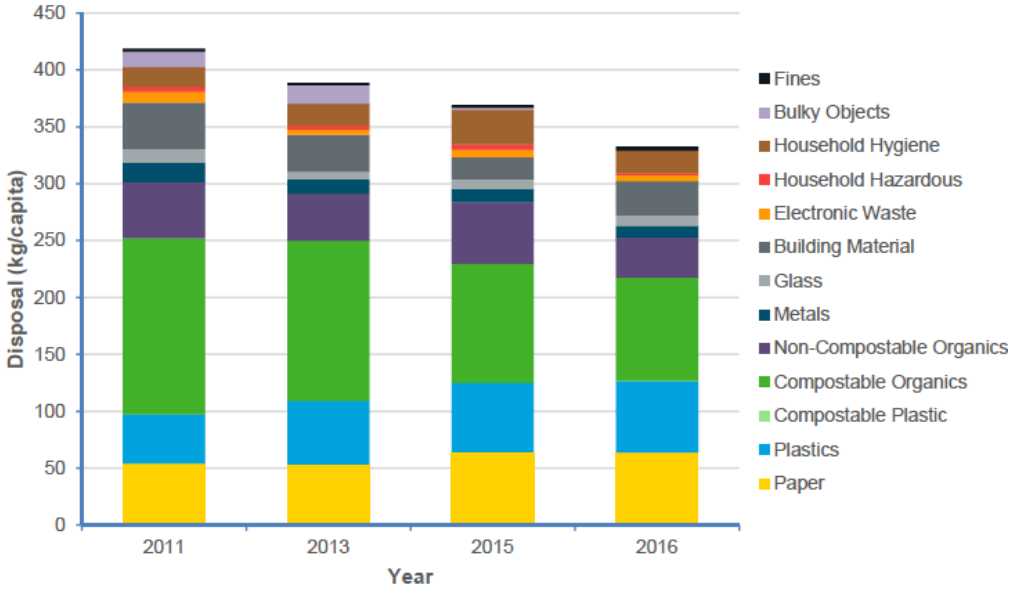


Figure 8: Source separated garbage per capita by composition, all sectors combined for 2011 to 2016 (Metro Vancouver, 2016).

The regional capacity for processing organic waste in Metro Vancouver cannot be precisely determined as composting facilities' permitted capacity and realistic capacity differ from each other. However, the current, realistic capacity for processing organic waste is estimated to be approximately 340,000 tonnes annually (personal communication, Metro Vancouver, July, 2017). This indicates a processing capacity concern for organic waste in Metro Vancouver. Given that the source separated tonnage of organic waste reached approximately 400,000 in 2016 and that there is the potential for additional tonnage with improved source separation, increasing regional capacity for processing organic waste is an acknowledged priority of Metro Vancouver and overarching challenge affecting the composting system.

Composting in Metro Vancouver

The primary output of composting organic waste is the production of compost, a dark, earthy-smelling organic material with high nutrient and humus content (MOE, 2017). Compost is a valuable soil amendment that can be used to improve plant productivity, suppress soil-borne diseases, prevent soil erosion and topsoil loss and in soil remediation (MOE, 2017).

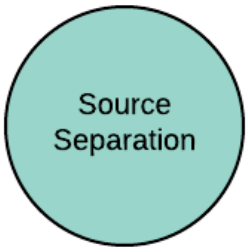
The Organic Matter and Recycling Regulation (OMRR) regulates composting in BC; it defines compost as a stabilized earthy matter having the properties and structure of humus, is beneficial to plant growth when used as a soil amendment, is produced by composting, and is only derived from organic matter (MOE, 2016). There are two classes of compost, class A and B, based on the end use of the compost material and determined by trace element concentrations and fecal coliform counts (CCME, 2005; MOE, 2016). OMRR is used to determine if a compost is stable, mature and pathogen-free (MOE, 2016). In addition, standards are used to determine the acceptable quantities of trace elements and foreign materials, such as plastics, glass and metals (MOE, 2016).

Despite compost production meeting the standards outlined in OMRR, stakeholders of the organic waste to compost process in Metro Vancouver have indicated that the most persistent contaminant in compost produced from MSW is plastics, in particular, plastic bags. This falls under the foreign materials category in OMRR. In addition, compostable/ biodegradable plastic has been identified as a problematic contaminant as it is often intentionally source separated into the organics stream by misinformed consumers. Compostable/biodegradable plastics cannot be processed at commercial composting facilities as they decompose at a much slower rate relative to food and yard waste; they are also not easily distinguishable from regular plastics and must be handled as a contaminant (Metro Vancouver, 2017; MOE, 2013). Screening for and removing plastics add significant processing costs to composting facilities. Trace element concentrations in compost (including heavy metals) have not been identified as a concerning contaminant in Metro Vancouver.

There are a variety of private composting facilities that process the organic waste produced by Metro Vancouver. Characteristics such as processing technology, type of feedstock accepted, and output type will vary based on the business model and are dependent on one another. Appendix B characterizes the major composting facilities that process the region's organic waste, and Appendix C describes the different composting technologies used.

Results and Discussion: Evaluation of the Institutional Framework

Source Separation



Key issues:

- **The step where contaminants enter the system.**
- **Residents are not incentivized or dis-incentivized to improve source separation techniques.**
- **Plastic bags are the most persistent contaminant.**
- **The fact that compostable/biodegradable plastics are not acceptable in green bins is widely misunderstood.**
- **The MF sector is the most likely to contaminate the organic stream.**

The source separation step is where residents and businesses separate food scraps and yard waste from the garbage they produce. For residents, this typically involves the disposal of food waste into a kitchen container that is emptied into a green bin outside; yard waste will go directly from one's yard to the green bin. Businesses must separate food and yard waste similarly. Each municipality will develop a list of acceptable green bin items; these lists are similar but will vary slightly in content and presentation across municipalities. The City of Vancouver's acceptable green bin items list is in Appendix D.

The source separation step is primarily where contaminants enter the organic waste to compost system. Once in the system, contaminants will impact every step and stakeholder involved. Because of this, reducing contamination at the source separation step should be a priority for all stakeholders.

Plastic bags are the most common contaminant that enter during the source separation step. This is likely due to consumers separating their organic waste into plastic bags in order to transport them to their green bin. In addition, the MF sector has the highest contamination rate; the extra effort that is required to transport food waste from an apartment unit to the green bin and return the container to one's apartment may affect this rate by encouraging the use of plastic bags.

A critical issue identified in this step is that the stakeholders responsible for source separation are not incentivized or dis-incentivized to improve their source separation techniques. When contaminants are put into a green bin, it will be the hauler picking-up or the composting facility processing the waste that pay the fines, surcharges and costs associated with the contaminants. Specific strategies have been developed to address these issues (Table 2).

Key strategies:

- **Develop a Metro Vancouver-wide standard on curbside contamination allowances with the implication that municipalities implement fines.**
- **Target contamination reduction in the MF sector by municipalities incentivizing building managers to improve source separation resources for residents, such as providing compostable containers and liners.**
- **Municipalities should update acceptable items lists to specifically indicate that plastic items labelled compostable/biodegradable are not accepted; compostable/ biodegradable plastics should not be grouped under plastics.**

Table 2: Issues that are present in the source separation phase of the institutional framework and subsequent strategies to resolve issues.

Issue	**Strategy**
Contamination of green bins at source: A) Consumers of all sectors are not fined for contamination at the source and are therefore not incentivized or dis-incentivized to reduce contamination/improve source separation techniques.	A) A Metro Vancouver-wide standard determining an acceptable level of contaminants in green bins should be set (e.g. maximum 25% visible contamination of green bins at source, similar to the standard for organics content in garbage entering landfills). Haulers can then use this standard to reject pick-up and municipalities can use this standard to fine negligent consumers.
MF residences have a relatively high level of contamination compared to other sectors: A) MF residents must transport and return kitchen compost bins a far distance and often residents are not provided bins. Plastic bags are likely used here to make this process easier, contributing to contamination. B) Newcomers to Metro Vancouver likely reside in MF buildings and may not be familiar with organic waste diversion. C) There is a lack of accountability when many consumers dispose their waste into a communal green bin.	A) Incentivizing building managers to provide kitchen containers, waxed-lined paper liners for containers or paper containers that are completely compostable to building residents; incentives could be provided by municipalities. B) Increasing the frequency of the free distribution of educational resources on acceptable items, organic waste diversion and compost production in various languages. C) If provided resources such as containers and information as to why reducing contamination is important, accountability may increase.
Feedstock types and volumes: A) MF produces high volumes of FW and SF produces high volumes of YW, seasonally.	A) Composting facilities should practice accepting a balance of FW and YW feedstocks to complement the composting technology used.
ICI sector and packaging: A) ICI sector typically produces organic waste that has already been packaged and requires de-packaging (such as boxes, wrappers and bags) which increases likeliness of contamination.	A) Similarly to source separation requirements for residents, ICI sources could be required to de-package before disposing of organic waste.

Issue	Strategy
Compostable/biodegradable contaminants: A) Compostable/biodegradable plastics are a persistent contaminant; there is wide-spread consumer misperception on acceptability. Such plastics are particularly problematic because they are often intentionally disposed of in the organics stream by consumers. B) Marketing has influenced wide-spread consumer misinformation which challenges the entire system; in addition, green bins are often lined with compostable/ biodegradable plastic bags, further perpetuating the consumer habit.	A) To reduce the disposal of compostable/ biodegradable plastics by consumers, there should be direct communication that compostable and biodegradable plastics are not acceptable rather than grouping the item under 'plastics' on green bin acceptable items information. B) Metro Vancouver could set a regional ban on compostable/biodegradable plastic liners for green bins; however, large plastic bags have been identified as easily screened in the feedstock inspection phase whereas small plastics are more challenging to remove and should be targeted.
Cross-municipality confusion regarding rules, procedures and acceptable items: A) Each municipality will have unique source separation rules and pick-up procedures, as well as acceptable green bin items lists based on the kinds of residents and businesses in their municipality. It is possible for the public to be confused and frustrated by inconsistency.	A) A cohesive organic waste diversion plan across all member municipalities in Metro Vancouver is an option; however, this would be quite difficult. Alternatively, improving the accessibility of information regarding source separation rules and pick-up procedures should be practiced by every municipality.

Organic Waste Collection and Transportation

Key issues:

- **Haulers are paying for contamination that results from poor source separation.**
- **Haulers are competing for business and are therefore pressured to accept curbside loads, despite contamination.**
- **Haulers do not commonly inspect loads before pick-up.**

Once source separated, organic waste is collected and transported by waste disposal companies, also known as haulers. Haulers are typically private companies contracted by municipalities, businesses and the building managers of the MF sector to pick-up and dispose of organic waste; the process is the same for garbage. There are numerous haulers in Metro Vancouver operating in a competitive environment.

Haulers pay tipping fees to dispose of organic waste at composting facilities and garbage at landfills. Landfill tipping fees are approximately 50% higher than composting facility tipping fees. Composting facilities will have varying tipping fee rates for different sources and types of organic waste. In addition, it is common for a composting facility to have a private rate for major clients, such as for food waste from a municipality. For this reason, it can be difficult to define the rates as they will differ amongst clients. A list of tipping fees at landfills are shown in Appendix E and an example of rates at composting facilities in Appendix F.

Haulers are the stakeholders who pay fines and surcharges associated with contaminated organic waste. The most expensive outcome for haulers is when a load of organic waste is rejected at a composting facility due to contamination and a hauler must dispose of the load at a landfill. The hauler then has to pay the (higher) landfill tipping fee as well as a 50% surcharge imposed due to the ban on organics from landfills in Metro Vancouver (Appendix E) (Metro Vancouver, 2017). Haulers are entitled to reject curbside collection of organic waste based on contamination, however, this is uncommon as rejecting pickup will likely result in the loss of a client.

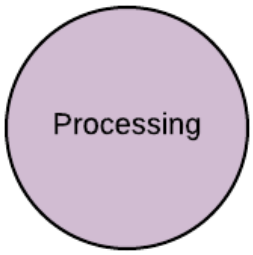
Some composting facilities apply a surcharge for disposing of organic waste that is contaminated with 2-5% garbage by weight (personal communication, July, 2017). Given that a high proportion of contaminants are light-weight plastics such as bags, 2-5% by weight can be a significant volume of contaminants. There is no industry standard for the use of surcharges on contaminated organic waste disposal at composting facilities.

Key Strategies:

- **Metro Vancouver-wide standard on curbside contamination allowances (the same standard as recommended for source separation step) with the implication that haulers reject the contaminated load.**
- **Haulers should inspect curbside loads before pick-up using a technology such as inspection cameras.**
- **Haulers should share fines and surcharges with clients.**

Table 3: Issues that are present in the collection and transportation phase of the institutional framework and strategies for stakeholders to address each issue.

Issue	**Strategy**
There is no curbside standard on acceptable levels of contamination: A) Haulers are pressured to fulfill contracts and pick-up curbside loads despite contamination. If one hauler rejects a load, a consumer can phone a different hauler to pick-up the load and the contaminants will enter the system regardless, and the hauler will lose business. In addition, different clients may have their own standard as to what is acceptable; e.g. municipality A wants organic waste to be picked up regardless of contamination, where municipality B would rather the waste be left for residents to deal with and learn from.	A) A Metro Vancouver-wide standard on allowable contamination at the source should be set (e.g. 25% visible contamination at source results in rejected pick-up). Municipalities can implement subsequent fines for contamination (strategy identified for the source separation step), or consumers will have to take their green bin load to a landfill by self-haul. This prevents contaminants from entering the system, incentivizes consumer habit change, and reduces pressure on haulers to pick-up contaminated loads. Municipalities could also implement notifications to be left on rejected green bins identifying why it was rejected for both consumers and the public to learn from.
A) Haulers aren't aware that a pick-up load is contaminated until they've reached the composting facility and have dumped the load.	Haulers should practice source inspection strategies, such as: A) Inspection cameras have been developed for hauling vehicles that can recognize contaminants and document location through GPS (personal communication, July 2017). This could be implemented by haulers and would reduce overall costs after initial investment.
A) Haulers bear the burden of surcharges, fines and fees associated with the disposal of contaminated organic waste and the disposal of garbage with visible organic waste.	A) Haulers should enter contracts with clients allowing for the shared or completely diverted surcharges, fines and fees associated with contamination to the client who has contracted the hauler (i.e. the business or municipality). This puts the responsibility of reducing contamination to the source and will prompt a change in consumer habits.
A) Organic waste that is diverted to landfills because of contamination and rejection at composting facilities a) sends more waste to landfills, contributing to GHG emissions and landfill input volume, and b) isn't fulfilling the overall purpose of the organics disposal ban put in place by Metro Vancouver.	A) Addressing contamination during source separation will reduce the need to address contamination issues at the collection step. Developing Metro Vancouver policies will facilitate the changes by stakeholders to reduce contamination; municipalities should follow up by providing resources and implementing fines.



Key issues:

- **Composting facilities are experiencing pressure to accept organic waste due to a limited regional processing capacity.**
- **Once at a composting facility, it is expensive for contaminants to be removed from organic waste.**
- **Plastics are the most common and persistent contaminant identified by composting facility stakeholders.**

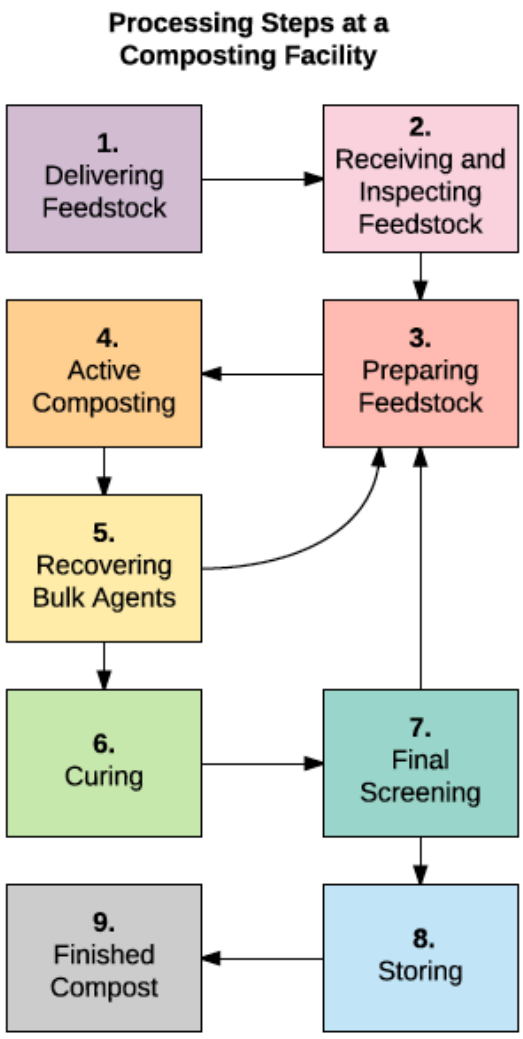
Upon arrival at a composting facility, a hauler's load will be rejected or accepted based on the facility's capacity or if there are any contamination concerns. Some composting facilities develop close relationships with haulers and only accept waste from particular haulers who are disposing of organic waste from reputable sources and will define a private rate for particular sources. These facilities usually have a higher standard for feedstock quality and are not concerned with increasing volumes of feedstock input.

Often composting facilities accept feedstocks even if there is a high level of contamination; this can be due to pressure from local governments to process organic waste, or because there are sometimes no checks in place to inspect a load before a hauler leaves the composting facility. Contaminated organic waste will cost a composting facility significantly more to process than non-contaminated waste; costs include the additional screening and separation of contaminants, transportation of contaminants to a landfill, and the landfill tipping fee to dispose of the contaminants.

Once accepted, processing organic waste at a composting facility involves several steps that take place over the course of weeks to months in order to produce compost (Figure 9).

Some facilities follow criteria in addition to OMRR in order to further improve the quality assurance of their compost product and increase product utilization. For example, some facilities follow standards set by Organic Materials Review Institute (OMRI), a third-party certifier that assures the suitability of products for certified organic production, handling, and processing in Canada; this allows compost to be used for certified organic farming (OMRI, 2016).

Each facility will vary in the technologies they use and the rigor they practice in each step of the composting process. The variability in processing standards reflects financial investment in the composting process, and the resultant return a facility will experience on their product. Finding the ideal balance of technology, feedstock type and quality standards is the challenge for most facilities in producing a product that suits the utilization of their target market.



Receiving and Inspecting Feedstock: Feedstocks are received and can be rejected based on capacity, feedstock type or contamination. The accepted feedstock is inspected for major contaminants. There is an emphasis at this stage to remove materials that are dangerous to facility employees and equipment.

Preparing Feedstock: The feedstock is prepared to create optimal physical and chemical characteristics for active composting. This includes grinding materials to create a smaller, more homogenous particle size, or adding amendments such as wood waste and mixing feedstocks to ensure a combination of materials that will provide optimal structure and nutrient levels (MOE, 2013). Composting facilities typically have large machinery such as a grinder, a mixer or a shredder to complete this (CCC, Composting Processing Technologies).

Active Composting: The feedstock materials are placed into the windrow, pile or vessel where the rapid decomposition of organic materials will take place. There are high rates of biological activity creating a high demand for oxygen and increasing the temperature of the mixture (MOE, 2013). This step also has the highest potential for causing nuisances such as odors and vector attraction such as rodents or birds. Depending on several factors such as the type of composting technology, climate, and feedstock management, active composting can take from 3-4 weeks to 8-12 months (MOE, 2013).

Recovering Bulk Agents: In this step, the composted material will be passed over a screen where the smaller particles will move onto curing and the larger particles will be recycled back to aid in preparing feedstocks (step 2) (MOE, 2013).

Curing: During this step, microorganisms convert organic carbon into carbon dioxide and humus, and organic nitrogen into nitrates (MOE, 2013). As readily degradable materials in the feedstock are consumed, the kinds of micro-organisms present change and the overall populations decrease. The climate will also impact curing as biological activity will decrease or stop in cold temperatures. The curing step is where the stability and maturity criteria outlined in OMRR are met (MOE, 2013).

Final Screening: This step involves making the cured compost into a more suitable soil amendment before selling or using it. It will be screened using a finer screen than in step 4 to remove oversized materials and any remaining contaminants (MOE, 2013). A portion of the finished compost is sometimes blended with sand, perlite or topsoil to produce a soil blend that can be readily used.

Storing: the final step that occurs at composting facilities, proper storing is important to prevent odors from developing, contamination from weeds, leachate or other contaminants; compost can be stored in bulk or bags (MOE, 2013).

Figure 9: The processing steps that typically occur at a commercial-size composting facility.

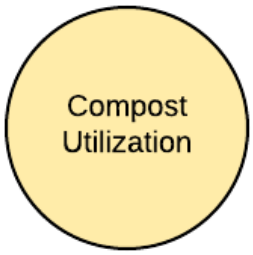
Key strategies

- **Develop a Metro Vancouver-wide standard regarding surcharges/fines for contamination arriving at composting facilities; implication would be that all composting facilities in the region apply uniform charges, facilities can offset costs of removing contaminants, and haulers should improve inspection.**
- **Composting facilities should practice developing close relationships with haulers and accept organic waste from reputable sources.**
- **Ultimately, the development of new composting facilities should continue to be encouraged by Metro Vancouver and municipalities to alleviate regional capacity concerns.**

Table 4: Issues that are present in the processing phase of the institutional framework and strategies for stakeholders to address each issue.

Issue	**Strategy**
Regional capacity: A) Composting facilities processing Metro Vancouver's organic waste are experiencing pressure to accept and process organic waste based on high volume and limited regional processing capacity. Facilities are more likely to experience quality issues when operating at high capacity as the composting processes are strained.	A) Metro Vancouver and municipalities are currently encouraging the establishment of more composting facilities to increase regional capacity. The Surrey Biofuel Facility is currently under construction and is projected to begin operating in the fall of 2017; as a facility with a relatively large processing capacity it should alleviate some regional capacity concerns.
Contaminants are entering composting facility: A) Composting facilities currently have no standard regarding allowable contamination to use in order to reject loads. If one facility rejects a load, another facility may accept it and the contaminants still enter system. Similarly to haulers, composting facilities are private and competing for business which impacts their operational decisions. B) When a contaminated load arrives at a composting facility, it is typically un-loaded before inspection occurs. Rather than re-load, haulers will typically pay the fee or leave, meaning the composting facility has to deal with removing the contaminants. In addition, the source of the waste (e.g. which businesses or neighborhoods) is sometimes unknown.	A) A Metro Vancouver-wide standard for surcharges/fines for contaminants arriving at composting facilities (per tonne or per visible percentage) should be developed; the implication is all composting facilities will have uniform charges and will not lose out on business by rejecting loads or fining haulers, and haulers will be incentivized to reject contaminated loads at the source. B) Composting facilities should practice developing close relationships with haulers, inspect loads upon arrival and only accept organic waste that has come from reputable sources. E.g. The Answer Garden Products composting facility in Langley only accepts organic waste from a few, select sources and will turn away haulers with loads from sources they do not have a relationship with; this results in reported low quality concerns and high quality assurance relative to other facilities.
A) Once accepted, it is expensive to remove contaminants during the composting process. Expenses include increased screening labor and technology, and the costs of separating, storing, transporting and disposing of contaminants. Composting facilities reported a reluctance to invest in advancing screening technology without assurance of financial return.	A) Reducing contamination at the source separation step will prevent contaminants from entering the system, and reduce costs for all stakeholders. This strategy will have the most impact in reducing costs for composting facilities. Metro Vancouver-wide standards regarding source separation will help facilitate change.

Compost Utilization



Key issues:

- **MOW compost is under-utilized by the agricultural sector due to uncertainty in compost quality and strong substitutes.**
- **Compost is under-utilized by small scale users due to limited accessibility and a lack of awareness regarding MOW compost characteristics and processes.**
- **Compost users have identified visible plastics as a concerning characteristic of compost produced from MOW.**

Compost can be purchased and utilized by public and private stakeholders. It is typically purchased in commercial scale quantities and is under-utilized by small scale users such as residents. Metro Vancouver and municipalities often prioritize using compost produced from MOW for their operations in order to benefit the organic waste to compost system. No composting facilities in Metro Vancouver have identified an inability to sell the compost that they produce.

Accessibility is one of the key factors that impacts which sectors are utilizing MOW compost. Options such as distributing compost off-site (such as at a nursery or garden center), bagging compost, and producing compost blends such as a potting mix will allow more users to access compost. Many facilities only offer compost for purchase on-site and in bulk, requiring consumers to have their own vehicle for transport and yard space to store the compost. This prevents certain user groups such as the MF sector from utilizing compost.

Improving education on the organic waste to compost process in Metro Vancouver will improve a diversified user group of compost. If residents develop a relationship with compost produced from MOW, they will feel more accountable and inclined to improve source separation habits. Improving compost utilization will improve the overall quality and profitability of the organic waste to compost process. This has the potential to improve the source separation techniques of problematic sectors such as MF.

The persistency of plastics throughout the composting process has resulted in compost users describing a lack of confidence in the quality of compost produced from MSW. This perception can only change by reducing contamination and by users developing a positive relationship with compost over time.

Key strategies:

- **Municipalities should partner with composting facilities to participate in compost giveaways, public sales at community events, and improving awareness regarding the organic waste to compost process.**
- **Composting facilities should reach out and communicate with farms in their area to improve utilization; improved quality assurance will also improve agricultural use.**
- **Composting facilities should continue to diversify the range of products they produce and services offered to improve accessibility to small scale compost users.**

Table 5: Issues that are present in the compost utilization phase of the institutional framework and strategies for stakeholders to address each issue.

Issue	**Strategy**
Visible contaminants are present in finished compost products: A) Compost users have reported finding small contaminants in MOW compost, such as small pieces of plastic that have been ground up and are nearly impossible to remove. In addition to visible contaminants, some compost users have identified the unknown source of feedstocks as a concerning characteristic that further impacts quality assurance.	A) Composting facilities that have established an operating procedure with high standards, that consistently produce compost with high quality and low presence of contaminants should partner with municipalities in organizing compost giveaways, public sales and redistribution. This requires municipalities to organize events or attend existing events and share the costs of purchasing and transporting compost. By combining compost sales and giveaways with education around the organic waste to compost process, the municipality's residents will learn about the impact of source separation and the green bin program. Ultimately, reducing contamination at the source separation step is necessary to address the issue of contaminants in MOW compost.
Lack of education around the organic waste to compost process: A) Some compost users have identified that there is a lack of awareness regarding the organic waste to compost process; specifically, that organic waste diverted into green bins is used for compost production and that it can be purchased locally.	A) Metro Vancouver and municipalities should build upon existing educational resources regarding organics diversion (which has demonstrated success) and include information regarding the organic waste to compost process and the importance of preventing contamination at source separation.
Under-utilization by certain sectors: A) Agriculture has been identified as the sector with the highest under-utilization of compost produced from MOW (MOE, 2013). This is typically because farmers have their own supply of fertilizers from sources they have developed a relationship with or from their own farm. Many farmers are wary of compost produced from MOW due to the uncertainty of feedstock origin; in addition, many farms utilize chemical fertilizers because they are normalized and cheap. B) Small-scale purchasers such as residents, especially those without yard space or vehicles, experience limited accessibility to compost.	A) Composting facilities should be encouraged to connect with farms near to their facility. Improving the connection between compost and agriculture further improves the organic waste to compost life cycle. Composting facilities that are producing an OMRI listed compost should reach out to organic farms and explain that MOW compost has the potential to be certified for organic farming. B) Composting facilities should continue to invest in diversifying their product lines including distribution options, delivery options, and compost blends.

Conclusions

The institutional framework that has been developed to support the organic waste to compost system in Metro Vancouver has been successful in diverting organic waste from landfills. However, there have been several points identified throughout the institutional framework where the system is operating inefficiently. These issues are interconnected and can be traced back to the primary challenge: improving the quality of source separation at the consumer level. The issues within the institutional framework are exacerbated by the overarching challenge of limited regional capacity for organic waste processing in Metro Vancouver.

There are three main policy recommendations outlined in Figure 10 targeted at Metro Vancouver and its member municipalities.

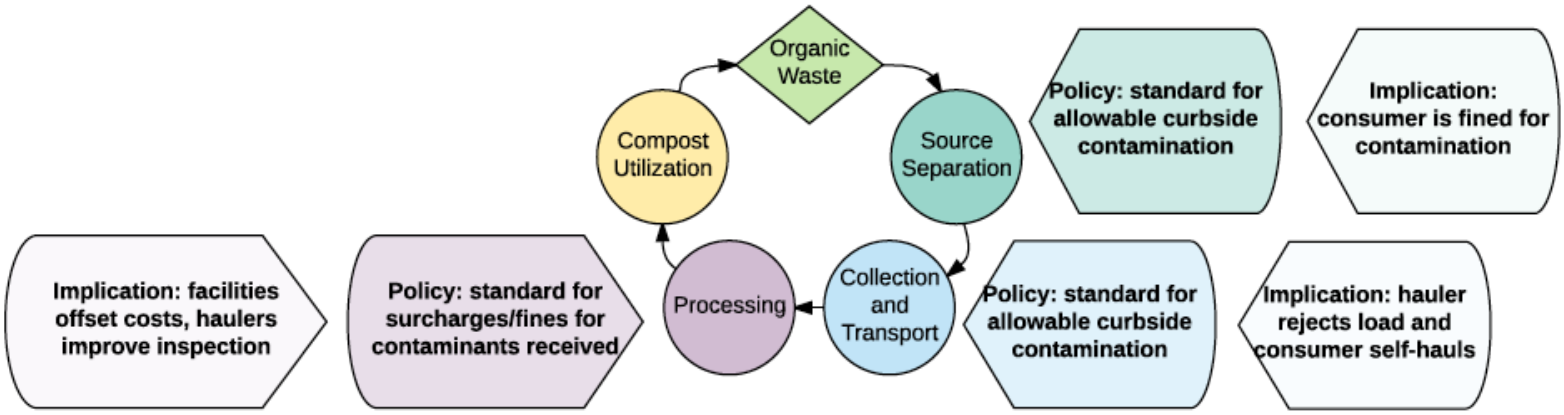


Figure 10: Policy recommendations for Metro Vancouver and resultant implications for stakeholders.

The recommendations summarized in Figure 10 are aimed at preventing contamination at the source separation step through financial incentives and disincentives for stakeholders. By implementing policies, Metro Vancouver can reduce the pressure on private stakeholders to operate in a competitive environment and improve profitability for the composting industry. This could increase regional capacity by encouraging the establishment of new facilities.

In addition to policies, Metro Vancouver could develop a new educational campaign directed at reducing and preventing contamination at source separation. In particular, the MF sector should be targeted, as well as preventing the contamination by plastics with special attention to compostable/biodegradable plastics.

The residents and businesses of Metro Vancouver are the critical stakeholders within the institutional framework. The public can influence both the quality of compost produced and the profitability of the composting industry by changing their behaviors. This behavioral change must be initiated by stakeholders such as local governments and composting facilities. Improving education around compost and the lifecycle of organic waste will improve the source separation techniques and resultant compost quality, as well as increase the utilization of compost as a resource. These strategies will benefit all stakeholders of the composting system in Metro Vancouver and make the entire system more efficient, productive and profitable.

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Appendices

Appendix A

Existing Online Resources on Organic Waste and Compost for Metro Vancouver Residents and Businesses.

City of Vancouver. (2017). *List of Food Scraps Service Providers*. Retrieved from: http://vancouver.ca/doing-business/food-scraps-haulers-list.aspx

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Appendix B

A selection of composting facilities both within and out of the Metro Vancouver region that process Metro Vancouver's organic waste.

Within Metro Vancouver:					
Facility	**Processing Technology**	**Accepted Feedstock**	**Output**	**Location**	**OMRI listed products**
Harvest Power	Windrow and Anaerobic Digestion	FW and YW	Compost	Richmond	No
Enviro-Smart Organics	Windrow	FW and YW	Compost	Delta	No
Vancouver Landfill	Windrow	YW	Compost	Delta	No
Ecowaste	Windrow	YW	Compost	Richmond	No
Surrey Biofuel Facility*	Anaerobic Digestion and In-Vessel Aerobic Decomposition	FW and YW	Biofuel and Compost	Surrey	No
Enterra Feed Corporation	Insect Digestion	Pre-consumer FW	Feed Production	Langley	No
Out of the Metro Vancouver Region:					
Facility	**Processing Technology**	**Feedstock Type**	**Output**	**Location**	**OMRI listed products**
The Answer Garden Products	Windrow	FW and YW	Compost	Abbotsford	Yes, some products
Net Zero Waste	Enclosed Aerated Static Pile using 'Gore Cover'	FW and YW	Compost	Abbotsford	Yes, all products
Revolution Ranch	Windrow	FW and YW	Compost	Lytton	No
Sea to Sky Soil	Enclosed Aerated Static Pile using 'Gore Cover'	FW and YW	Compost	Pemberton	Yes, all products

**Under construction and projected to open in fall, 2017*

Appendix C

Composting technologies used in Metro Vancouver to process regional organic waste.

Composting Technology	**Description**
Windrows	Outdoor composting in piles that rely on mechanical aeration, typically with a compost windrow turner, to optimize the composting process.
Enclosed Aerated Static Pile using 'Gore Cover'	Gore Cover is a membrane cover that is permeable to gaseous substances but retains odor emissions and helps regulate moisture and temperature. It is used to cover an aerated static pile where the majority of composting occurs. The process is finished using windrows.
In-Vessel Aerobic Decomposition	Tunnel composting systems with forced aeration through the floor and internal air circulation. The tunnels are loaded from one end and operate in batch mode after the tunnel is fully loaded; multiple tunnels are used to obtain continuous operation.
Anaerobic Digestion	The biological breakdown of organic materials in the absence of oxygen. During this process, biogas containing methane and carbon dioxide is produced which can be captured and used as an energy source. The remaining material is a partially stabilized organic material that can be aerobically cured and used as compost.

(CCC, Composting Processing Technologies)

Appendix D

Items accepted and not accepted in green bins as outlined by the City of Vancouver; each municipality will indicate their own acceptable items for organics collection.

Accepted Items	**Not Accepted Items**
Food scraps:	**Fecal matter:**
Dairy products, including cheese and yogurt	Animal waste
Egg shells	Diapers
Fruit and vegetable scraps	**Large or heavy items:**
Meat, bones, fish, and seafood shells	Branches or prunings over 10 cm thick and 50 cm long
Noodles, rice, beans, grains, and bread	Lumber or other wood products
Plate scrapings	Rocks, soil or sod
Small amounts of oil and fat that has been soaked in paper towel or newspaper	**Plastics:**
Teabags, coffee grounds, and filters	Compostable or biodegradable plastic bags
Tissue paper (no blood or fecal matter)	Plastic bags, wrap or containers
Food-soiled paper products:	Products made of Polylactic Acid (PLA) (containers, disposable plates, cutlery)
Empty cereal boxes (no plastic liners)	
Paper bags	
Paper napkins	
Parchment paper, wax paper, and waxed cardboard	
Pizza boxes	
Newspaper	
Used paper dishes (with no plastic coating)	
Yard trimmings:	
Leaves and grass clippings	
Short branches and prunings	
Weeds, plants, and flowers	

(City of Vancouver, 2017)

Appendix E

Current tipping fees for Metro Vancouver's waste disposal facilities (landfills), including North Shore Transfer Station, Surrey Transfer Station, Coquitlam Transfer Station, Langley Transfer Station, Maple Ridge Transfer Station, and the Waste to Energy Facility in Burnaby.

Tipping fees for MV's waste disposal facilities	
Type of Load	**Fee**
Garbage 0 to 1 tonnes	$133 per tonne
Garbage 1 to 9 tonnes	$112 per tonne
Garbage 9 tonnes or more	$80 per tonne
Transaction fee for garbage	$5 per load
Surcharge for >25% visible organic waste content in garbage load	50% of tipping fee
Organic waste	$95 per tonne (as of September 1, 2017)

(Metro Vancouver, 2017)

Appendix F

An example of tipping fees for drop-off/self-haul by private composting facilities processing Metro Vancouver's organic waste (rates retrieved from facility front desks).

Facility	**Yard Waste**	**Food Waste**	**Commercial Organics**
Net Zero Waste	$65/tonne	Not Specified	$85/tonne
Ecowaste	$60.93/tonne	Not Accepted	Not Specified
The Answer Garden Products	$38/tonne	Not Specified	Not Specified