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Why Waste Waste? A Strategic Plan to Achieve Zero Waste in Portland, Maine

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A Strategic Plan to Achieve Zero Waste in Portland, Maine

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1.1. The Story of Waste

At its most basic, waste is what is wasted. Waste is an item that has lost its purpose, that is not wanted. In this sense, waste is a truly manmade object. When a tree falls in the forest, it does not become waste, no more than do fragments of eggshell once a bird has hatched or the bones of a woodland creature expired of natural causes. Instead, their essential elements are deconstructed and used for other processes of growth and regrowth. The story of waste begins with the story of people, for as long as human beings have created, used, and cast aside, waste has existed.

For most of the long voyage of human history, waste has been managed in the same way. In early human settlements, waste was disposed of in piles called middens adjacent to dwellings, at the waterside or at a village’s edge. Waste in these early days consisted of pieces of bone not used for making tools, shells from the harvest and consumption of shellfish, broken pieces of ceramic or stone vessels or hunting points (Kelly & Thomas, 2013, p. 8). Packed under earth or in the alkaline environment generated by a large concentration of shells, these unwanted objects have endured millennia to inform contemporary archeologists about the nature of our prehistory. Modern landfills, capped with thick plastic and host to a hot, oxygen-free environment, will preserve our civilization’s waste longer than early man’s first forays into waste management ever could. If future archeologists unearth the artifacts of our civilization, what story will it tell?

1.1.1. Sanitation and Public Health

By and large, waste was managed as it had been for many thousand years until urban density began to push the approach to its limits. While some high density urban areas through history have been notable for their sanitation, such as the use of plumbing in some Roman cities and street cleaning and sewer systems in some large pre-Columbian urbanities in the Americas (Mann, 2005, p. 126), the level of urban density first encountered in medieval European walled cities was at the root of broader change in waste management practice. Human waste, food scraps, and ashes dominated the medieval waste stream, in short, organic waste (Mumford, 1961, p. 292). Pigs and goats roamed freely, consuming much of what organic material remained edible, while the short supply of glass, metal, paper and other materials ensured its collection by rag pickers and others who built a livelihood around the recovery and resale of cast off materials. The most noxious wastes were by-products of early industry, most notably of slaughterhouses and tanneries, and were typically released into the water body on which a city was established and drew its drinking water.

Epidemics provided the first impetus for regulating urban wastes. As the root causes of devastating diseases such as smallpox and influenza were poorly understood, the unpleasant nature and ubiquity of pre-industrial waste provided a tangible etiology on which to place blame (Melosi, 2000, p. 19). Before the advent of virology and bacteriology established a firm basis for the mode of disease transmission, different theories proliferated about the cause of such disease. One broadly accepted explanation was that of *miasmas*, the stale or fetid air locked in cramped and polluted cities, carried diseases such as cholera. The fact that the air was malodorous was evidence of the disease it carried. While the first response to this theory was broad improvement in sewer systems, particularly to prevent sewer gas from filtering into residents' plumbed homes, the public management of urban waste and refuse was soon to follow, first developing at the end of the 19th century (Melosi, p. 175). Semi-formal collection systems had developed in many urban areas, with most waste collected by hand and dumped onto vacant plots in poor neighborhoods or into the ocean or river abutting the city's edge; yet increasing institutionalization of public health generated the conditions necessary for the assumption of waste management by municipal authorities.

Perhaps the most pivotal event in the broader change towards formal management of waste was the naming of Col. George E. Waring Jr. as the Commissioner of Street Cleaning in New York City in 1895. The reforms Waring initiated synthesized America's first comprehensive approach to municipal waste management: adopting heretofore disparate approaches such as source separation of organic waste, paper, metal and textile "rubbish," and ashes from coal fires and furnaces, as well as creating the country's first hand-sorting operations for resource recovery and resale. Sweeping the streets of litter and horse manure was his main purview, and the white uniforms in which he garbed his 2000 employees helped associate waste collection with public health in the collective consciousness (Melosi, p. 190).

Where the extent of preindustrial resource recovery had been ragpicking and metal scrap salvage, conducted principally by single individuals, Waring set the stage for a broader shift towards the municipal extraction of value from the waste stream. In general however, once advances in medical science showed that garbage was not directly responsible for the spread of disease, pressure to expand waste and sanitation systems leveled off.

1.1.2. Resource Recovery and Pollution

It was not until World War II brought material shortages that resource recovery efforts began to expand again, and dramatically so. Presented as a patriotic responsibility to support the war effort, Americans participated in scrap and rag collection drives at record levels. Yet when shortages turned to surplus in the post-war period, the market for many types of used materials evaporated and with it political and community dedication to resource recovery efforts (MacBride, p. 35). Yet the sense that residents and consumers had a role and responsibility in waste reduction, management and diversion was not lost. As the US population and household incomes began to rapidly increase, the amount of waste produced by the American public began to outstrip the capacity of existing infrastructure to accommodate the waste. In the increasing ubiquity of incineration, public dumping, litter, and open burning as methods of disposal, solid waste became known as the "3rd pollution," after water and air contamination. In 1965, Congress passed the Solid Waste Disposal Act, prioritizing waste management as an issue of national concern. In 1970, following the establishment of the Environmental Protection Agency, Congress passed the Resource Recovery Act, shifting the focus of waste management away from disposal and towards resource recovery, effectively establishing a "waste hierarchy" for the first time, as a system of prioritizing different methods of waste management (see Figure 1) (Melosi, p. 352).

1.1.3. The Emergence of Modern Recycling

Figure 1. Waste Management Hierarchy (U.S. Environmental Protection Agency, 2013)

Though prototypical source separation had been developed during George Waring's tenure as New York's Commissioner of Street Cleaning, recycling as it is broadly imagined today was born out of the first Earth Day celebration in 1970, and is deeply tied to the modern environmental movement. The distinction here is important; while recycling and reuse had been born earlier through concern for public health and cleanliness, the practice was reborn out of concern not for waste's impact upon people but upon the earth. While garbage collection and management continued to be organized around principles of sanitation (as it had been for nearly a century), resource recovery was assumed by neighborhood councils and environmental advocacy organizations with little to no prior experience in the practice (MacBride, p. 38).

With the support of the EPA, many of these non-profit and informal organizations began to supplant existing scrap businesses in the industrial supply chain. One of the most significant impacts of this shift was that the profit motive was no longer the sole motivator for resource recovery activities. Nowhere is this more clear than in the elimination of glass from recycling collection in New York City in 2002 due to a resource market rate that was less than the cost of its collection and management: the public reaction to this change was clear and fierce, and the collection was reinstituted less than two years later (MacBride, p. 41). The disparity between the goals of different stakeholders (citizens groups committed to recycling as an environmental issue, municipal governments responsible for public health and wellbeing and seeking to minimize taxpayer expense, and private hauling companies seeking to maximize profits) has resulted in waste policy that is widely varied between municipalities. This range of priorities has led to frequent struggle over the trajectory of local approaches to waste management. In many cases, efforts to modernize and scale operations to the volume of waste generation have been at the expense of those with the most experience and highest rates of waste diversion, albeit at a smaller scale: private haulers and scrap dealers (Weinberg, Pellow, & Schnaiberg, 2000, p. 185). Balancing this diversity of stakeholder goals has become as critical to administering a waste management program today as managing the diversity of the materials collected.

1.2. History of the Zero Waste Movement

The Zero Waste Movement is a newcomer to the waste management landscape. The movement's philosophy is a clear outgrowth from systems theory and ecology, as applied to waste. The fundamental precept expounded by the movement's advocates is that waste cannot be separated from its prior existence. As the opening phrase of this report states, waste is only waste when it is wasted. While waste management over the last century has focused primarily on dealing with materials once they became waste, Zero Waste advocates call for much broader changes to production and consumption systems in order to ensure that materials never become waste in the first place. In ecological systems, there are flows of energy and nutrients, with the by-product of one process becoming the input of another. When applied to processes of production and consumption, this ensures that the waste product created by one industry becomes the source product of another. When one waste product has no potential for reuse or remanufacture it should be redesigned or an alternative should be employed. This may sound like gratuitous control of industrial production, but when placed in the context of the country's waste breakdown it becomes clear that most current approaches to waste management in the United States are wildly out of scale to the issue as a whole.

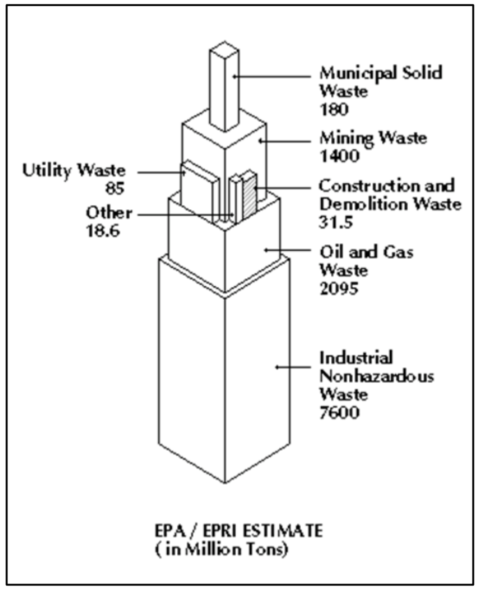


Figure 2. Relative Importance of Different Waste Streams (Harkopf, 2015)

A sense of personal responsibility has been key to the development of resource recovery programs from before World War II until today. This ethic of individual responsibility was the foundation upon which early environmental and community group involvement in recycling efforts was built and continues to be an important tool in diverting waste from the residential waste stream. However, EPA estimates show that the entire (MSW) stream constitutes only a small fraction of all waste generated in the U.S., with the majority made up of industrial nonhazardous waste as a byproduct of industrial manufacture (see Figure 2). While municipal governments have been able to address residential waste to varying degrees, the extent to which cities have been able to manage, direct, and limit the waste generated by commercial enterprise and manufacture has been extremely limited. For this reason, Zero Waste advocates have argued for a more comprehensive approach to waste management, one that considers the elements that drive waste generation, from the point of a product's design to its disposal, and build a response that is appropriately scaled to the broader issue.

While the central pillar of Zero Waste thinking is a well-designed production and consumption system, several other issues are inextricable from this approach. First, concern for public exposure to toxic chemicals and compounds, both released in the process of many current waste disposal practices and through daily contact with products containing toxic components, is at the root of the movement's call for the reduction and eventual elimination of toxic compounds from consumer goods and waste management practices. Of particular concern is both the leachate that seeps from sanitary landfills once the impermeable rubber liner begins to age and break down, polluting local water sources, and the emission of dioxin, a carcinogen emitted through the process of incineration (Connett, 2013, p. 44). Whereas the federal government and many states, including Maine, have adopted waste hierarchies that place waste-to-energy facilities above landfills, Zero Waste advocates contend that neither is an acceptable method for disposing of solid waste. In this sense, the Zero Waste movement rejoins both the initial public health impetus for waste management seen during the incipient stages of industrialization, and the environmental aspirations of 1970's environmentalists for broad adoption of recycling programs.

Second, minimizing waste without thought to the social impacts of the employed strategy is antithetical to Zero Waste thinking. Finding an appropriate location for new landfills and incinerators has been a historical challenge due to the unwillingness of many local residents to accept such a structure in close proximity to their homes (NIMBYism) (Gould, Schnaiberg, & Weinberg, 1996, p. 136). Community resistance has been most focused on siting procedures that have been largely determined by political expedience, with the poor and minorities disproportionately hosting landfills and incinerators in their communities. The rights of these communities to define the degree to which they engage in waste management efforts and to empower them to have a voice in defining waste policy that affects them is a central focus of Zero Waste leaders (MacBride, p. 167).

Additionally, the specter of climate change has given rise to a third tenet of Zero Waste and is grounds for the movement's principle focus on reuse and source reduction. While waste has been attributed only a marginal responsibility for U.S. greenhouse gas emissions [at 2.1% of all emissions (U.S. EPA, 2015, p. 450)], Zero Waste advocates contend that if products are considered throughout their production, consumption, distribution and reproduction processes, so too must emissions relating to those processes be counted. Emissions avoided through reduced consumption or reuse promises much higher impact than emissions avoided through recycling or composting. Therefore, Zero Waste advocates, activists, and entrepreneurs have justified the attention they dedicate to reuse and source reduction above other strategies using the lens of climate impact.

1.3. Zero Waste Policy Priorities

The motivations of the Zero Waste movement have solidified into several central policy priorities.

- First among these is a mid-range goal of *a waste diversion rate of at least 90%.* Recognizing that even with aggressive and successfully applied waste reduction and diversion policies, some inorganic, non-recyclable fraction of waste will remain. The measurement of a diversion rate should not be limited to residential municipal solid waste (MSW), but also to businesses and industry.
- In order to address this remaining indivertible fraction, responsibility should be shifted to manufacturers under the form of *Extended Producer Responsibility (EPR) regulation*. Bottle bills, a deposit/refund system for containers, are an example of such an approach, and have been shown to be extremely effective.

However, many forms of EPR exist and can me tailored to the unique conditions surrounding each product. This approach is particularly important considering that most products are traded nationally or internationally and waste is dealt with at a municipal scale (in "home rule" states such as Maine). With broad distribution, eliminating waste at the source can be more effective and efficient.

- *Industrial ecology* approaches to reuse and remanufacture, particularly in the form of eco-industrial parks in which businesses with complementary inputs and outputs co-locate to leverage their complementarity into higher profits and waste diversion.
- *Adequate support of reuse enterprise*, in both its small and large-scale forms, is a priority directly derived from a strict interpretation of the waste hierarchy. Initial support has been directed primarily towards small, neighborhood scale businesses. Admittedly, the capacity of the existing reuse industry to process and resell products is out of scale with the volume of waste produced. Support for regional scale reuse industry to adapt to regional volume waste is a key priority as diversion rates increase.
- In order to reduce exposure to toxins in the environment, *incineration and landfilling should be phased out*, and in order to reduce toxins in consumer products, *production techniques and toxic materials should be more restrictively regulated*.

1.4. Resources and Obstacles in Portland, Maine

Portland is a city of just over 64,000 residents (City Data), with its urban core located on a peninsula and lower density built-up areas reaching out towards Westbrook to the west, South Portland to the south, and Falmouth to the north. Maine's commercial hub, it is home to an older population than Maine as a whole. Portland also hosts a large student-age population, a thriving art scene, an increasingly renowned culinary culture, and many locally owned and operated small businesses, due in part to a successful "Buy Local" campaign. The city's unique characteristics provide many opportunities for the development of a waste strategy founded on the principles articulated by the "Zero Waste" movement with diversion rates that approach 90%. However, Portland, like any city, also has elements that can be barriers to the implementation of a comprehensive waste strategy. Resources and obstacles are not always clearly differentiated. Some resources may constitute obstacles in certain contexts.

1.4.1. ecomaine

Southern Maine is relatively unique in the United States for its approach to municipal waste management. Where most municipalities in "home rule" states are exclusively responsible for their own residential waste collection and disposal, Portland has joined with 20 other member towns and 25 client towns to jointly process municipally collected waste (ecomaine, 2015). The company is operated as a non-profit, which allows the organization's municipal leadership to set goals that take a long-term view and prioritize diverse interests of the member communities, rather than being driving principally by a company-specific profit motive.

ecomaine's size is one of its greatest assets. Many smaller towns that are solely responsible for their waste management struggle to establish economies of scale and are left to pay relatively high rates with a constrained budget. The economies of scale achieved by ecomaine have enabled Portland and other member communities to collect recyclables curbside in addition to garbage collection, making recycling much more convenient for city residents. ecomaine's primary facility consists of a materials recovery facility (a recycling center) and a waste-to-energy plant (an incinerator). The main facility is located in Portland, with ash from the waste-to-energy facility mined for residual metal and deposited in an ashfill located on the South Portland/Scarborough line.

ecomaine's governance structure allows all member communities a voice in operational decisions as a number of votes proportional to the volume of waste each town delivers to the facility. This serves as a reminder that Portland does not have absolute control over the management of its own waste. The negotiation that is required through this regional collaboration can slow or compromise progress towards the goals Portland sets for itself, but it also allows for the extension of waste reduction and diversion measures to towns that would not otherwise be able to adopt such approaches, thus increasing the collective regional impact of this style of management.

The physical organization of the facility provides unique opportunities as the regional waste management needs and desires grow and change and the existing facility reaches the end of its functional life. With the co-location of recycling and waste-to-energy, the complex has all the makings of an eco-industrial park. This central goal of the Zero Waste movement, built on principles of industrial ecology, would see the development of regional industry around the facility, using some of the recyclable or reusable materials extracted from the waste stream to be used as inputs to manufacture. The precedent for this is already set: Ruth's Reusable Resources, a recycling business catering to teachers, is already steps away from the ecomaine facility. The development of such a park would reorient the current waste management strategy further up the waste hierarchy, away from incineration and with a greater focus on reuse and recycling.

As the existing incinerator reaches the end of its productive life, the member communities will be faced with a choice. In order to keep the facility running, a certain base level of garbage is required at all times, meaning that as Portland and other member communities begin to achieve the diversion rates they have set as goals, the waste diversion priority will begin to collide with the operational needs of the facility. The effects of this dynamic are visible in Sweden, where great success in decreasing consumption waste, increasing diversion to recycling and significant incineration infrastructure have forced the country to import waste from surrounding nations to keep its facilities running and the electricity flowing to the homes they power (Public Radio International, 2012). As ecomaine is presented with a shifting waste landscape in southern Maine, Portland and other member communities should remain aware of the potential for conflict between long-term waste reduction and diversion goals and the operational dependencies of existing infrastructure. Any opportunity to reduce this potential conflict should be seized, and perhaps the greatest opportunity will appear as the existing waste-to-energy facility reaches the end of its operational life.

ecomaine maintains an education and outreach program and a grant program that have had significant impacts in the surrounding community. In addition to frequent tours for school children and interested residents, and a grant program for waste reduction and diversion in local schools, the organization refunds excess revenue from tipping fees back to member communities for use in waste management and environmental stewardship (ecomaine recycling committee, 2015). These programs have contributed to a much broader awareness of recycling issues among area young people, enabled composting in public schools, and even funded the creation of a new 'sustainability coordinator' position at the municipal level (Harrington, 2015).

1.4.2. Riverside Recycling

In addition to the ecomaine facility, Portland's waste is managed at the Riverside Recycling facility on Riverside Drive. The site is owned by the city, but operated by a private company, and processes much of the city's construction and demolition (C&D) waste and yard waste into salable mulch and crushed stone. In compliance with Maine's Framework Legislation for Producer Responsibility (see Chapter 3.6.1.1), Riverside Recycling is also Portland's collection site for electronic waste, compact fluorescent light bulbs, mercury thermostats and all other items covered by the law. Household hazardous waste can be delivered to the facility. Facility personnel will remove hazardous materials from the resident's car without any further handling on the part of the resident. Bulky waste, such as furniture and rugs, can be delivered to the facility; Portland homeowners have the right to dispose of ten bulky items each year free of charge (Riverside Recycling, 2012). The remainder of construction and demolition waste not extracted for recycling is disposed of in a small sanitary landfill onsite. Enough space is available at the site to expand the existing recycling operation to accommodate a larger construction and demolition waste stream and to establish an organic material composting site, if desired. Compost produced by WeCompostIt!, a local source-separated organics hauling and composting business, is already sold alongside Riverside Recycle's own recycled C&D material. There may also be adequate space for the development of some other type of mid-scale infrastructure for waste reduction and reuse, such as a materials recovery and reuse facility.

As diversion expands, the facility's size is its main shortcoming in meeting Portland's aggregate need. While the facility can be expanded to some degree, it is unlikely that it will be able to process two or three times what it processes today, in the case that Portland doubles or triples its diversion rate of both residential and non-residential waste in line with broader waste reduction goals.

1.4.3. Municipal Leadership

In 2010, by order of the Portland City Council, a Solid Waste Task Force was established in order to assess the state of both private and public waste management in the city and to work with various stakeholders to achieve the State's 50% recycling rate goal within five years. The Solid Waste Task Force gave its report to the Council in 2011 (Anton & Leeman, 2011) and the city's leadership has diligently worked to achieve those goals ever since. While many of the task force's recommendations remain under consideration, several among them have been achieved.

Most notable among them is Order 264 12/13, a recently passed ordinance requiring that the owners of multi-family apartment buildings provide recycling facilities to their residents (City of Portland, 2014). Where many households living in large apartment buildings had been precluded from participating in curbside collection of recyclables due to logistical barriers, this ordinance enables participation in recycling efforts of many residents who had been largely excluded from convenient recycling programs.

Waste reduction measures, though not explicitly delineated in the Task Force report, have also found form in two recently adopted measures: a five-cent fee placed on every disposable shopping bag in Portland stores and a ban on the use of polystyrene “clamshell” takeout containers in restaurants and eateries in the city (City of Portland Department of Environmental Programs & Open Spaces). When recyclable and compostable material is extracted from the waste stream, this type of packaging is what remains. By coming close to removing it from the waste stream altogether, the city will be better placed to achieve its waste diversion goal, whether 50% or 90%.

1.4.4. Community Organizations

Portland is home to many small non-profits and informal volunteer groups that advocate on environmental issues, waste among them, as well as a strong presence from numerous environmental advocacy organizations operating at the state level. Since Portland is the commercial center of Maine and its largest administrative hub outside of Augusta, the Natural Resources Council of Maine, Environment Maine, the Maine Audubon Society, and the Sierra Club Maine Chapter all have oriented some of their efforts towards some facet of waste policy and have been active stakeholders in some of the recent municipal waste reduction ordinances passed in Portland (Billings, 2013). Partnership with these groups will be as important in crafting a tenable Zero Waste policy for Portland as cooperation with operational partners such as private waste haulers.

Additionally, many of the most proactive groups in waste reduction and diversion efforts are the student “Green Teams” in Portland’s public schools. Many church groups and informal neighborhood coalitions have been central to neighborhood-scale community organizing around recycling and composting efforts. One of the most recent and most vocal proponents of a systems-based approach to food waste is the Portland Permaculture Hub, which has proven to be an active informal organization uniting farmers and gardeners, residents desiring a lighter footprint, and community organizers and activists. The group has been significantly involved in the Mayor’s Initiative for a Healthy Sustainable Food System, which has established a significant reduction in food waste and support of private composting businesses as a central goal (City of Portland, 2014).

While these advocacy groups can be useful partners in the development of waste policy, they can be limited in the degree of their involvement by personal constraints. Since statewide groups have few staff and a large geographic purview, they must be selective about which issues they take on as centers of focus. On the other hand, small groups can focus on smaller issues, but may be constituted entirely of volunteers, in which case the time constraints of work, school, and family can make long-term consistency a challenge.

1.4.5. Private Waste and Compost Haulers

Private business manages many part of waste produced in Portland. Since the waste generated by commercial establishments is not included in municipal curbside collection, it is the sole responsibility of business owners to contract with a private company to collect, manage, and dispose of their waste. Many haulers provide recycling services to their commercial clients, though some choose not to. While numerous small to mid-sized haulers have provided garbage collection service for decades, several new entrants to the market are noteworthy. Garbage-to-Garden collects organic waste from residential clients in Portland and six nearby towns, while WeCompostIt! (formerly Resurgam) collect principally from commercial clients in Portland, though they have recently expanded residential curbside collection to Brunswick and Kennebunk.

As Portland considers waste policies oriented towards commercial generators of waste, these private hauling companies will be key to the development of viable approaches. There are numerous opportunities for cooperation and coordination to achieve greater recycling and organics diversion rates in the city. The organics waste haulers have already been considered in ecomaine's 2013 organics collection and composting feasibility study in four of nine scenarios. Under these scenarios ecomaine would partner with private haulers and composting businesses to expand organic waste collection to residents of all member communities without having to invest in infrastructural development of their own (Northern Tilth, 2013). Though all scenarios were ultimately judged financially infeasible at the time of the study, as conditions under which organics collection would become feasible develop either under pressure from municipal policy or as a product of market changes, these private haulers are important stakeholders in the development of Zero Waste policy in Portland.

That involvement of these haulers is central to Portland's waste diversion strategy does not imply that they do not have limitations. First among these is their size: the size of the businesses and their processing facilities is commensurate with current levels of demand, but would not be adequate to manage the full volume of Portland's organic waste if it were to be extracted in its entirety. Since organic waste constitutes roughly a third of the residential waste stream, local haulers may not be prepared to process the organics generated by an aggressive organic waste diversion policy. While new haulers may enter the market to compensate, the current scale of operations does not allow Portland area composters to achieve the economies of scale that have been achieved in larger cities that have instituted organic waste diversion policies with either municipal facilities or a single franchised hauler. Additionally, traditional trash collection services, particularly those that do not currently offer recycling collection, may present significant resistance to policies that would have an impact on their current business choices.

1.4.6. Reuse Businesses

The reuse industry is a well-established tradition in Maine and Portland is no exception. While large-scale, national thrift businesses such as Goodwill Industries, Catholic Charities and the Salvation Army are certainly present, many smaller thrift shops have sprung up in recent years targeting different submarkets, generally in a higher price bracket. While the large-scale businesses tend to sell a wide range of reusable items, these smaller shops tend to sell only clothing. Numerous antique stores and pawn shops sell used goods in a wide price range.

Portland is also host to a number of specialized reuse enterprises, most notably Ruth's Reusable Resources, which offers used art, craft and school supplies to teachers whose schools have paid a membership fee, and the Habitat for Humanity ReStore, which sells reclaimed, partially used or overstock building construction materials and home hardware. While the used material diverted from the waste stream might conceivably be measured, far less quantifiable is the vast number of informal exchanges that occur through yard and garage sales, Craigslist, EBay, and Uncle Henry's classified listings.

ReStore targets construction and demolition (C&D) waste, just as Riverside Recycling does, but diverts it at a much higher point on the waste hierarchy. A board that becomes mulch at Riverside Recycles retains its original purpose at the ReStore. However, the ReStore has limited storage space and will refuse material if there is no room for it, constraining the degree to which Portland can lean on it as an outlet for higher levels of the city's C&D waste. Goodwill provides an additional service to that of reselling used products; it is one of the only textile recyclers in the area, sending unsaleable or unsold clothing to be remanufactured into industrial rags or automotive trunk liners. While equipped with the capacity to accept a much larger volume of textile material for recycling, source separation, collection and transport are not within the scope of their operations, and many in the public are unaware that ruined textile material can be recycled there.

1.4.7. Local Farms/Local Restaurants

Portland has become renowned for the caliber of its restaurants and eateries. This culinary focus translates into a great deal of food waste, but this abundance of organic waste is also an opportunity. Where large, municipally-run composting facilities need a large volume of organic waste in order to benefit from economies of scale in the production of compost, Portland's restaurants can provide the basis for such scale. WeCompostIt! and Garbage to Garden have already proven this to some degree, but would likely be unable to cope with the entire volume of Portland's organic waste. A 100% organics diversion mandate, tied to municipal collection and discounted collection fees for restaurants, would set the stage for the scaling up of composting facilities to adequately address the total volume of Portland's organic waste.

Portland area farms are also a potentially consistent market. Benson's Farm sells in bulk any compost above and beyond that which Garbage-to-Garden returns to its customers in bagged form. However, the single farm operation is not at a scale that can truly tap into regional demand for high quality bulk compost. Maine's burgeoning small and mid-sized farm sector is an important market that can be used to best monetize Portland's organic waste resource and give the City a return on the costs of its management.

Of course, there are risks in relying on a single market for any product. Where supply exceeds demand, depressed prices are certain to result. This is likely to be the case with compost produced from Portland's organic waste. On the one hand, depressed prices may make the compost more competitive with conventional fertilizers. On the other hand, it may become more difficult for the City to continue to turn a profit, particularly considering the costs of management. Yet there are multiple ways to use organic waste. In addition to being the key input in the production of compost, it is also used as an input for the creation of biogas through the process of anaerobic digestion. The breakdown of the organic waste in an oxygen-free environment creates methane as a by-product, which may then be used as a fuel for collection vehicles converted to run on natural gas, or more feasibly as a fuel source for the generation of electricity.

The sale of this electricity back to the grid would be another market for food waste, allowing further monetization of the resource without encouraging depressed prices for compost by flooding the regional market. Here too, farms may be a vital resource: where the anaerobic digestion process benefits from the inclusion of high carbon material, such as hay or straw, local dairy farms would be prime sites for the location of such digesters. In this way, farms already participating in the management of Portland's food waste would be able to maintain a similar role through profit sharing from the sale of electricity generated by a combination of the animal waste and food waste delivered by municipal collections vehicles. As undigested food generates up to three times more gas than digested animal waste, the inclusion of a guaranteed stream of organic waste could ensure the success of this type of public-private partnership.

Where markets are subject to external pressures, this diversity of production is key to maintaining a stable profit from the management of the organic waste resource. Particularly when on-farm demand for compost is largely dependent on climatic factors and regional demand for agricultural products, market shifts can often occur without considerable warning and with few opportunities for loss mitigation. One of the prime opportunities to mitigate these risks is in the diversity of markets in which food waste can be sold, where each market is influenced by largely separate external factors.

The interrelation of farms and organic waste is a prime example of the systemic nature of production, consumption, and waste. Thinking of waste as an element of this broader network lays the foundation for establishing approaches to waste management that fit into this broader context. As much as possible, Portland should consider ways to close loops of production, consumption, and waste in order to build stable supply chains and mitigate the impacts of economic growth on the environment.

1.4.8. Maine's EPR Law

Maine's Framework Legislation for Producer Responsibility is not specific to Portland, but it is a background condition over which Portland's assets and challenges have been transposed. Maine currently has one of the most comprehensive extended producer responsibility (EPR) laws in the country, requiring manufacturers of certain products to either establish a system to recover and recycle their products once they have reached the end of their productive life or to pay for the municipal collection and management of those products. Currently covered by the law are mercury thermostats, compact-fluorescent light bulbs, rechargeable batteries and cellphones, electronic devices, and mercury auto switches, though the program will soon be extended to include architectural paint as well (Bureau of Remediation and Waste Management, 2015). Many retailers of these materials, such as hardware stores, accept the materials for recycling. Goodwill Industries now accepts e-waste, as does Riverside Recycles (in compliance with the Framework legislation). It is likely that the law will continue to expand, as the State has named several other products, including carpeting, as potential targets for inclusion in the law.

Chapter 2

The Why of Waste:

Discerning the Socio-Economic Drivers of Residential Recycling and Waste Disposal Behavior

Given the amount of waste produced nationally and plateauing diversion rates[1] despite broad based campaigns for recycling, a great deal of attention is directed nationally towards understanding why people waste. In general, investigations into the defining factors for why and to what degree households generate and divert waste focus on two types of explanations. The first, and more common, is the ideological basis for conservation and recycling. This tends to center on the environmental and populist ethic of each household, and attempts to measure the degree to which political or ethical leanings define participation in recycling programs and waste reduction efforts (Peretz, Tonn, & Folz, 2005; Hornik & Cherian, 1995; Guerin, Crete, & Mercier, 2001). These social analyses are most often conducted using surveys of individuals who participate in and avoid recycling programs, with specific questions geared toward understanding their internal motivations for such participation or non-participation.

The second type of study is oriented towards discovering the socioeconomic drivers of waste generation and recycling rates. Because the level at which economic, demographic, housing and waste generation statistics are most available is at the city, regional or state level, the most common analysis of these factors is performed using aggregated city data. These inter-municipal comparisons are often used to define household level generation, in order to maintain comparability between cities of differing size and levels of economic activity.

Some of the studies focusing on the social determinants of recycling behavior have established a wide range of independent variables against which to measure the generation of waste tonnage and recycling rates. On the other hand, many studies focusing on the demographic and economic drivers of waste and recycling have been based upon a much more limited scope. The tendency has been to compare the generation of solid waste and the diversion rate to personal income, population density, and the presence of different waste policies (Mazzanti, Montini, & Zoholi, 2008). Where recycling behavior has been examined exclusively, educational attainment, median age, housing type and ownership are also examined (Shan Shan, 2010), but cross comparison with the other dependent variables is less common.

Many research studies have explored the relationship between income and household waste generation, with a significant number of such studies geared toward discerning whether or not increases in waste generation decouple at some point from income, with less waste being generated per unit of income after a certain income level is passed (an environmental Kuznets curve) (Johnstone & Labonne, 2004; Karousakis, 2006;

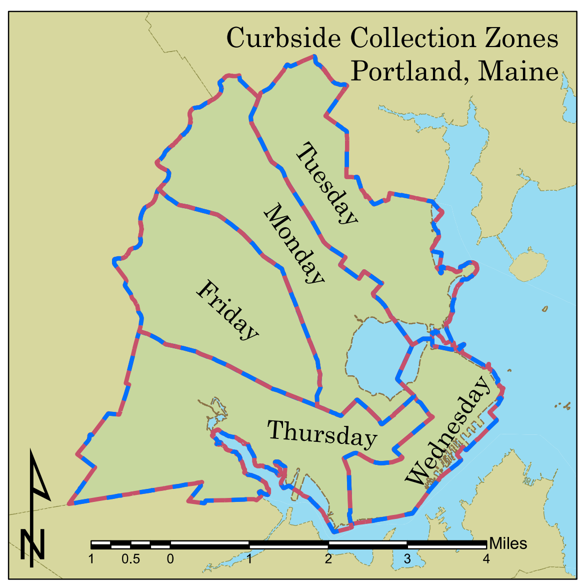
[1] Diversion rates refer to the percentage of total waste diverted from lower priority management such as landfilling and incineration and towards higher priority management such as recycling or reuse. In reference to municipal solid waste collected from residences, it is recycling divided by total waste (garbage plus recycling).

Abrate & Ferraris, 2013; Vassilis, 2012; Emery, Griffiths, & Williams, 2003). In all studies, research was conducted at the country, state or city level, and findings varied significantly from one study to another. Nearly all multi-country studies have shown that waste generation tends to increase alongside other economic factors and that there is not strong evidence that the generation of waste per dollar declines after a certain household income level is reached. Yet because prior studies have focused nearly exclusively on broad scale aggregated data from multiple cities or countries, a consistent caveat has been that broad-scale trends disguise important variations between heterogeneous factors at the sub-city scale. One important meta-study calls for further research into the localized relationship between socioeconomic factors and waste generation to fill this gap (Mazzanti, Montini, & Zoholi, 2008). In the intervening years, more finely detailed data has become available and such fine-grained analysis has become increasingly feasible. As Portland continues to develop its policy agenda regarding waste management, recycling, and sustainability initiatives including "Zero Waste," fine-grained analysis of the socioeconomic features of the city's waste landscape will establish a firm foundation on which the city can develop its policy.

2.1. Methods

The scale, scope, and precision of studies comparing waste generation and diversion to socio-economic factors are largely defined by the availability of data. In most cities, the waste that is measured is that which is at least partially municipally managed between its point of generation and its point of disposal. When private haulers manage waste, the process of measuring it becomes much more challenging. In some cases, this is because the tonnage records kept by those haulers are not aggregated by a central administrative body; in other cases, this is because no tonnage data is kept at all. In Portland, commercial waste and the waste of large apartment buildings and many condominium associations is managed by private haulers and data detailing these waste streams is either inaccessible or non-existent.

However, the City collects both trash and recyclables at the curbside for all residential properties and those condo associations or apartment buildings that request the service. Collection is undertaken by city employees using a city-owned fleet of collections vehicles and the waste is brought to the ecomaine transfer station and waste-to-energy facility. Because each vehicle is numerically designated and is weighed before and after depositing waste and recycling at the ecomaine facility, separate daily tonnage values for waste and for recycling are available. Because collection of waste on any given weekday corresponds with a clearly delineated



Map 1.) Curbside Collection Zones in Portland

area, the waste that is generated in each of five collection zones can be aggregated separately per month and per year (**see Map 1)**. Because waste and recycling is collected in separate trucks and deposited separately, an accurate recycling rate can be assessed for each zone for any given period of time. This data has been reliably collected since 2008, soon after the institution of single sort curbside collection of recyclables (all types of recyclables mixed in a single bin). This study has primarily analyzed yearly averages from 2008 to 2014.

At the same time, Portland's tax roll can be joined with a geographic information system (GIS) map of the city to establish the nature of the building stock in each collection zone. Both the number of units in each building and the property value ascribed to each unit in a building (two units in a building would both be assigned an equal share of both building and land value) are socioeconomic indicators of the households that live therein. Thus, for each zone it was possible to define a ratio of single-family detached homes to other types of housing, effectively defining the degree to which the zone was typified by urban or suburban neighborhoods. Socioeconomic data is also available from the US Census, through the decennial census and American Community Survey (ACS). Both are connected to spatial boundaries that correspond closely with Portland's solid waste collection zones, so the data available from those sources are useful for comparison to the waste for which each zone is responsible.

From the decennial census, the number of households and housing units for 2000 and 2010 were available. The ACS provided data on educational attainment, household income, personal income, median age, housing vacancy rate, and housing ownership. Models were created to estimate a single yearly value for each variable in each collection zone. Estimates of the number of households served by municipal curbside collection were used to discern how much trash and recycling an average household in each zone generated in each study year. The degree to which changes to multiple variables from year to year resemble each other describes the degree to which those variables are correlated. While not enough to strictly establish that one variable causes another, the presence of a strong correlation demands more detailed examination of the way those variables interact. **For a more detailed explanation of the processes used to establish and compare the variables used in this study, see Appendix A**.

2.2. Correlations and Relationships

In order to discern how strong a relationship exists between each set of variables, each dependent variable was compared with each other independent and dependent variable to find a correlation coefficient. Because each of the dependent variables (except for the recycling rate) are derived from three sub-models with approximately 90% confidence, any correlation with a probability greater than 65% can be interpreted as significant, although higher degrees of correlation clearly show a more direct relationship. From the calculation of the correlation between different variables and the subsequent interpretation of the nature of that relationship, a picture of the drivers of household waste and recycling in Portland emerges.

A 93% correlation between average household income in each collection zone and the average amount of total waste generated by each household is a clear indicator that where household income is higher, total waste is greater. In this case, waste generation does not appear to level off after a certain level of income. This conclusion is reflected in some prior studies comparing income and waste generation at the city and country level, but not with some studies that have shown that the increase in waste generation has slowed as income has climbed (Mazzanti, Montini, & Zoholi, 2008). In a broad sense, this could mean that waste is uniformly driven by consumption: that the more money one has, the more they buy, and the more they buy the more they waste. That the correlation between these two variables is so high would seem to support this conclusion.

Household income also shows a strong relationship with the amount of recyclable material generated by each household, with an 88.9% correlation. Because total household waste generation and household generation of recyclable material is closely connected (87.7% correlation) and the recycling diversion rate is connected to the amount of recyclable waste produced by each household at a moderately high level (74.6%), the three elements appear to be strongly interrelated. Where income is greater total waste generation is greater, where total waste generation is greater the generation of recyclable materials is greater, and where the generation of recyclable materials is greater the diversion of recyclable material from the waste stream is higher.

However, because the amount of trash (excluding recycling) generated by each household is not strongly correlated with household income, it is clear that the relationship between wealth and income is more complex than at first glance. Total household waste generation and household generation of recyclables is also higher where homeownership rates are higher (88.4% and 92.3% correlations, respectively) and where the ratio of single-family detached homes to buildings with two or more housing units is highest (74.5% and 87.6% correlations respectively). At the same time, an area's percentage of single-family detached homes is strongly related to the percent of recyclable materials diverted from the waste stream (67.25% correlation). There is also a relationship between a higher median age in each zone and a higher level of household generation of both total waste and of recyclable material (76.6% and 83.9% correlation, respectively).

Percent Correlation Between Variables	Average Waste Per Household (lbs/year)	Yearly Recycling Diversion Rate	MSW Per Household (lbs/year)	Recyclables Per Household (lbs/year)	Average Median Household Income	Average Median Personal Income	Owner Households as an Estimated Percent of All Households	Ratio of Units in Single Family Dwellings to Units in Multi Family Dwellings	High School Graduates as a Percent of the Population	College Graduates as a Percent of the Population	Average Median Age
Average Waste Per Household (lbs/year)											
Yearly Recycling Diversion Rate	33.61%										
MSW Per Household (lbs/year)	61.34%	18.57%									
Recyclables Per Household (lbs/year)	87.65%	74.63%	51.86%								
Average Median Household Income	93.31%	45.35%	55.54%	88.93%							
Average Median Personal Income	77.67%	46.51%	55.26%	78.00%	78.40%						
Owner Households as an Estimated Percent of All Households	88.35%	59.37%	51.92%	92.34%	92.04%	78.30%					
Ratio of Units in Single Family Dwellings to Units in Multi Family Dwellings	74.46%	67.25%	39.62%	87.63%	85.95%	77.98%	82.51%				
High School Graduates as a Percent of the Population	29.50%	31.90%	26.37%	36.38%	30.17%	73.86%	29.68%	37.10%			
College Graduates as a Percent of the Population	-26.24%	15.76%	-17.49%	-9.97%	-11.36%	23.53%	-19.35%	12.05%	65.25%		
Average Median Age	76.61%	59.33%	46.62%	83.89%	75.03%	81.37%	86.95%	73.78%	36.43%	-5.65%	

Table 1. Percent Correlation Between Waste Generation and Socioeconomic Variables in Portland, Maine from 2008 to 2014

Despite the connections drawn between levels of education and an individual commitment to recycling and environmental causes, educational attainment shows a very weak relationship with total waste generation, recycling rate and household generation of trash, and household generation of recycling as measured by the percent of the population having graduated from high school and the percent of the population having graduated from college.

2.3. Change over Time

While broader relationships between variables are visible by examining all years as a whole, it is also clear that changes of the amount of waste and the recycling rate have not been homogeneous across collection zones over time (see Figure 3). While the city's waste as a whole has increased over time, so too has its population (City Data). These two factors, when examined together to interpret the waste generated in Portland, show that the waste generated by each household has gone slightly down since 2008. However, a decline in the citywide average disguises the very different shifts in each collection zone. While total waste generation in the Wednesday collection zone (Portland's peninsula except for the Parkside neighborhood) sees a significant decline between 2008 and 2014, the drop in waste generation in the Thursday collection zone (Parkside and outer

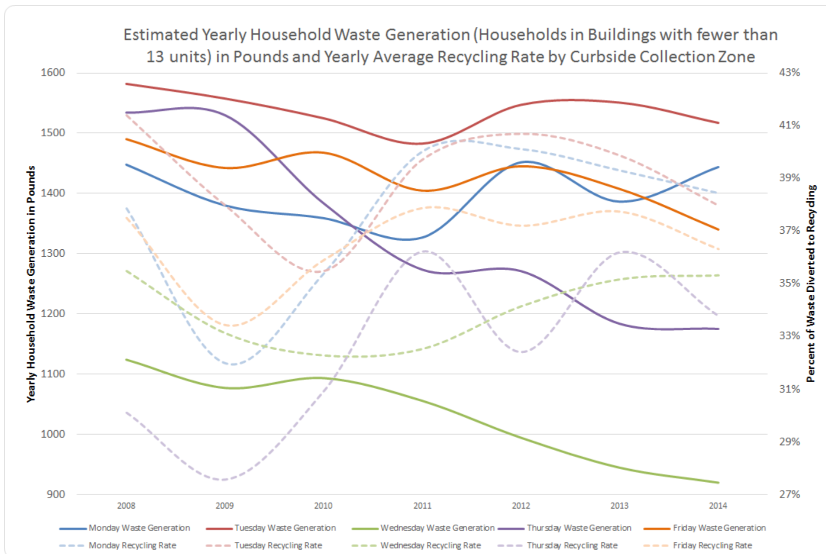


Figure 3. Changes in Household Waste Generation and Recycling Rate by Collection Zone

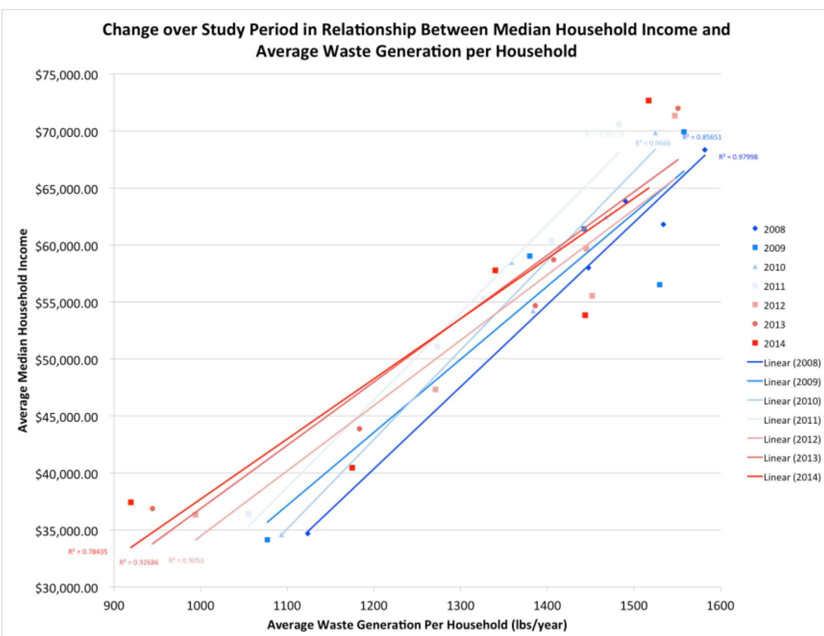


Figure 4. Change over Study Period in Relationship between Median Household Income and Average Waste Generation per Household

Congress Street) is precipitous. At the same time these are the zones that have historically hosted, and continue to host, the city's lowest recycling rates. However, the increase in their recycling rates has mirrored the decline in their waste generation tonnage over time, so even while their rates of diversion are lower than elsewhere in the city, their improvement has been more dramatic than elsewhere and their per household generation of waste has remained lower.

On the other hand, household generation of waste in the Monday, Tuesday, and Friday, and Friday zones (the neighborhoods bounded by outer Forest and outer Washington Avenue, by outer Washington Avenue and the Town of Falmouth, and outer Forest and Brighton Avenues, respectively) has remained relatively stable over time. In these three zones, recycling rates peaked around 2011 and have declined for the past few years, with total waste generation per household declining slightly in the Friday zone and increasing slightly in the Monday zone.

The relationship between household income and waste generation also appears to have changed over time. While between 2008 and 2011 waste generation per household decreased relatively evenly across all income levels, this relationship began to shift after 2011, with waste generation increasing for those households at the upper end of the income spectrum and decreasing for those at the lower end. Economists would refer to the relationship between household waste generation and household income level as increasingly elastic. Simply put, in any given year, a smaller change in household income level would correspond with a more substantial change in household waste generation.

Because the model upon which this analysis is dependent is based upon numerous sub-models, precise comparison of the zones is not possible. However, broad trends are more reliably interpreted and can contribute to directing waste reduction efforts at the neighborhood level.

2.4. Conclusions

The strong correlations found in this study lays the foundation for a more comprehensive understanding of the factors driving household waste and recycling behavior. Household income does appear to have a strong influence over the quantity of waste generated at the household level. This is supported by the findings of numerous other large scale studies (Raymond, 2006; Karousakis, 2006; Mazzanti, Montini, & Zoholi, 2008) but also makes intuitive sense: with a greater income, a higher level of consumption is possible, and to the extent that such consumption is of material goods, a higher level of resultant waste would be expected. However, the correlation between a higher level of waste diversion and a higher household income appears to be channeled through several intermediate factors. In Portland, areas with a high median household income are also areas with high levels of homeownership and a high ratio of single-family detached homes to other types of dwellings (92% and 86% correlation, respectively), as well as a higher median age (75% correlation). The picture this paints is one of suburbia.

Thus, it is likely that household income plays a strong role in material consumption, but so too does the type of housing and the age of the homeowner. The extent to which these three factors reinforce each other is not easily discernable, but it is clear that when combined, they are at the root of a higher level of total waste generation. But areas with a lower median income, a greater proportion of renters and fewer single-family detached homes (urban areas) are not necessarily absolved of responsibility for waste generation.

Instead, proximity to urban amenities means that many households can easily externalize a greater proportion of their waste (as eating at a restaurant generates no waste at the household level, shifting the waste from household consumption onto the restaurant instead). Because there is effectively no collection of data from commercial generators of waste in Portland, accurate measurement of the extent to which urban households externalize their waste is currently out of reach.

At the same time, areas with a higher median household income, more homeownership, and a greater proportion of single-family detached homes generate more recyclables by weight. The fact that these areas generate more total waste is attributable to their generation of recyclable waste. That household generation of municipal solid waste (MSW) is only weakly correlated to these same factors belies this fact. Higher recycling rates occur in areas in which households generate a greater amount of recyclable material (74.6% correlation and where there are more single-family homes (67.3%). This means that at the same time as Portland's suburban areas have higher levels of waste generation at the household level, they are also disproportionately responsible for Portland's recycling rate.

As Portland decision-makers consider policies directed towards the single-minded goal of a 50% diversion rate, they should be aware of the fact that without well-considered intervention, increases in the diversion rate may occur concurrently with increases in total household waste generation, due to influence of the intermediate factors described above. This would mean that in terms of raw numbers, households would send a greater amount of waste to disposal, even though the percentage of their waste constituted by recycling would have increased.

2.5. Policy Implications

As Portland reexamines its goals for waste management, particularly those contained within the 2011 Solid Waste Task Force report to the City Council, there are several lessons from this research that can cast light on the efficacy of new and existing policies.

2.5.1. Portland should adopt a waste tonnage reduction goal in addition to its recycling rate goal.

As household income grows in Portland, and as an aging population relocates to a greater extent to Portland's suburbs, both total waste generation and recycling rates can be expected to increase. Currently, households in collection zones with recycling rates around 40% also generate up to 50% more waste than those with recycling rates around 35%. While this increase in recycling rate would meet the goals set out to Maine municipalities (38 §2133.1-A) in the State municipal recycling goals (38 §2132), it fails to address the state waste reduction goal of a 5% reduction in municipal solid waste (MSW) tonnage every two years. Portland should add a waste tonnage reduction goal to its existing recycling rate goal, and consider both in tandem during the development of new policy.

2.5.2. Portland should introduce and maintain economic measures that decouple waste generation from income levels.

Higher household income is related to greater waste generation and higher recycling rates. This relationship is both direct, and indirect through the propensity of wealthy families to own single-family homes. An implication of this is that in order to create policy that maintains a high recycling rate at the same time as total household waste declines, the generation of waste must be "decoupled" from income driven consumption. While a few studies analyzing waste at the country or intercity level have shown some slight decoupling of waste generation from income at levels exceeding the area median income (Mazzanti, Montini, & Zoholi, 2008), such decoupling is not visible in the study of Portland collection zones and thus cannot be expected to occur without intervention. Intervention can either occur before or after consumption, with post-consumption intervention being a more direct and powerful tool for a municipal government to employ.

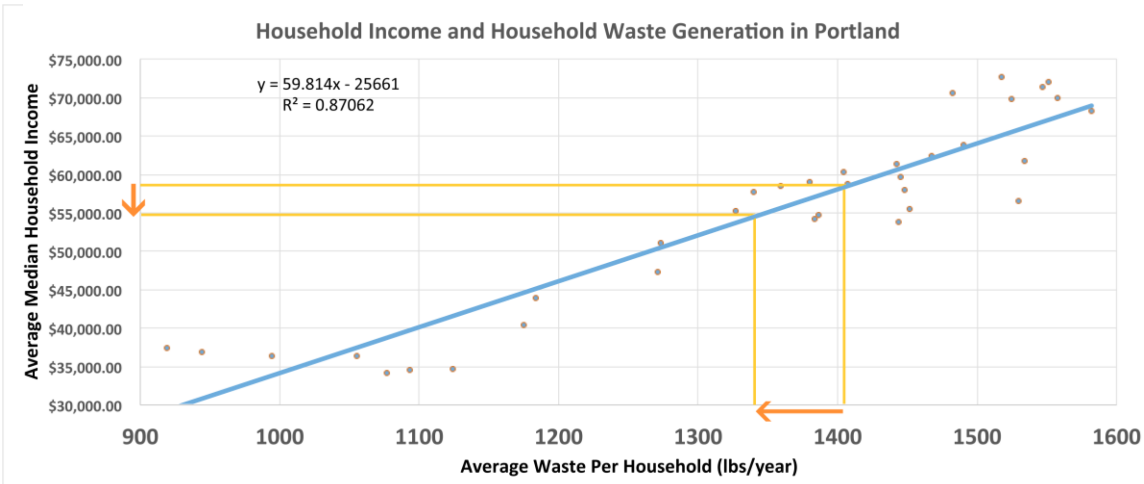
2.5.2.1. *Intervention before consumption*

In order to reduce the amount of waste produced from any given level of consumption without forcing the consumer to modify their choices or behavior, manufacturers must make changes to their products and the way they are packaged. Policies promoting or requiring Extended Producer Responsibility, otherwise known as Product Stewardship, by companies are the forms such intervention would take. Maine's Product Stewardship Framework Law (Title 38, Chapter 18: Product Stewardship) has led to the enactment of numerous Product Stewardship Laws concerning specific products, including rechargeable batteries, mercury auto switches, electronic waste, cell phones, mercury thermostats, fluorescent light bulbs, and paint (MaineDEP). In Portland, recent passage of an ordinance banning the use of polystyrene foam containers for food vendors in the city (City of Portland) effectively excludes that material from the waste stream prior to its consumption by restaurant goers. When undertaken voluntarily by manufacturers, extended producer responsibility often takes the form of either materials conservation (reducing the amount of material used to make each product, as a cost saving measure) or a voluntary mail-in program under which consumers are encouraged to mail the waste from their product to a third party recycling program (Tom's of Maine). **For more details on municipal options for EPR policy, see Chapter 3.6.**

2.5.2.2. *Intervention after consumption*

In order to reduce the amount of waste produced from any given level of consumption after consumption of a product has occurred, increasing the cost of waste disposal encourages households to reduce the amount of waste they produce. Effectively, an increase in waste disposal costs prompts households to create waste as if they were a household with a lower income. The degree to which this is effective depends on the "supply curve" of household waste in any given community, i.e. the degree to which household waste increases as household income increases (see Figure 5). If waste generation increases faster than income increases, the supply curve is relatively elastic; if it does not change dramatically as income increases, it is relatively inelastic. If the household waste supply curve is elastic, waste will drop significantly as a price is put on waste disposal. If the curve is inelastic, a greater price on disposal will be necessary in order to elicit a drop in household waste generation. Pay-As-You-Throw (PAYT) systems are post-consumption market interventions that have been shown to be extremely effective, but should be tailored to respond to the household waste supply curve specific to each municipality. As the relationship between household income and waste generation becomes more elastic, as it has in Portland (see figure 4), a PAYT system becomes increasingly effective. **For more details on municipal options for PAYT policy, see Chapter 3.1.5.1 and 3.1.5.2.**

Figure 5. Impact of Economic Intervention on Household Waste Generation in Portland



2.5.3. Portland should develop more precise waste measurement techniques.

As Portland's population grows and shifts, the city's waste landscape is bound to change as well. Portland has been a locus of regional growth, as newcomers from Boston, New York, and elsewhere have been attracted by the city's culture and amenities to resettle. The attraction of its urban environment, in part due to its perceived provincial character, has led to an increase in the cost of living, housing prices, and household incomes on the peninsula in recent years. To the extent that household waste generation is driven by household income, increasing incomes on the peninsula can be expected to push household waste generation above current levels. To the extent that waste generation in urban areas appears lower due to the convenience of externalizing household waste (due to the proximity of restaurants and other amenities), waste generation in urban areas is not lower than in suburban areas, it is simply unmonitored. With both of these factors in play, increasing household incomes on Portland's peninsula means the generation of a greater quantity of untraceable waste.

In order to develop policy that is well tailored to the specific dimensions of waste present in Portland, a more comprehensive measurement of the city's waste stream should be developed. In order to expand data collection beyond curbside collection, tonnage reporting from private haulers should be required. The haulers covered by such mandate would include trash, recycling and organics hauling enterprises, with data aggregation and management assumed by municipal employees. **For more details on municipal options for mandating tonnage reporting from private haulers, see Chapter 3.2.1.8 and 3.2.2.2.**

At the same time, though the findings of this study address more fine-grained spatial units than have been previously investigated in other studies, they would be made more accurate through a smaller unit of analysis. Some cities track the household generation of waste at the household level, with scales in each truck measuring the waste collected curbside from each house. As Portland looks to replace its aging collection vehicles, it should consider purchasing vehicles that would facilitate more precise measurement of waste generation in the city on which to base policy. **For more details on collection programs suited for household level waste data gathering, see Chapter 3.1.2.1.2.**

Chapter 3

Tools of the Trade:
A Zero Waste Policy Toolbox for Portland

A wide variety of policy tools are available to decision-makers and advocates seeking to develop a comprehensive waste policy that begins to close the loop on the production and waste cycle. Because the materials that become waste are generated on a broader scale, federal and state level policies are needed to address many of the underlying issues. However, because waste is managed at the local scale, there are many options available to municipalities as well. While many city-scale waste policy tools have been targeted specifically at residential waste, generally referred to as municipal solid waste (MSW), many municipalities have sought to manage waste generated by other sectors as well.

The following policy toolbox summarizes many of the waste policies available to municipalities. In addition to policies designed to divert materials from the municipal solid waste stream, policies addressing commercial recycling and organics diversion, tourism-related waste reduction and diversion, the recycling of construction and demolition waste, the reuse and recycling of electronic waste, and local-scale extended producer responsibility policies are also detailed. Summary assessments of all the policies detailed in Chapter 3 are included in Appendix B.

3.1. Municipal Solid Waste (MSW) Collection Strategies

3.1.1. Collection Frequency

3.1.1.1. Increasing waste collection to Every-Other-Week while maintaining weekly recycling and organics collection

The shifting of a collections program to Every-Other-Week (EOW) garbage collection while maintaining weekly collection of recycling and organics is the most powerful policy tool currently available in terms of both increasing the diversion rate and decreasing total waste tonnage to the landfill and incinerator. While the advantages of the approach are quite clear, a great deal of political capital is necessary in order to make the change, as it constitutes a significant departure from the waste collection norms with which most households are familiar. In recent years, they have become increasingly common in Washington State (in addition to numerous examples in Canada), but have also been instituted in some municipalities on the East Coast of the US as well, mostly in the form of pilot projects, though Hamilton, Massachusetts has a fully developed program.

By weight, in 2012, 37% of ecomaine's waste from residential MSW was organic and compostable. This means that a successful organics extraction policy has the potential to remove up to the same amount from the waste stream. This has been true of the municipalities that have chosen EOW garbage collection: Portland, Oregon saw a 38% decline in total waste collected during the first year of the program. At the same time, this collection schedule has led to a 279% increase in organics collection as compared to voluntary programs existent prior to EOW garbage collection (Northern Tilth, 2013, p. 74).

Discerning the precise diversion rate attributable to EOW garbage collection and weekly organics and recycling collection is challenging, as municipalities typically tie the collection schedule to bans (see Chapter 3.1.1.2), integrated or variable rate structures (see Chapter 3.1.5.2, 3.2.1.2 and 3.2.2.6), and significant social marketing programs. To a great extent, these companion policies are key to the success of an EOW garbage collection schedule; in Hamilton, Massachusetts where participation is voluntary (and measured at 44% (Northern Tilth, 2013, p. 72)) the diversion rate is 37% (MassDEP, 2013, p. 18), while in Prince Edward Island, Canada, where participation is mandatory, the diversion rate is 64%.

Collection itself could be undertaken in a number of different ways, which largely define the cost of the program but have little impact on the diversion rate achieved through it. The three most common collection strategies, and those detailed by the composting feasibility study conducted for ecomaine in 2013, are 1.) The use of split vehicles, with trash and recycling being loaded into one side with organics loaded into the other (in this case, both trash and recycling are collected EOW while organics are collected every week), typically with automatically loaded carts 2.) The use of existing vehicles with organic waste and recyclables each collected in bags similar to the PAYT system currently employed in Portland for garbage or 3.) The use of separate collection vehicles for organic waste from those used for trash and recycling collection, either purchased by the city or through municipal contract with or franchisement of private haulers. ecomaine's feasibility study estimates that additional costs for curbside collection of organics over current solid waste collection costs associated would be around $250,000 per year for collection in bags, and twice that for collection with additional vehicles (Northern Tilth, 2013, p. 203). It is likely that bagged collection for recyclables would drive this cost up somewhat, but not dramatically. On the other hand, the cost of EOW collection with split trucks was estimated to be only a fifth of the additional cost projected for bags. However, because Portland does not currently use the split body collection vehicles used in other ecomaine member municipalities, the upfront capital investment for split body vehicles would significantly raise the cost of this program.

As Portland faces the obsolescence of its current fleet of collection vehicles, purchase of split body vehicles instead of new single body vehicles would enable a switch to EOW collection without upfront capital costs beyond what would be necessary for continuation of the existing collection program. In the interim, the use of bags for organics and recyclables would enable greater diversion by assuming slightly higher operating costs while avoiding any substantial capital investment (thus remaining more flexible and adaptive to new policy initiatives).

Whichever mode of collection is selected, social marketing and education is essential to the success of the policy. While Portland tends to have a more receptive public than many, with broad support for waste reduction and diversion initiatives such as the polystyrene "clamshell" ban and the multifamily recycling requirement, policies such as the fee on single use bags receive more significant pushback. This has been true of other communities with a strong culture of environmental protection instituting EOW garbage collection (such as Portland, Oregon), with many reacting in anger about the prospect of having to hold onto their household waste for two weeks, with a particular aversion to the smell. The point of EOW collection, of course, is to extract any putrescibles from the garbage, so that waste collected every other week would not produce any smell. For this reason, it is important to address public concern with publicly stated awareness of the limitations of the program and exclusions or additional targeted recycling programs targeted towards households with unique needs. Diapers have proven to be a recurring point of contention, as they are often excluded from composting and recycling, while two weeks of diaper storage can prove to be quite unpleasant for the homeowner (Profita, 2013). Exceptions for those who are high volume producers of such waste, or a targeted diaper-composting program (see Chapter 3.1.3.2) can effectively reduce contamination of weekly collection with such waste. A strong outreach campaign with involvement from area non-profits would be key to addressing these concerns before roll-out of the program, while continued outreach regarding the specifics of the plan, when collection will occur in different collection zones, and what products are permitted in source-separated organics and recyclables must remain a consistent priority if participation is to be maintained and contamination limited. Because the policy tends to create an incentive for households to dispose of inorganic, non-recyclable waste among the wastes collected weekly, a universal ban on cross contamination of waste streams may be necessary to reduce such contamination (see Chapter 3.1.1.2).

3.1.1.2. Universal Disposal Ban on Divertible Materials

One of the most stringent policies is a universal ban on the disposal of divertible materials, and when applied carefully, it can also be one of the most effective. At its most comprehensive, it is applied across the board. Seattle's disposal ban, enacted in 2005 and expanded in 2014, prohibits the disposal of recyclable and compostable materials from residential, commercial, and self-hauled waste (Seattle Public Utilities). Purely applied bans, mandating 0% contamination of inorganic, non-recyclable waste with organic and recyclable materials would be infeasible, as the costs of enforcement would become increasingly prohibitive as the contamination rate approached zero. Instead, Seattle has opted for a 10% contamination rate; if the curbside collections worker assesses greater than a 10% contamination rate, the bag is left uncollected with a notice warning the waste generator that disposal of recyclables and organics in the trash is prohibited (Seattle Public Utilities). Two notices are given before fines are assessed, which amount to a $50 fine for an apartment or business owner, and a $1 additive increase in the waste collections bill for single family residents upon each infringement.

Two simultaneous strategies are key to the success of a universal ban. First is the provision of recycling and composting services that are cheaper and more frequent than garbage collection. For residential customers, this often means free curbside collection of recyclables (which Portland already has) and free or low-cost organics collection. Every other week collection of garbage with weekly collection of recyclables and organics may overcome price parity between organics and garbage. Second, the ban must be adequately enforced. Enforcement can either be the responsibility of curbside collection workers or dedicated enforcement personnel. In the case that a private hauler collects organic waste, assessment of contamination and the deposition of the warning notice would be that hauler's responsibility.

Transition from current collection practices to collection under a disposal ban presents particular challenges. If there is any public unfamiliarity with the range of materials that are prohibited from garbage collection, the receipt of a warning or fine may come as a surprise. This has the potential to generate public resistance to the ban. The threat of receiving a fine for non-compliance is important to the success of the ban, as compliance tends to rise proportionately with the size of the fine, but public resistance to such policies tends to rise proportionately to the fine amount as well. San Francisco instituted a two-year moratorium on fines for many types of customers in order to acclimate residents to the new policy (Coté, 2009). Permanent exclusions, allowances or free municipal support for residents with disabilities or limited mobility are shared by both San Francisco and Seattle ordinance. Effective public education is important, so that the public is prepared to comply with the policy.

While Seattle permits 10% contamination, San Francisco permits none (San Francisco Board of Supervisors, 2009); this discrepancy appears to be proportional to the political willpower and public tolerance for a universal ban. Where the city wishes to devote less political capital to the policy, or where public resistance is predicted to be high, a higher contamination allowance may be necessary. As residents and other customers become more accustomed to comprehensive source separation, the city may amend the ordinance to permit a lesser degree of contamination. Additionally, the ordinance may need to be worded so that the ban on contamination is reflexive; disposal of trash in source-separated organics and recyclables is prohibited as well as disposal of recyclables and organics in the trash in order to reduce cross-contamination.

3.1.2. Recycling

3.1.2.1. Container Size/Container Alternatives

3.1.2.1.1 Larger open bins

When a curbside collection program already has a high level of participation, several approaches can overcome the barriers that inhibit a city's recycling rate from increasing. Aside from an increase in frequency (see Chapter 3.1.1.1), the only alternative is to increase the size of the collections container in order to accommodate more material. As either total household waste generation increases or the percent of total waste diverted to recycling increases, a small recycling bin may result in overflow as its capacity is reached, with excess recyclables either ending up in the trash or as litter. Items placed next to a small bin with hopes that they will be collected along with the contents of that bin can blow away without the residents intention and create additional litter collection and storm drain cleaning costs for the city.

Increasing the size of the collection bin would require an upfront investment of municipal funds in order to replace the existing collection containers. Municipalities that have attempted to directly pass this cost on to residents have seen very low program participation (EPA, Chapter 5, 1994, p. 59). The upfront costs of the replacement of existing bins with larger collection containers may seem substantial. However, the cost is much less than that of replacement of existing bins with roll-out carts (see Chapter 3.1.2.1.2), as current collection vehicles may be used. However, the long-term savings from decreased tipping fees may be less than what is possible with roll-out carts, due to their lower maximum capacity. At the same time, because collections workers are lifting a greater quantity of material in each bin without the assistance of an automated system, workers are put at greater risk of work-related injury from lifting. The cost of such work-related injuries has the potential to be quite substantial. Some residents may complain that they do not have adequate space for the new bins, but to a lesser degree than for roll-out carts, as larger bins often are taller but not wider than smaller sized-containers.

3.1.2.1.2. Roll-out Carts

Many communities have chosen to replace their manual curbside collection program, one in which collections workers descend from the collection vehicle at each stop to manually lift and empty the curbside collection bins into the rear of the vehicle, with an automated collection program. With automation, the collection vehicle is equipped with a robotic arm that lifts collection containers from where they are placed on the curb, empties them into the rear of the vehicle, and replaces them curbside. The arm is controlled by the operator of the vehicle, thus requiring only a single employee to perform the task for which two had been necessary under the manual collection program. Thus, the upfront costs for the replacement of the existing fleet of collection vehicles with new automated collection vehicles can be largely offset in the long run by diminished labor costs.

Yet automated vehicles have relatively rigid requirements for their operation: large rolling carts with a grip adapted to the mechanical arm are necessary, as well as uniform placement along the roadside and a pivoting lid. The large rolling carts may come in various sizes, though the 60-gallon cart is the most commonly used, and come with several obvious benefits. Because the capacity of the cart greatly exceeds that of the existing collection containers, the upper limit of the quantity of recyclable material that residents can put out for curbside collection is shifted upwards of the high end of household weekly generation of recyclable waste. If collection is conducted on a weekly basis, it is unlikely that recyclables would spill over into the garbage for reason of a lack of adequate space in the collection container. As a result, incidental litter (recyclables blown from the existing open containers) would be all but eliminated.

When compared to the benefits and risks of larger containers, the roll-out carts are more effective at diverting recyclables that would have been wasted due to lack of space in the collection container and also reducing the risk of lifting injuries to municipal employees. For the municipality, the upfront capital costs for the replacement of the existing collection vehicles with vehicles equipped with a robotic arm and the existing collection containers with roll-out carts will be quite significant. The cost of these upfront investments will be partially offset through the reduction of tipping fees from increased diversion rates and reduced litter cleanup costs, as well as through increased property values in neighborhoods currently most affected by litter.

3.1.2.1.3. Bags

In lieu of open top containers, recyclable materials can be set out in dedicated bags similar to the existing Pay-As-You-Throw bag system currently employed in Portland. The bags can reduce the amount of litter that may be blown out of the existing collection bins by completely enclosing the recyclable material and are easier for collection workers to load into the collection vehicles. Any recyclable material must be fit into the bags; anything left adjacent to the bags would not be collected. Because of this ease of collection, there may be cost savings to the municipality if the reduced amount of time necessary for each stop translates into reduced labor hours. One limitation of the bags is their size: residents may struggle to fit very large boxes or other oddly sized recyclable material into the bags, so alternatives to curbside collection (i.e., "silver bullet" source separated collection containers) may need to be placed at additional locations throughout the city to accommodate the disposal of this type of waste. Without other options, residents unable to fit some of their recyclable waste into the bags may place those items next to the bag in hopes that it would be collected, instead contributing to neighborhood litter.

In order to maintain participation in recycling efforts, the recycling bags should be supplied for free to residents, as open top containers are currently. Though cheaper than the bins in the short term, the bags may add up to a greater long-term cost. The mode of delivery of the bags is also an ongoing cost, with residents either obtaining the bags at a local intermediary (as is currently done with Portland PAYT trash bags (City of Portland, 2012)), or being mailed a weekly or monthly quota. In the first case, obtaining the recycling bags risks becoming a barrier to participation in curbside recycling unless included in the purchase of Portland PAYT trash bags, with the potential to reduce Portland's recycling rate. In the second case, the weekly or monthly delivery of bags to residents would be at significant cost, potentially outweighing savings from increased collection efficiency and decreased litter cleanup.

3.1.2.2. Disposal ban for recyclables in residential waste

This policy is a scaled-down version of the universal disposal ban on divertible materials (see Chapter 3.1.1.2), and consequently much more common. Seattle adopted this policy in 2005, nine years prior to its adoption of the universal ban (Seattle Public Utilities). There are several forms that the ban might take. The first is the outright prohibition on the inclusion of any volume of recyclable materials in curbside garbage collection. Curbside collection workers, under this approach, will leave the garbage uncollected, along with notice of a fine for non-compliance. The second is a ban on the inclusion of "significant amounts of [recyclable] material" in the garbage, above which the waste is left uncollected with a fine; in Seattle, this threshold is 10%. A third form is in the exclusion of certain high-volume recyclable materials from disposal in the landfill or incinerator. This is the approach taken by the State of Wisconsin, whose standards individual municipalities are permitted to exceed. Types #1 and #2 plastic, glass, aluminum and steel cans and containers, corrugated cardboard, newsprint, magazines, many appliances and electronics, and lead-acid batteries, among other materials are all banned from disposal in the landfill and incinerator (Wisconsin Department of Natural Resources, 2014, p. 2). This approach targets low-hanging fruit while opting not to mandate recycling for materials that do not have a developed market or that have an average sale price lower that the cost of their management.

The ban is structurally simple, but requires a municipal investment in order to develop an adequate enforcement mechanism. Without enforcement, the policy is ineffective. Like the universal ban on all divertible materials, enforcement of a ban on recyclables can either be the responsibility of curbside collection workers or dedicated enforcement personnel.

While Seattle permits 10% contamination, San Francisco permits none (San Francisco Board of Supervisors, 2009); this discrepancy appears to be proportional to the political willpower and public tolerance for ban on disposal of recyclables with other solid waste. Where the city wishes to devote less political capital to the policy, or where public resistance is predicted to be high, a higher contamination allowance may be necessary. As residents and other customers become more accustomed to comprehensive source separation, the city may amend the ordinance to permit a lesser degree of contamination. If only certain materials are covered by the ban, additional materials may be covered as markets for them develop or as management costs diminish.

Additionally, the ordinance may need to be worded so that the ban on contamination is reflexive; disposal of trash in source-separated recyclables would be prohibited as well as disposal of recyclables in the trash in order to reduce cross-contamination.

3.1.3. Organics Extraction

3.1.3.1. Residential Organics Collection Strategies

As Portland seeks to surpass a 50% diversion rate, the first and most obvious single element of the waste stream that could be diverted in order to achieve this is residential food waste. Since food waste has been estimated to constitute approximately 28% of the Maine residential waste stream (Criner & Blackmer, 2012, p. 8), Portland would achieve a 50% diversion rate by diverting half of its residential food waste (ecomaine, 2015). The lowest upfront cost option for the diversion of this material that would result in the highest diversion rate is composting; indeed, some Portland residents already practice composting on a small scale in their backyards, and several private organic waste haulers operate in Portland (most notably Garbage-to-Garden and WeCompostIt!, though Garbage-to-Garden is currently the only private hauler that collects from residential clients in Portland). While voluntary participation in organic waste diversion by contracting with a private hauler is worthy of note, a monthly flat fee of $14 (Garbage to Garden, 2013) effectively limits the number of residents likely to engage in organic waste diversion measures, by means of an economic disincentive. Numerous cities have elected to expand their curbside collection service to include organic waste, including Seattle, WA, Portland, OR, San Francisco, CA, Boulder, CO, Salem, CO, and Hennepin County, MN. In 2013, ecomaine commissioned a feasibility study to explore the possibility of expanding its services beyond recycling and waste-to-energy to organic waste collection and management (Northern Tilth, 2013). Though ecomaine ultimately judged that none of the scenarios explored in the feasibility study were financially feasible under present conditions, the study's findings may still lay a path towards an effective organics diversion strategy.

A large part of the challenge Portland faces in diverting its residential organic waste is the issue of volume. If the 2011 UMaine study of Maine waste is representative of Portland's waste stream,[2] the city should be prepared to manage 2650 tons of organic waste per year, particularly if the city chooses to adopt a stringent organics diversion requirement alongside a curbside collection program, as Seattle and San Francisco have done (see Chapter 3.1.1.2). The ecomaine study presented ten scenarios for the management of residential organics. These can roughly be divided into two central approaches: ecomaine management of the waste or contracting with private composting companies. Portland is faced with a similar dilemma; it can either take on the management of organic waste using

[2] Questions as to whether the findings of the UMaine study adequately represent Portland's waste stream are a strong indicator that a Portland-specific waste characterization should be undertaken.

the existing municipal facility available to it (Riverside Recycling), acquire new property for the purpose, contract with existing composting companies, or assist existing organic waste haulers and composters to raise the level of voluntary subscription to their service.

In the short term, the most effective options appear to be the use of the Riverside Recycling facility and either a contract or cooperative agreement with area organic waste haulers. One of the central startup costs for organic waste haulers is the cost of the land necessary for composting the city's waste. The city could dramatically lower the operational costs of existing haulers and the barriers to entry for new haulers by permitting such businesses to use municipal land in exchange for some role in expanding service to a wider range of Portland residents. This expanded service may also help the city achieve better economies of scale, helping to facilitate more willing participation in organics diversion efforts by a broader range of residents on a voluntary basis. An arrangement with private haulers would also allow the city to pursue organic waste diversion, with swift attainment of the 50% diversion goal, but without having to purchase new collections vehicles specific to the collection of organic waste.

In order to expand the collection of organic waste beyond voluntary participants and avoid redundancies of service (with vehicles collecting recyclables, garbage and organic waste separately along the same collection routes), some cities collect recyclables and organics at the same time in split-body collection vehicles (see Chapter 3.1.2.1.2). Where some have opted for a franchise agreement with a private hauler, Portland's

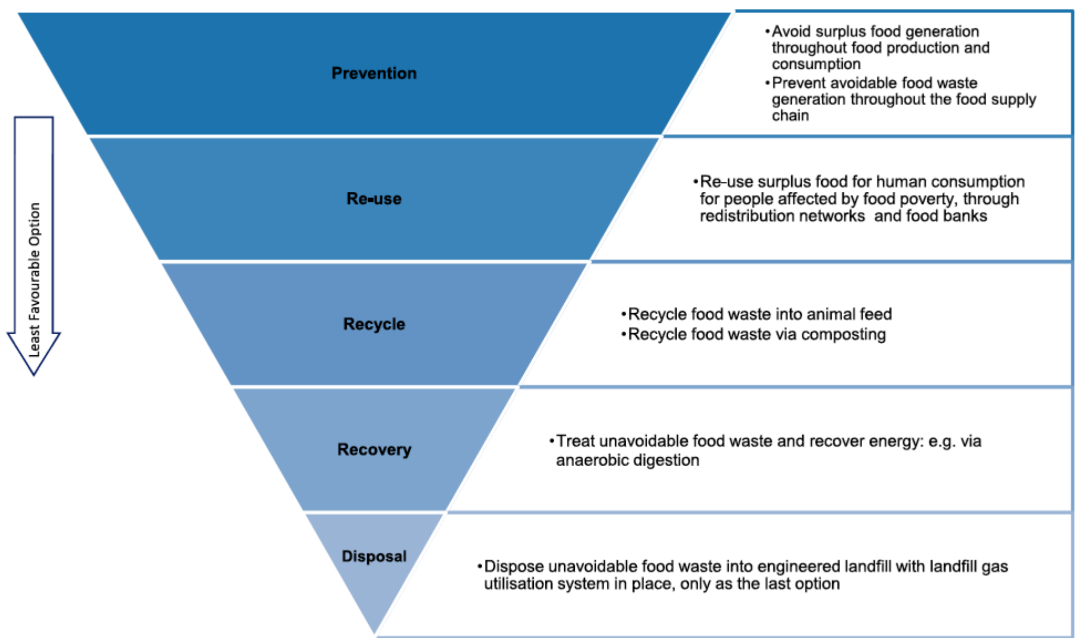


Figure 6. Organic Waste Hierarchy (Papargyropoulou, Lozano, Steinberger, Wright, & Ujang, 2014, p. 114)

familiarity and success with municipally managed curbside collection suggests that as the city looks to replace its aging collection vehicles, it should consider purchasing split-body vehicles that would allow the city to take on the collection of organic waste if the city chose to move in that direction.

While curbside collection of organic waste may be extremely effective at achieving the diversion rates sought by the city and the State of Maine, when considered in a broader context, other approaches may have an even greater impact. Just as waste management strategies can be classified into a hierarchy that prioritizes the retention of a product's embodied energy (the aggregate energy that went into its production and distribution), organic waste also has its own specific hierarchy (see Figure 6). While composting is certainly more effective at retaining and utilizing a greater portion of the energy embodied in organic material than incineration or landfilling, it is not as effective as reuse (e.g., redistribution of surplus food to food pantries) or food waste prevention (e.g. educating consumers on the difference between a "best by" and a "use by" date or educating consumers in the value of buying smaller quantities of food closer to the date of consumption). Because reuse and prevention strategies require some degree of culture change, they are not as straightforward as reactive approaches such as curbside collection. However, given that curbside collection on a city-wide scale will likely involve ecomaine's participation, in the absence of any action on ecomaine's part, composting efforts undertaken by the city may be well complimented by source reduction and reuse efforts to offset the relative difference in management capacity. Of course, while some reuse potential may be present with surplus food in food service contexts, it is less likely in residential contexts, where source reduction efforts promise a greater impact.

3.1.3.2. Hard to Compost Materials (Pet Waste/Diapers)

Certain materials pose a significant challenge to a comprehensive policy intended to divert all waste from the landfill and incinerator. Foremost among these are pet waste, (mostly fecal matter from dogs and cats and clay cat litter) and soiled diapers. Though these materials are primarily organic in nature, their management as waste must address both waste and public health concerns. Both are potential vectors for the transmission of disease. If this waste is used to make compost for agricultural purposes, the inherent liability risk for municipalities would be prohibitive.

For this reason, there are two principal approaches to diverting these types of waste. The first is a low impact, voluntary approach. In some cities with a developed market for "green" products and services, private businesses have emerged to fill this demand. In Portland, Oregon, for example, the Green Pet Compost Company collects pet waste left in the yards of private residences or leaves the resident to collect the waste, and simply collects the container for processing once a week for a fee (Green Pet Compost Company, 2012). In Minneapolis, a cloth and compostable diaper service collects soiled diapers and sanitizes the cloth ones for reuse while sending the compostable ones to a composting partner business (Do Good Diapers). Although these types of businesses collect waste with the same or greater frequency than weekly curbside collection, the price of service exceeds that of disposable diapers. What this means in effect is that in order to increase participation in such voluntary diversion efforts, the household must either see a reduction in cost of the service or an incentive in greater frequency of collection. The cost incentive could be achieved through a municipal start-up grant or administrative support to businesses working with hard to compost materials, as a greater number of businesses providing the service would compete and bring down service prices. Alternatively, switching to every-other-week garbage collection (see Chapter 3.1.1.1) creates a strong incentive for households to participate in these voluntary diversion programs, as one of the most common complaints regarding EOW collection regards the unpleasant nature of two weeks of uncollected diapers. Private collection services are a simple solution to this disagreeable facet of EOW collection.

The second approach is one adopted by Toronto, and is largely dependent on specific infrastructure for organic materials management. The City of Toronto has adopted a policy mandating the source separation of organic waste for households in both single family and multifamily dwellings, and collects such waste at the curb. In addition to food waste and soiled paper, residents can include cat liter, animal waste and soiled diapers in their organic waste bin. After collection, the compost is shredded, liquefied, and separated from residual plastics, which are sent to the city's landfill (The City of Toronto, 2015). In this way, the plastic element of a soiled diaper can be separated from its organic component. In the anaerobic digestion process, the mixture is heated to a temperature that effectively kills any bacterial or viral contaminant. The anaerobic digestion process creates biogas, after which the remaining solid digestate is aerobically composted in windrows (long, aerated piles of compostable material) to create a publicly available soil amendment. The key here is mechanical separation of organic material and residual plastic, the liquefaction process of which necessitates anaerobic processing prior to any other organic waste management process. Dewatering the digested material creates wastewater that requires proper management.

If adopted purely as a response to the management of hard to compost materials, the cost of this approach is prohibitive since they constitute a marginal fraction of the total waste stream. In the long run however, the city may consider the development of large-scale composting facilities as a waste management strategy, and the capture of this fraction can be considered as an additional benefit of such a system.

3.1.4. Reuse Initiatives

3.1.4.1. Municipal Partnership Reuse and Reclamation Center

While the private reuse industry is quite developed in the US, there are municipal or quasi-municipal reuse center models that fit well into a comprehensive "Zero Waste" strategy. The basis for this type of reuse center (and the element that differentiates it from the conventional form of reuse centers as exemplified by Goodwill and Salvation Army) is its foundations in "Industrial Ecology." The principles of industrial ecology dictate a closed-loop manufacturing and remanufacturing process, with products designed to be disassembled, recyclable at no loss of quality, and completely non-toxic. Because this approach is highly dependent on the choices made by manufacturers, the adoption of principles of industrial ecology on a broader scale are dependent on the adoption of a comprehensive suite of regulations and policies designed to build "extended producer responsibility" (EPR; see Chapter 3.6) However, some manufacturers have not waited for the eventual adoption of policies seeking to build this approach, but have voluntarily developed eco-industrial parks in order to capitalize on the benefits of proximity, where one business' waste can become another's input without a great deal of effort.

Tangent to this approach has been the effort to extract all possible use and value from the waste stream before the residual fraction is deposited as trash. Many items are discarded through the curbside collection system that retain some usefulness, either through repair or repurposing, or which might be recyclable if it were disassembled into its constituent parts for adequate source separation. CHaRM (Center for Hard to Recycle

Materials, at the Eco-Cycle recycling center in Boulder, Colorado) is an operation that extracts much of this reusable, reparable or repurposable material before the waste is processed in the recycling facility. To a great extent, the facility does not directly sell the materials it manages, but instead resells them to a range of local manufacturers (Eco-Cycle). Recycling fees for the deposited materials cover most of the rest of the cost of operating the facility, with the price for disposal of each item largely defined by the labor required for its deconstruction or repurposing (Eco-Cycle). The program's success is largely dependent on municipal control over which materials are permitted to be wasted as garbage. A ban on the disposal of electronic waste (E-Waste) has been in effect since July, 2013, and gives residents few options other than to use the CHaRM facilities or a local thrift shop for disposal of this sort of item (Boulder County Resource Conservation).

One of the great benefits of this approach, beyond its potential to remove otherwise unmanageable waste from the waste stream, is its labor intensiveness. This has a downside in terms of passing costs of recycling along to users, and creating a negative incentive for use of the program. However, such a system has the potential to create more jobs per ton of waste than landfilling, incineration or recycling. As EPR laws shift the burden of end-of-life product management to manufacturers, the cost to the public for use of facilities such as CHaRM will decline, permitting the approach to simultaneously increase participation rates and job opportunities. The costs of the facility are covered by a combination of user fees, Eco-Cycle's other recycling operations, and the City of Boulder, with the relative contribution of each shifting according to the economic climate (Eco-Cycle).

There is more potential for a facility similar to this to be constructed alongside the existing ecomaine facility, in a regional agreement with other member municipalities. The key to the success of the program is scale. This program is unlikely to support itself and will likely depend on other sources of revenue. A recycling or other type of waste management program with adequate revenue to absorb some of this program's losses is essential.

3.1.4.2. Support for or management of reuse website

As modern versions of early scrap sellers and rag pickers, garage and yard sales, thrift shops, consignment shops, Uncle Henry's, and countless online resale websites such as Craigslist and EBay address waste diversion high on the waste hierarchy, at reuse. It is near impossible to measure the amount of waste that these private and informal sales divert, as sales are often between individuals and constitute part of Maine's informal economy. Business bookkeeping may track total sales but not the number or nature of the items sold. However, the 2011 Maine Residential Waste Characterization Study conducted by the University of Maine assessed that 1% of Maine's waste stream is constituted of electronics (Criner & Blackmer, 2012, p. 6). Though this number appears small, it is likely a significant underestimate: most households tend to retain electronics for many years after they stop using them. In general, these stored electronics were not replaced because they ceased to function but instead because they became outdated by a newer model of a similar product. To some extent, these items can be sold or given away through existing reuse enterprises, and to some extent they will need to be recycled.

Yet a significant barrier to disposing properly of this wide and diverse range of items, in various degrees of repair, is their varied modes of disposal. While there is a clear financial incentive for selling many items through consignment shops and Craigslist, this option is only viable for those items in high demand and in a fine state of repair. For less desirable items, the time and effort required for someone seeking to dispose of an item can be significant barrier to diversion, especially when sale of an item is not feasible. A comprehensive list of reuse and recycling locations can be an invaluable resource for overcoming this barrier.

Some cities have made basic websites directing residents to a limited number of reuse and disposal options. Portland is an example of this, with a relatively hard-to-locate webpage directing residents to the websites of six local and national organizations and to the phonebook (City of Portland). Contrasted with this limited resource, one of the two recycling centers that serves the City of Sedona, Arizona maintains a comprehensive online resource, with 47 common products or materials and the area businesses and non-profits where each product or material may be brought for resale, reuse or recycling. A list of all area thrift shops is also kept (Sedona Recycles, 2015). Orange County, North Carolina maintains a reference webpage that is somewhere between Portland's and Sedona's in terms of it comprehensiveness, though still quite exhaustive (Orange County Solid Waste Management, 2015). Each listing contains contact information and a link to the pertinent website. The City avoids showing preference to any individual business by making the list comprehensive.

Alternatively, the city can include these resources within a broader effort promoting local businesses. The city of Austin, Texas has created a website that lists by type all of the locally-owned and operated businesses in the city, with easily identifiable icons next to the businesses that are organized around recycling, reuse, and repair (Austin, Texas). Portland could easily capitalize on existing energy in the city around "buying local," and simply help direct some of that energy towards waste reduction and diversion businesses already present in the city.

Municipal support or facilitation of such a website would help address the most common shortcoming of such lists: continuity. Because reuse enterprises leave and enter the market with relative frequency, the list must be frequently updated, which requires management with some longevity. Municipal support can help maintain that list, while municipal maintenance would all but ensure its permanence.

3.1.5. Collection Rate Structures

3.1.5.1. Pay-As-You-Throw (PAYT) Systems

Historically, most municipalities have funded their waste management programs from property tax revenues. Under this system, each resident's share of the cost of waste management is defined not by the amount of waste that they generate, but by the value of their property. Thus, a resident can vastly increase their weekly generation of waste, increasing the total cost of municipal waste management, without increasing their contribution to the program to compensate for their increased level of waste production. Those who generate large volumes of waste then pay less per pound than do those who generate a smaller amount of waste, effectively creating an incentive to generate larger volumes of waste. This is a classic example of "The Tragedy of the Commons" as detailed by Garrett Hardin: the municipal waste management system is a common resource and without either strict control of their use of the resource or a cost to the user that relates to the level of their use, then each user is motivated to use as much of the resource as possible so that they are not simply supporting the consumption of other users.

Pay-As-You-Throw (PAYT) systems are designed to dispose of this problem without the use of blanket regulation. Where a universal divertible material ban (see Chapter 3.1.1.2) or recyclable material ban (see Chapter 3.1.2.2) are politically unfeasible or otherwise undesired by the municipality, the PAYT system can be extremely successful in diverting recyclable material from the waste stream simply using market-based incentives. The fundamental principle on which the system is based is that the cost of waste management to each resident is proportional to their contribution to the waste stream. PAYT programs typically take the form of either a tiered subscription service for waste collection or through the requirement that garbage be placed in special bags (typically colored bags, although tags or stickers affixed to bags purchased by the resident are also common) for which a nominal fee is assessed. Some municipalities have elected to apply these user fees on top of a base fee to all homeowners served by curbside collection in order to maintain revenues high enough to adequately fund the waste management system as revenues decrease.

That revenues have a tendency to decline over time is a sign of the success of the strategy. As residents start seeing the direct costs of their behavior, they change their consumption and waste generation habits in order to minimize their total costs from waste collection. Some municipalities have seen close to a 50% decline in the total waste tonnage collected curbside after the adoption of a PAYT program (Canterbury, 1994, p. 11; MassDEP, 2010). Because fees are assessed proportional to waste generation, a reduction in total waste collected results in a decline in revenue from the program. However, because total waste tonnage from the municipality is reduced, the tipping fees for that waste will decline as well, as will the total costs of collection and management of that waste. These diminishing costs will attenuate the declining revenues to some degree.

In addition, although changing consumption habits account for some percentage of the drop in municipal solid waste generation, the majority of this reduction is due to the fact that residents seek out alternative ways to dispose of their waste. Where recycling programs exist and are cheaper to residents than the cost of waste disposal (free curbside collection is most effective), the extraction of the recyclable portion of the household waste stream is a low-hanging, cost-minimizing fruit. Likewise, where composting programs are cheaper than other forms of waste management, residents will tend to remove organics from their waste stream in order to further reduce their costs. The differential between trash collection and its alternatives can either be by chance or by design. If the local market for organic waste disposal is undeveloped, municipal support to local haulers of source-separated organics (that helps to reduce the cost of collection to residents) may be dramatically more effective with a PAYT program in place.

There are several risks to a PAYT system. One that receives a disproportionate amount of attention from opponents of the strategy is the potential for illegal dumping of waste. It is true that in some communities with PAYT programs, illegal dumping has been observed. However, the risk of this is largely overstated; in a 2014 statewide census of Massachusetts municipalities with PAYT programs, it is clear that illegal dumping is observed predominantly in towns where residents are required to bring their recyclables to a drop-off location, or where the per bag fee for curbside trash collection is three to four times that of surrounding communities (MassDEP, 2014). With a curbside collection program and an appropriate per bag fee, illegal dumping becomes a non-issue.

A greater risk is the variability of revenues from the program. Because revenues are proportionate to the amount of waste generated by households, the revenue stream from the program, and thus the capacity of the program to support its own operational needs, is vulnerable to external economic factors. To the extent that household waste generation is driven by household income (see Chapter 2.4), fluctuations in the broader national economy such as the 2008 recession may decrease consumption levels to the point that the waste that is generated may no longer support the base capital costs of the collection system (at the same time as the price of recyclable materials tends to decline on the spot market for recyclables, squeezing the waste management budget from two sides). It is important, then, to ensure that the collection program is funded at a base level from a stable funding source, in order to smooth out periodic market shifts. Such funding might be from a small flat tax on all residents participating in curbside collection, or from a dedicated line in a municipal discretionary fund.

One of the greatest challenges of both establishing and adjusting a PAYT system is in setting an appropriate unit cost. If the cost is too low, it may not adequately fund collection or give residents enough of an impetus to reduce or divert the waste generated at the household level. If it is too high, it may encourage illegal dumping. The degree to which the residents of a city are responsive to a given unit cost is dependent on the relationship between household income and waste generation. If a small change in household income leads to a dramatic change in the amount of waste generated by that household (a relationship economists would refer to as elastic), a small per bag cost can be expected to drive a sizable decline in household waste generation. If a large change in household income sees relatively little change in household waste generation levels (an inelastic relationship), a much higher per unit cost would be required to create real waste reductions (see Chapter 2.5.2.2). In order to better discern the appropriate level of cost for each unit of waste (whether in a bag, cart, or bin), a precise economic analysis of the relationship between household income and waste generation should be conducted.

3.1.5.2 Two-tiered and Multi-tiered commercial garbage/ organics /recycling rates

As an alternative to a Pay-As-You-Throw (PAYT) system based on unit pricing of bags, with each unit costing the same amount, a tiered pricing system provides an economic incentive for residents or businesses to maintain their solid waste generation at a lower level or divert a greater percentage of their waste to recycling and organic waste collection. The pricing system can operate in two ways. In the first case, as the resident or business generates a greater amount of solid waste, each additional unit of waste becomes more expensive, making waste increasingly costly for the producer as generation increases (multi-tiered rate). In the second case, a base fee is exacted with each additional unit of waste costing an additional flat fee per container (two-tiered rate) (Canterbury, 1994, p. 33). The municipality can choose to employ one or both of these methods.

There are few examples of a multi-tiered rate system applied to bags. The reason for this should be clear: If differentiated by size, with smaller bags priced cheaper per gallon of waste than larger bags, most residents and businesses would simply purchase a greater number of the smaller bags to reduce their disposal costs. Because of this, most effective tiered rate systems operate by subscription with additional carts or bins costing the same amount per cart or bin, regardless of how many extras are purchased. While Portland's existing PAYT system is already well established and effectively diverting waste from the residential municipal solid waste stream, there is still great potential for the application of the rate structure to commercial waste management.

As private haulers from the greater Portland area currently manage commercial waste, a tiered rate structure could be integrated into the permitting process for private hauling businesses. Alternatively, if the city were to franchise a hauler or haulers, a tiered rate structure could be clearly defined in the contract agreement. A municipal employee could verify compliance through yearly or semi-yearly audits.

The main shortcoming of a tiered rate system is its complexity. Because multiple levels of subscription service exist, and many tiered-rate systems have multiple sizes of collection container that correspond with different rates, administrative procedures that accommodate billing structures are necessary that are unique at the household level. This complexity comes at a cost to the municipality, and introduces the opportunity for billing errors, particularly when a household or business reduces their waste enough to shift to a cheaper subscription. At the same time, because part of the cost to users is billed at a flat rate, the potential for savings from waste reduction efforts is reduced and thus the likelihood of substantial waste reduction as well. The program's strongest suit is in its capacity to stabilize revenues from collection. Due to the base subscription fee, earnings from the program are only partially responsive to declines in waste generation brought on by economic recession (United States Environmental Protection Agency, 2012).

3.1.5.3. Ban self-haul disposal at ecomaine and Riverside

As municipal waste policy becomes more successful in diverting materials from the waste stream, residents will be increasingly motivated to avoid those restrictions, particularly if some elements of that policy shift some of the burden of disposal onto residents in terms of time, effort, and cost. A number of municipalities have chosen to limit residents in their disposal options by limiting disposal at the city's facilities to municipal collection vehicles and licensed haulers (Shanoff, 2001). Because residents tend to be less aware of the fuel, vehicle, and labor costs associated with their own vehicle and time, the cost of disposal may appear less than it truly is and consequently encourage residents to waste more than they would otherwise if those costs were integrated directly into the price of disposal, as it is under PAYT disposal (see Chapter 3.1.5.1). While not explicitly a rate structure applied to disposal, banning private disposal at transfer facilities ensures that the costs to all residents are uniform and reduces noncompliance with an otherwise comprehensive policy. Admittance of private vehicles carrying construction and demolition waste for recycling and other recyclable materials would continue uninhibited.

3.2. Commercial Recycling and Organics

3.2.1. Commercial Recycling

3.2.1.1. Encourage recycling of targeted materials

Some wastes constitute a much larger portion of the waste stream than others, such as corrugated cardboard, mixed office paper, and types 1 and 2 plastics. Rather than pushing for complete recycling of all materials and in an effort to maximize the outcome of their investment, some municipalities have chosen to focus instead on targeted materials that make up the lion's share of total waste (City of Portland, Oregon, Office of Sustainable Development, 2008). Alternatively, some large businesses or businesses producing a large volume of such waste might be encouraged to recycle them. Because these select materials are also the materials of highest value, many businesses already recycle them for the price they garner.

In order to properly target the correct materials, the city must first commission a waste stream characterization. A limited study undertaken by the University of Maine in 2011 displays significant demographic and seasonal bias and would be inadequate for the development of a targeted materials program in Portland (Criner & Blackmer, 2012). Once the highest volume wastes have been identified, the largest commercial sources of such waste would be singled out. City employees would then reach out to those businesses and assist them in expanding their recycling capacity and continuing their commitment to the practice.

This approach requires little new infrastructure; additional storage and processing facilities, either for the businesses in question or for the municipal recycling center, are usually unnecessary. However, the burden of responsibility for the program is unequally distributed, with the largest businesses required to expand their recycling capability while smaller businesses remain unchanged. The overall outcome is entirely dependent upon each business' willingness to consent to municipal guidance. The cost to the city is quite low, generally limited to the cost of the waste stream characterization and the labor cost of outreach to businesses.

3.2.1.2. Mandate that haulers integrate cost of recycling into solid waste fees

One of the main reasons that many businesses choose not to participate in recycling programs is that even when haulers offer recycling services, these are often more expensive than waste hauling services. Thus haulers may comply with municipal requirements that recycling services be offered, but few businesses will participate due to the absence of a financial motive. A number of communities in California and Washington have elected to require haulers to integrate the cost of hauling recyclables into the cost of hauling waste so that all businesses pay a single higher rate for waste services and the hauling of recyclables is carried out at no cost to businesses (SWANA, 2013, p. 12; Castro Valley Sanitary District). Thus businesses have a motive to recycle a greater volume of waste in order to reduce costs, as well as negotiate a competitive rate with their hauler for combined services.

Ultimately, the program has two layers of requirements. First, all haulers are required to take recyclables in addition to mixed waste. Second, the cost of recycling must be embedded in waste fees. But in order for these two requirements to be effective, compliance must be maintained through regular audits. The licenses required to operate as a commercial waste hauler are a municipal point of leverage, and temporary or permanent loss of this permit in tandem with the threat of fines will likely be adequate to substantially increase Portland's recycling rate. As the auditing process can be built upon existing municipal processes, cost to the city will remain relatively low. Resistance from commercial waste haulers is likely to be the greatest political obstacle to this approach; waste producing businesses stand to benefit financially from recycling a greater percentage of their waste.

3.2.1.3. Universal mandatory commercial recycling and/or ban on disposal of recyclables

A strict ban on the disposal of any recyclable materials as waste or a mandate on universal recycling of recyclable materials is by far the broadest and most complete approach to increasing the recycling rate among commercial waste producers at a municipal level. A number of large cities have opted for this model, including Portland, Oregon, Cambridge, Massachusetts (The Cambridge Department of Public Works, 2014), Arlington, Virginia (City of Arlington, 2015), Seattle, Washington, San Francisco, California, and New York, New York (NYC Dept. of Sanitation), as have a number of counties, such as Orange County, North Carolina, and Lee County, Florida. What is actually banned can range from the disposal of recyclable materials exceeding a certain volume to only certain select high volume recyclables. San Francisco and Portland have elected to ban the waste disposal of any volume of any type of recyclable material. Any hauler found to be non-compliant risks the loss of their license. Some cities have chosen to implement such a ban alongside requirements that the cost of recycling services not exceed the cost of waste services, in order to minimize the financial impact on businesses.

While this approach is simpler than many others in terms of its legal and technical management, it is highly contingent on effective enforcement and data collection. Critics of New York's commercial recycling mandate noted that nearly 20 years after institution of the law, the absence of data on waste and recycling by private haulers and insufficient enforcement means that little is known about the volume of recyclable materials or other waste generated by New York businesses (Raheja, 2010). Therefore, an ideal companion for this approach is a tonnage-reporting requirement for commercial waste haulers.

If Portland were to institute a recyclables disposal ban, ecomaine is a significant potential asset in facilitating this approach. Because Portland has a stake in the non-profit, visual assessment by ecomaine employees as private haulers release their load on the tipping floor is a potential method for regular verification of compliance. In the end, both businesses and haulers will shoulder the costs of such a sweeping mandate, but these costs will be spread equally across the marketplace and are unlikely to have disproportionate impact upon individual businesses. Political resistance to the institution of an adequately enforced mandate may be the greatest barrier to increasing Portland's recycling rate using this method.

3.2.1.4. Mandatory recycling for certain business types, certain materials

In Maine, the bottle return program was a product of a bottle bill enacted into law in 1976. This may be the first program many imagine when considering the dimensions of a recycling mandate for selected materials or business types, and it does provide a useful model, but it is by no means the only iteration of such an approach. While plastic and glass bottles do make up a large portion of the municipal waste stream, other materials such as old corrugated cardboard, office paper, and metal may make up a much greater portion of the commercial waste stream. Once a commercial waste characterization has been conducted, a city may choose to target three to five of the material classes that make up the greatest portion of the waste generated by businesses (City of Portland, Bureau of Planning and Sustainability, 2007). While a deposit and refund program is not likely to be viable on a municipal scale, an outright ban on the disposal of certain high volume materials is well within the jurisdiction of the municipality.

Businesses subject to the ban may be those disposing of more than a certain volume of the target recyclables, those generating the most waste overall, or those over a certain threshold of gross yearly receipts. Because the scale of this approach is more limited than a universal mandate, both fiscal and political costs are less. However, because the largest businesses may be saddled with a disproportionate share of the mandate's cost, political resistance from the city's largest businesses may be notable. Direct cost to the municipality is limited to the potential hiring of new staff for enforcement of the mandate, and the waste characterization study that is key to effectively selecting which materials to target.

3.2.1.5. Triggered mandates

While not truly a waste reduction strategy, triggered mandates can be extremely useful if political resistance to a desired commercial recycling strategy appears insurmountable (Skumatz Economic Research Associates, Inc., 2011, p. 63). By attaching a delayed time frame to the appropriate program, the city can allow a certain period of time (typically one to two years) during which less sweeping programs may be attempted. If these programs fail to meet a certain recycling rate improvement goal during the allotted time, the original mandate will come into effect. This can develop a sense of cooperation and goodwill between the municipality, haulers, and businesses that can carry over if the mandate becomes necessary. The specifics of delaying a program, such as the conditions that would need to be met, range widely and are easily tailored to the city's needs.

The risks of such an approach lie in the timeframe. If goals are set too high, effective action may be deferred. There are no real costs and a high potential for significant benefits. However, if there is already sufficient willpower to institute substantial mandates, this method is unnecessary and will only serve to delay effective commercial waste reduction programs.

3.2.1.6. Increased MSW tax or surcharge

Rather than offering incentives to promote increased recycling rates, financial disincentives may also be useful in shifting recyclable material out of the commercial waste stream. By increasing the cost per ton of waste brought to the ecomaine tipping floor for incineration, both haulers and businesses would likely attempt to reduce their costs by sorting as many recyclables out of each load as possible (EPA, Chapter 6, 1994, p. 74). As ecomaine's fee structure already differentiates between member communities and other waste haulers, an increased fee could be targeted at private haulers while leaving fees for municipal solid waste unchanged. Of course, such a pay structure would not shelter the general public from the increased cost if they wish to dispose of waste outside the framework of municipal curbside pick-up. Though ecomaine's member communities have recently sought to reduce tipping fees and this approach appears to advocate the opposite, a graduated fee system would make this technique consistent with ecomaine's current financial goals.

Of course, a major limitation stems from the fact that the City of Portland does not govern ecomaine's strategic trajectory alone. Though Portland carries greater weight within the organization than other municipalities, decisions must be made through consultation between member communities. While increasing an MSW tax or surcharge is not impossible in this case, the successful development of such a policy is unlikely. Additional resistance would surely come from both haulers and the general public; in order to be effective, the disincentive must be substantial enough to shift commercial waste management behavior. Because a disincentive requires no facilitation or enforcement, there would be no monetary cost to the city for the institution of this program.

3.2.1.7. Social marketing program for outreach / education

A well-designed and effectively managed social marketing program for education and outreach to businesses has been shown to enhance a city's commercial recycling efforts by as much as 3%. However, the success of such an effort requires some financial investment and considerable face time with business representatives (City of Kirkland Washington Public Works Department, 2014). It further depends on the capacity of city employees tasked with outreach to both develop approaches tailored to each business' needs and understand the barriers perceived by business owners to the development of effective recycling programs. Social marketing's flexibility is one of its principal assets. Ultimately, the program has little impact unless applied as a support for more structured methods. Its main shortcoming is the challenge of quantifying return on investment, and thus garnering continued financial support of such a program.

3.2.1.8. Require tonnage-reporting from private haulers (3.2.2.2)

This is a foundational approach to most municipal commercial recycling programs. In order to measure the success of its recycling efforts, a city must be able to gauge the volume and the nature of commercial waste tonnage. Some cities seeking to counter the inaccuracy inherent in previous estimation procedures have mandated reporting by private waste haulers by municipal ordinance (The City of Alexandria, Virginia, 2002; King County, Washington, 2013, p. 23). Requiring tonnage reporting from waste haulers has been shown to be an effective method for the collection of baseline data, and may be prescribed by municipal mandate. Compliance is enforced with the threat of a fine for failure to submit a report by a given date. Alternatively, a license or permit to operate can be made contingent on the submission of tonnage reports, either for all haulers or for haulers hauling more than a certain amount of waste each year (The City of Los Angeles, 2013). Data collection can be implemented in a variety of ways; for example, haulers might be required to report on a monthly, quarterly, bi-annual or annual basis. The challenge and expense of paper accounting is eased by numerous advances in modern electronic communication technologies.

The construction and management of reporting processes and databases constitute the primary expense of such a program, which is further compounded by administrative facilitation and enforcement work with local haulers. Because electronic accounting has not historically been a priority for many municipal waste management agencies and private haulers, the cost of and resistance to instituting an electronic accounting system should not be underestimated. Political resistance comes mostly from haulers opposed to additional regulation and a change in accounting techniques. The city employees responsible for this program must be adept at customer relations and able to build a sense of partnership with haulers in advancing the city's recycling goals.

3.2.1.9. Options for residential recycling service routes to add small businesses

Small-businesses often produce marginally more waste than individual households. One method for increasing recycling rates without additional investment in infrastructure is to permit small businesses producing less than a certain volume of recycling to pay a fee and participate (up to a certain volume limit) in existing curbside recycling programs (DSM Environmental, 2011; Kirkland Solid Waste Division, 2014). For example, small businesses in Fayetteville, Arkansas pay a monthly fee of $5.88 for the curbside collection of up to five 18-gallon recycling bins (The City of Fayetteville, Arkansas). Waltham, Massachusetts provides free curbside for 600 small and medium-sized local businesses (Waltham, Massachusetts, 2013). Newport, Rhode Island is seeking to increase the city's recycling rate from 23% to 35% using this method (City of Newport Public Services).

Despite the ease with which this program may be implemented, the total volume of waste produced by a city's small businesses is a relatively small proportion of the total commercial waste stream. Although Portland is host to many small businesses, this approach is unlikely to be responsible for any dramatic increase in recycling rates, but may work well in tandem with other programs targeting large businesses. Because the infrastructure is preexistent, fees can be structured to make the system cost-neutral to the municipality. However, high levels of participation in the program may require the city to expand existing curbside recycling collection service.

3.2.1.10. Cooperative approaches to decrease costs to business

In a densely developed urban center with many small businesses on relatively small parcels, a lack of adequate space for gathering and managing recyclable materials can be a real barrier to participation in recycling efforts. Compounding this issue is a low level of generation of recyclable materials by many small businesses that makes the cost of collection prohibitive without an economy of scale. In order to address these issues, some municipalities have worked to organize small businesses to create cooperative waste management agreements. These small businesses must be in close proximity to each other and produce similar types of waste. These agreements can either be facilitated by the city or by a business or development-related non-profit, and can include cost sharing of recycling management costs and haulers' fees between the facilitating agency and the small-business cooperative. The cooperative itself would function as a buyer's club or purchasing cooperative: the collective scale gives the participating businesses much greater purchasing power than each would be able to achieve on its own (Howard County Chamber of Commerce, 2013). The co-op would be made up of representatives of the participating businesses and the facilitating body, who would collectively establish the prerequisites for entry into the cooperative.

Aggregation of recyclable material at a central location helps overcome the common barrier of limited space, though the co-op may also simply establish a common set-out time, when a private hauler would collect the limited amount of material produced by each business in sequence. The degree to which the municipality shoulders the cost of collection varies, from assuming an equal share with participant businesses to assuming the entire cost of the program. Continual upkeep and facilitation of the cooperative will be required, in order to ensure that business needs are met and that cost reductions are being achieved. Some challenges might arise as many small businesses produce waste that is dealt with by the property manager of the rental properties they occupy, so coordination between business, property manager and cooperative may become overly complex. Because participation is voluntary, some businesses may not want to make changes even if the financial costs of recycling are reduced through cooperative purchasing power below those of trash disposal. Business participation is much more predictable when recycling service is made entirely free of charge (Griffen, 2011).

3.2.1.11. Hauler must offer recycling of certain materials

Some cities have sought to increase recycling rates by requiring private haulers to provide recycling services to all commercial clients alongside existing waste management services (City of Portland, Bureau of Planning and Sustainability, 2007, p. 4; City of Portland, Oregon, Office of Sustainable Development, 2008, p. 19). However, a disparity between two variations of this requirement is readily apparent. In the first case, the fees charged for recycling services are not controlled and are often set higher than the price for mixed waste disposal. Thus, even though the recycling is mandated, market factors dissuade most businesses from voluntarily participating. In the second case, a maximum limit is placed on fees for hauling recyclable materials, typically equal to or lesser than the cost of mixed waste hauling. Where the cost of hauling waste exceeds that of hauling recyclables, businesses can be effectively motivated to voluntarily participate in recycling activity.

As the requirement is limited to only the most abundant recyclable materials or those of most value, costs of management and enforcement remain relatively low because haulers tend to make a reliable profit from these materials. Yet because a significant portion of the waste stream remains unaddressed, this approach shows promise when instituted in tandem with other broader programs.

3.2.1.12. Technical Assistance from Municipality

Where businesses identify logistical complexity as a barrier to developing effective recycling programs, the municipality may encourage development of a variety of recycling approaches by providing technical support to businesses that request it. While facilitation by city employees is key to this method, they are not necessarily technical experts themselves. Some cities have contracted with private consultants in order to provide help at relatively low overhead cost to commercial generators of waste (City of Boulder, Colorado). Higher-cost assistance promises greater results; some municipalities have consistently supplied dedicated staff members to provide businesses with high quality support such as undertaking case studies, developing websites, and targeted outreach. Many municipalities providing technical assistance have developed a website with general guidance and resources, including printable signs for the office, fact sheets, local recycling and composting options and contact information, and case studies to reach a broader business base (Portland Metro).

Because such an approach to increasing business recycling behavior is entirely voluntary, success may be dependent on long-term investment in the process by each company and the city. However, a brief consultation (an assessment of facilities, cursory waste stream characterization and recycling techniques training) may be adequate for the long-term success of some business recycling programs in some limited cases. Because additional investment in recycling may put a company at a financial disadvantage in comparison to other companies that have opted not to adopt similar methods, companies may require ongoing support from the city. Long-term success is clearly dependent on the skill and versatility of the city staffer(s) set to the task, as well as the consistent support of municipal leadership and funds. When rolling out a more rigorous policy, such as a universal ban on the disposal of divertible materials as garbage (see Chapter 3.1.1.2), some level of technical assistance will help ensure business compliance.

This approach relies upon an investment from the targeted businesses, the municipality, or both and a long-term commitment by each to the goals set out by the program. A high level of commitment from the municipality potentially promises large waste diversion levels, as a few of the largest businesses in a city can constitute a large percentage of regional business waste generation. However, many of the largest businesses have already employed private consultants in order to glean savings from waste reduction, so exceeding their prior accomplishments may require a significant investment from the city. With limited municipal funds to devote to the initiative, the high costs and high level of time commitment per business could severely limit the number of businesses to which city workers might devote themselves. Therefore, the city should target the largest businesses first before assisting smaller producers of waste. Ultimately, this approach has the potential to be quite effective, but only when municipal investment is substantial and long-term. It is a prime example of the axiom, "you get what you pay for."

3.2.1.13. Incentives for Haulers

Because waste haulers are not obligated to offer recycling services alongside mixed waste collection, the city may choose to incentivize waste haulers to assume responsibility for increasing business participation in recycling programs. Incentives may take a variety of forms; in some cities, hauler-licensing fees have been reduced with recycling participation, while in other cities waste tipping fees have been reduced at a level commensurate with the increase in hauler recycling. Tax breaks or recycling revenue sharing is also possible where the recycling profit structure or municipal tax structure allows it (EPA, Chapter 6, 1994, p. 74). Token incentives are not likely to encourage haulers who would not have already engaged in recycling practices.

When compared with other incentives, reducing tipping fees for those haulers who offer recycling services to their business customers shows a great deal of promise. However, monitoring and measurement of hauler participation is challenging. Random audits are relatively affordable but less precise. Accounting of private haulers' loads at the transfer station and tailoring monetary or rate rewards to achieved levels of diversion is a more expensive and complex process, though in the latter case rewards closely reflect true participation by haulers. How much a hauler-targeted incentive program would cost will rise exponentially with expanded participation: while small incentives are unlikely to have a measurable impact, larger incentives will not only increase cost per ton of recyclable waste, but also attract much greater numbers of haulers to participate in such a program.

3.2.1.14. Offer rebates and/or grants for program launch

This incentive program is designed to help businesses, particularly those that generate a large volume of recyclables, develop effective collection and management infrastructure and techniques. Institutional inertia and upfront capital investment can be a barrier to the voluntary adoption of recycling practices, even where the cost of recycling collection is lower than the cost of trash collection. Small rebates or grants can help businesses overcome these initial barriers, where between $500 and $2,500 may be awarded to individual businesses for specific uses in support of organics collection. A grant fund can be established and funded from municipal coffers (The City of Boulder, Colorado, 2015), from a surcharge on waste fees (The City of Livermore, California Public Works Department), or alternatively, city employees can apply for grants from external sources. Acceptable uses for program launch monies can be left broad; waste stream characterizations or organic waste audits, materials costs, adequate recycling collection bins, or employee education are all acceptable beneficiaries of such rebates and grants.

The challenge of maintaining recycling collection behavior as funding lapses is a major concern, as start-up costs are rarely the only barrier to participation. Where capital investment costs and institutional inertia are the only barriers to adoption of recycling collection by businesses, the grants should be effective; any other persistent barrier can easily mean the cessation of collection once the grant money is exhausted. Furthermore, because measurable results are inconsistent, continued municipal support may be difficult to justify. The cost of small grants tend to snowball quickly and enrollments in grant programs are unpredictable; the cost associated with such a program ranges from practically nil to prohibitively high.

3.2.2. Commercial Organics

3.2.2.1. Require that haulers offer organics collection service

There are already a number of private organic waste haulers that service Portland businesses that are dedicated solely to the collection of organic waste, including Garbage-to-Garden and WeCompostIt!. These haulers currently offer their services to those businesses (often restaurants) that approach them. To build upon this existing service, haulers that currently haul trash and recycling may be required to extend organics collection service to their clients in order to remain licensed, whether they undertake the collection themselves or outsource such collection to an existing organic waste hauler (Denver, Colorado, 2013, p. 3). Haulers are may or may not be required or incentivized to offer the collection of organic waste at a lower cost than that of trash or recyclables. No business would be compelled to participate if it was not in their interest to do so. Those businesses that do participate can be expected to be those that either already have goals of environmental stewardship or those that will reduce the cost of trash disposal by removing organics from the mix. Such a requirement will tend to be most effective where the cost of trash disposal is high or where general levels of participation in organics collection services are high enough to ensure economies of scale to haulers. This policy might be well paired with a rate structure change to the PAYT system and residential curbside collection of organics.

3.2.2.2. Require tonnage-reporting from private haulers (3.2.1.8)

This is a foundational approach to most municipal commercial recycling programs.

In order to measure the success of its recycling efforts, a city must be able to gauge the volume and the nature of commercial waste tonnage. Some cities seeking to counter the inaccuracy inherent in previous estimation procedures have mandated reporting by private waste haulers by municipal ordinance (The City of Alexandria, Virginia, 2002). Requiring tonnage reporting from waste haulers has been shown to be an effective method for the collection of baseline data, and may be prescribed by municipal mandate. Compliance is enforced with the threat of a fine for failure to submit a report by a given date. Alternatively, a license or permit to operate can be made contingent on the submission of tonnage reports, either for all haulers or for haulers hauling more than a certain amount of waste each year (The City of Los Angeles, 2013). Data collection can be implemented in a variety of ways; for example, haulers might be required to report on a monthly, quarterly, bi-annual or annual basis. The challenge and expense of paper accounting is eased by numerous advances in modern electronic communication technologies.

The construction and management of reporting processes and databases constitute the primary expense of such a program, which is further compounded by administrative facilitation and enforcement work with local haulers. Because electronic accounting has not historically been a priority for many municipal waste management agencies and private haulers, the cost of and resistance to instituting an electronic accounting system should not be underestimated. Political resistance comes mostly from haulers opposed to additional regulation and a change in accounting techniques. The city employees responsible for this program must be adept at customer relations and able to build a sense of partnership with haulers in advancing the city's recycling goals.

3.2.2.3. Support program for increasing organics collection in schools

The Mayor's Initiative for Healthy Sustainable Food Systems has named the provision of healthy, locally sourced food to area schools as a central goal for the city. The initiative's 2014 priorities include using 50% local food in the Portland Public Schools lunches (City of Portland, 2014). This commitment comes alongside a commitment by the schools to institute multiple waste reduction measures, such as the elimination of Styrofoam dining trays and the source separation of trash, organics, and recyclables, as facilitated by student "Green Teams." Ultimately, the schools have been successful in diverting 80% of their meal-related waste, with the organics fraction collected by WeCompostIt!, formerly Resurgam Zero Food Waste (Portland Public Schools). While 80% diversion of waste during meals is certainly a success, there may be opportunities to expand the model so that area colleges may magnify their existing composting efforts. Central oversight or management of the efforts at each school could reduce the overall costs of program implementation. One of the most successful elements of source separation efforts in schools is its focus on culture change during childrens' developmental stages that helps lay the way for a continued commitment to waste reduction later in life. Support for social marketing efforts oriented towards raising student awareness of the program and casting it in a positive light is central to the success of this program, waste diversion being only one component of this policy's goals.

As schools continue to develop and expand their composting efforts, they would benefit from ongoing attention from the city, both in the form of organizational and material support. The costs of signage, social marketing and collection containers may be reduced through purchase at a larger scale, with costs either covered under a broader small grants initiative (see Chapter 3.2.2.4) or passed on to each school.

3.2.2.4. Municipal grants for start-ups

This incentive program is designed to help businesses, particularly those that generate a large volume of organic waste, develop effective collection and management infrastructure and techniques. Institutional inertia and upfront capital investment can be a barrier to the voluntary adoption of organics diversion, even where the cost of organics collection is lower than the cost of trash collection. Small rebates or grants can help businesses overcome these initial barriers, where between $500 and $2,500 may be awarded to individual businesses for specific uses in support of organics collection. A grant fund can be established and funded from municipal coffers (The City of Boulder, Colorado, 2015), from a surcharge on waste fees (The City of Livermore, California Public Works Department), or alternatively, city employees can apply for grants from external sources. Acceptable uses for program launch monies can be left broad; waste stream characterizations or organic waste audits, materials costs, adequate organics collection bins, or employee education are all acceptable beneficiaries of such rebates and grants.

The challenge of maintaining organics collection as funding lapses is a major concern, as start-up costs are rarely the only barrier to participation. Where capital investment costs and institutional inertia are the only barriers to adoption of organics collection by businesses, the grants should be effective; any other persistent barrier can easily mean the cessation of collection once the grant money is exhausted. Furthermore, because measurable results are inconsistent, continued municipal support may be difficult to justify. The cost of small grants tend to snowball quickly and enrollments in grant programs are unpredictable; the cost associated with such a program ranges from practically nil to prohibitively high.

3.2.2.5. Targeted programs to capitalize on institutional volume

As small or medium-sized haulers specializing in or exclusively devoted to hauling organic waste work to scale up and become more permanently and securely established, large clients can be key to establishing economies of scale and cost effectively expanding collection routes. Whereas the cost per ton of organics collection in residential neighborhoods can be quite high, as households are relatively small generators of organic waste (though organic waste does exceed one third of the MSW stream), the relative cost of collection from large commercial or institutional clients can be quite low, as generation is high, regular, and the entire volume of waste can be collected from relatively few collection points. In Portland, WeCompostIt!, formerly Resurgam Zero Food Waste, has effectively expanded the scale of their organic waste hauling business around this principle and is now beginning to service residential neighborhoods. Garbage-to-Garden has also used this technique to some success. However, municipal assistance has the potential to deliver a greater measure of security to private haulers of organic waste by diminishing per ton costs and establishing "cornerstone clients" in new neighborhoods.

Municipal assistance might take the form of facilitated outreach, by which the municipality identifies large volume generators of organic waste and approaches them on behalf of private haulers (not pointing those large volume generators towards an individual hauler, but towards the sector as a whole). Effectively, this becomes a marketing and outreach campaign. Though subsequent participation in organics diversion programs remains entirely voluntary, this approach may be useful where more firm or obligatory policies are politically unfeasible. Where they are feasible, this may be an effective interim approach to acquaint businesses with the practice of organics diversion in the months or years before the expected institution of a more exigent program. This approach may be limited by the collective capacity limits of all area haulers, as it can justify expanded collection of organic waste but does little to justify land acquisition and capital investment for additional composting or anaerobic digestion capacity. For this reason, it is best employed as a transitional approach or in tandem with capacity support for haulers (see the options detailed in Chapter 3.1.3.1).

3.2.2.6. Incorporate cost of organics waste into trash collection and management

Incorporating the cost of source-separated organics collection into the price of trash hauling typically requires that the same hauler collects all organics, recyclables and trash. This is typically done alongside the integration of the cost of recycling into trash collection and management. Because organics, recyclables and trash are all collected by the same hauler, this tool is used almost exclusively in cities with either municipal collection or a single franchise hauler for all types of waste.

The cost of organic waste management could be embedded into the trash fees in a number of ways, with varying levels of efficacy and political feasibility. First, the entire cost of organic waste collection and management could be added to the cost of non-organic waste collection and management, and the aggregate cost would be applied as a fee according to the amount of trash produced by weight (Livermore Sanitation, 2011). Any amount of organic waste that a business could remove from its trash would result in an absolute savings to the business. Over time, citywide trash fees would increase to account for revenues lost to organics diversion. The bulk of the cost would be borne by those companies with the lowest volume of organic waste, or those least successful in diverting it from their waste stream. Second, all businesses might be required to pay a flat fee for a certain base amount of organic waste collection, while businesses producing additional organic waste would pay a lesser fee for organic waste than for trash (Seattle Public Utilities, 2015). A third approach that would be more closely tailored to the organic generation of each business would be that of a graduated embedded fee: businesses producing above a certain threshold of waste would be allowed a certain volume of organic waste collection free of charge. This fee-free volume of waste would increase as businesses pay for the collection of greater volumes of trash. As with the flat fee, organic waste collection in excess of the allowance would come at a lesser cost than for trash collection.

Enforcement would occur through audits of the hauler or haulers. Of course, enforcement would not be an issue if collection were by municipal vehicles. As the fees are first introduced, education is key to the success of the policy. Businesses should understand the purpose of the policy and its potential impacts. Haulers should not be left with the sole responsibility of educating their business clients. Program success is much more likely if the municipality takes a role in continuing to ensure that businesses are aware of how they might save money through organics diversion. Haulers can also be required to inform their clients of their organics collection services at regular intervals.

3.2.2.7. Mandate organics source separation

When given teeth, a source separation regulation can be one of the most effective tools to increase diversion of organics among the largest generators of organic waste. Where one of the main barriers to the broader institution of organics composting or anaerobic digestion by the municipality or municipal partners is the lack of a sufficiently large waste stream to justify cost effective management of organics, such a mandate can be used to achieve the required base level of total organic tonnage. Since the costs per ton of collection and management tend to be lower for institutional generators than for residential producers of waste, this tool can effectively reduce the per ton costs of waste in a citywide organics diversion effort. Of course, an organics source separation mandate for commercial entities is best paired with a parallel mandate for residential generators. This is both for political reasons, as the fairness of applying the mandate to the former group but not the latter may generate significant political pushback from commercial generators, as well as for structural reasons, as an incompletely applied ban may simply shift commercially-generated organics into the residential waste stream as businesses work to avoid the costs of the mandate.

There are several viable models for such a ban, with the commercial sector subject to different iterations the ban to varying degrees. Some cities require all food waste to be diverted by all commercial generators of such waste, while others require diversion only from some kinds of commercial establishments, and still others require diversion only from some kinds of businesses that produce more than a certain amount of waste (Executive Office of Energy and Environmental Affairs, 2015). Fines can be assessed to businesses *in situ* upon site audit, while haulers in non-compliance can lose their hauling license after a failed load inspection at the transfer station. Of course, a number of "strikes" may be permitted before the first violation is assessed. Ideally, this approach works best when paired with embedded organics fees (see Chapter 3.2.2.6).

3.3. Tourism related waste measures

3.3.1. Large venues/events

Assessing the degree to which tourism impacts the total waste generation level and recycling rate in Portland is extremely difficult. Because the hotel industry, the restaurant industry and other tourist related businesses do not participate in municipal curbside collection, their waste is collected by privately contracted haulers and neither the relative nor absolute volumes of waste and recycling are measured or recorded. If sales are any good measure, those of Portland's hotel and restaurant industries have been increasing substantially in recent years (Bell, 2014), and $312,699,000 between 330 establishments in 2012 (Portland Maine: 2012 Economic Census of the United States). The waste associated with the tourism industry is likely to be substantial. While at least one study has calculated waste generation levels to be slightly less per day for tourists than for residents (1.31kg to 1.48kg per day, respectively) (Mateu-Sbert, Ricci-Cabello, Villalonga-Olives, & Cabeza-Irigoyen, 2013), this slight difference constitutes a major increase in the effective population of Portland, mostly during the summer months, and this additional population is entirely outside the purview of the existing municipal recycling system.

A range of approaches is available to a municipality seeking to reduce the waste impact of the local tourist industry. Wisconsin's State and local ordinances require all businesses to provide facilities for recycling for both long- and short-term events, regularly inform the users of the space about the recycling options available, and facilitate regular collection by private haulers (Wisconsin Department of Natural Resources). A policy with sweeping coverage such as this is described in Chapter 3.2.1.3. There is a precedent for targeting specific industries with a policy such as this, but coverage is typically defined by the volume or nature of the waste produced by the business, as detailed in Chapter 3.2.1.4.

Policies for one-time or recurring large-scale events such as fairs or festivals are often simpler for the municipality. New York City's street event policy provides a useful model (New York City Department of Sanitation). Planners of an event are required to contact the Sanitation Department three weeks prior to the planned even to discuss the specifics of how the waste and recyclables will be collected, separated and properly set out for collection. In lieu of municipal collection, Portland might facilitate the transfer of such wastes to any one of Portland's private haulers. Signage is key to the success of this sort of policy; many tourists are coming from locations where recycling is not as broadly instituted and may be unfamiliar with recycling practice. Both New York and the State of Wisconsin provide premade recycling signs and decals on their respective websites that may be printed and used by businesses during events or for day-to-day use.

In the initial phases of the policy, some support to hotels and event centers may be important, as some may be unfamiliar with the process of recycling and other forms of waste diversion and many may perceive barriers to the adoption of such approaches to waste management. Policies such as those detailed in Chapter 3.2.1.10 and 3.2.1.12 may be useful for helping these businesses develop their capacity in the first one or two years of mandated provision of recycling facilities. This kind of assistance, particularly to small hotels and inns for whom the costs and limitations of disposal are often significant, is as important as public outreach and education (Radwan, Jones, & Minoli, 2010).

3.3.2. Public Space Recycling

Though not exclusively targeted towards tourists, making recycling available in public places is one of the last easily adopted strategies available to municipalities seeking to increase their recycling rate when other common programs and policies have already been addressed. As Portland already had employed a Pay-As-You-Throw (PAYT) strategy alongside curbside collection, the provision of recycling containers alongside existing trashcans in public spaces is a logical next step. If successfully adopted, a public recycling initiative promises to enable recycling practice to follow residents outside of the home, as well as provide recycling facilities to visitors to Portland.

Though largely dependent on municipal funding for the purchase of recycling barrels, as well as municipal employees for collection, the success of the program is contingent on much more subtle factors. Even if the barrels are bought and serviced by the city, without sufficient forethought as to their placement, coloration, type, signage, size and shape of opening, and other factors, the recyclables gathered can be so contaminated with non-recyclable trash that the waste gathered cannot be recycled. For example, recycling and trash bins should be placed directly adjacent to one another, should be labeled simply with only a few words, bright consistent colors, and with openings that allow easy passage of desired materials but are narrow enough to give users pause before depositing an item without thinking. Flaps tend to inhibit use, since many users are concerned about the transition of contaminants upon contact. Coordination with other nearby municipalities can reinforce the association between recycling practice and bins of a certain size, shape and color. Numerous organizations have published useful guides to the elaboration of public recycling infrastructure and processes (Keep America Beautiful, 2013; Eureka! Recycling, 2011).

Engagement with community organizations has been shown to be an effective tool to help familiarize the public with the new recycling containers and to help promote their proper use. Pilot projects in Saint Paul, Minnesota by Eureka! Recycling hinged on engagement with neighborhood councils and "Green Teams" from area schools and businesses. Public involvement and co-ownership of the effort ensured more assiduous oversight of the effort than the city would have been able to undertake on its own, with residents connected to the program able to give useful feedback as to the best placement of public recycling bins and to give useful guidance to the municipality regarding shortcomings and useful improvements to the program. Eureka! Recycling noted that the use of public art on the bins was an effective way to convey a sense of public ownership of the program (Eureka! Recycling, 2011).

The cost of provisioning public recycling bins falls soundly on the municipal coffers, as does the cost of collection. However, some of this cost can be attenuated through reduced tipping fees. Currently, Portland has numerous solar powered compacting trashcans placed around the city. The tipping fee for the waste gathered from these cans could be reduced significantly if the recyclable portion were successfully diverted, while the labor costs associated with collection from these bins would double if an additional recycling container were placed alongside every currently placed can.

3.4. Construction and Demolition (C&D) Recycling

3.4.1. Disposal Ban for C&D recyclables

At its most restrictive, a ban on the disposal of construction and demolition waste as garbage is absolute. Any refuse from construction or demolition projects must either be preserved for reuse (as distributed through such establishments as the Habitat for Humanity ReStore) or processed as recyclable material (as is currently the purview of Riverside Recycling). However, the ban can be conditioned based on the type of business undertaking the project, the type of waste or the volume of waste produced, similar to the bans detailed in Chapter 3.2.1.4 and 3.2.2.7.

In Massachusetts, asphalt, brick, concrete, and wood have been banned from disposal in the State's landfills since 2006 and the State has integrated several conditions into the ban (MassDEP). If a load of waste contains less than 20% construction waste, it is neither subject to the ban, nor is separation required for loads less than 5 cubic meters.

Seattle has been more rigorous. In 2012, the first phases of a phased landfill ban were instituted for asphalt, bricks, concrete, metal, cardboard, and new gypsum scrap, to be followed by unpainted and untreated wood, asphalt shingles, carpet and plastic film (Seattle Public Utilities). However, the Director of Seattle Public Utilities has used his authority to delay institution of the ban for specific materials for six additional months until adequate reuse and recycling markets expand to meet the increase in supply (Seattle Public Utilities, 2015). Including this "authority for delay" into the wording of the ban ordinance allows the city to maintain firm standards, while garnering goodwill from developers through flexible implementation.

Many developers in the Portland area already use Riverside Recycling's construction and demolition waste recycling facilities. In this sense, a disposal ban on many commonly used and easily recycled construction materials would fit into the waste management practice with which they are already familiar. However, the success of a ban such as this depends on the effective source separation and on-site management of the banned materials. Support to developers (in the form of training for their employees in proper salvage, reuse, and diversion techniques) would help these developers transition to new waste management practice.

Enforcement is best applied both prior to waste generation and at the point of its transfer to a recycling or waste transfer facility. Licenses or permits for both building projects can be made contingent on the submission of an adequate waste management and recycling plan and subsequent report. The contents of private haulers' vehicles can be inspected for contamination with construction and demolition at the transfer facility. A fine would be assessed for non-compliance with the waste management plan and the waste report requirement, and for contamination of waste hauled to the local transfer facility.

3.4.2. Green Building Code Recycling Mandate

In 2010, the State of California adopted a "Green" building code on a statewide level that was based on building code adopted several years earlier in San Francisco. Among many stipulations regarding energy efficiency, insulation, and the use of certain materials, builders are required to divert at least 50% of their construction and demolition waste for recycling and reuse. Two additional voluntary programs set a higher standard, with 65% and 80% of C&D waste diverted, respectively. In Boulder, receipt of a building permit is dependent on the delivery of a C&D waste management plan and a minimum 50% waste diversion rate. However, Boulder's code diverges from California's by creating incentives for builders to exceed this 50% diversion rate (The City of Boulder, Colorado). Based on the size and type of building, a certain number of "Green Points" are required, leaving the builder to determine which are most appropriate for the project in question. Among measures that can earn such points are higher diversion and reuse quotas, both for specific elements of a building and for a higher total diversion rate. For example, the construction of a single family detached home between 1500 and 3000 square feet requires 20 Green Points, while diverting 85% of C&D waste from the project would apply 3 points towards that requirement (The City of Boulder, Colorado).

The point system already integrated into LEED certification can also provide a framework by which high levels of C&D waste diversion can be achieved. The Town of New Castle, NY has adopted a Green Building Code, one clause of which requires that in order to receive a building permit, the project must receive at least one point from LEED v3.0 MR Credit 2 (The Town of New Castle, 2011, p. 11). This sets a 50% diversion baseline for new construction, with builders able to gain another point towards receiving the mandated LEED certification by achieving a 75% diversion rate (US Green Building Council, p. 70). A pilot of this approach could easily be developed in Portland, since all construction that is funded all or in part by the City (exceeding 10,000 square feet) is currently expected to meet LEED standards (City of Portland, p. 54). An additional standard might be applied to preexisting standards without considerable strain. The cost of this approach is born mostly by those financing new construction, though many builders are already familiar with diversion methods and divert high value building products for reuse in order to reduce total disposal costs. Though labor costs of source separation and waste management are higher, the cost of waste disposal can decrease dramatically. Some support from the municipality in directing builders towards best recycling and reuse practices, drawing from a wealth of existing materials (Rubinstein, 2012; US EPA, 2000), could help facilitate the transition. Enforcement would be facilitated by existing building code officers in the normal course of their existing permitting processes. An additional audit(s) performed during the building process would ensure compliance.

Because many construction projects already divert a substantial percentage of their waste in order to reduce waste management costs, the potential for increased diversion may be limited. If the 50% diversion baseline is too close to the existing C&D diversion rate, the added cost for the municipality may not bring a notable increase in the city-wide diversion rate. For this reason, the baseline should be set well above the current industry diversion rate. Because this is not currently known, a C&D waste characterization for Portland should be the basis for the enactment of this ordinance.

3.4.3. Take back program for used building materials at large or mid-size building supply stores

Extended Producer Responsibility (EPR) take back programs (see Chapter 3.6.1) are typically applied to a single, clearly defined product in state or local EPR regulations, but can be applied to a much broader class of material when adopted on a voluntary basis by businesses. Where large-scale home improvement and building centers are a significant source of the products that become construction and demolition waste, particularly for homeowners and small to medium-sized building contractors, a take back program facilitated by such businesses could help close the waste loop of the small-scale building and home improvement industry. While large developers and construction firms may already be broadly participating in recycling practice in order to reduce their costs, or may be subject to more stringent restrictions on the disposal of C&D waste (see Chapter 3.4.1), the waste generated by smaller projects can slip through the gaps of other diversion efforts.

While some non-profit organizations, such as Habitat for Humanity's ReStore, reclaim building materials for resale and reuse, the potential supply of used material greatly exceeds these organizations' storage and management capacities. The scale of large for-profit building material supply stores offers a remedy. While most of these companies already participate as drop-off locations for compact-fluorescent light bulbs, mercury thermostats and batteries, and will likely participate in paint take back programs as of August, 2015 (PaintCare Maine), there is much room for growth in offering take back services for a wider range of products. In offering some take back and resale of a range of used or leftover building materials, these retailers can provide lower cost options to customers while using the program as a marketing tool.

Lack of public awareness about disposal options is a common and substantial barrier to the success of this sort of take back program. This makes outreach, public education and marketing an important foundation upon which this program can be built and a point where the municipality can have a role in the program's success. The municipality can share responsibility for outreach supporting the take back program. This support may be in the form of informational campaigns about waste management and recycling options in the Portland area. It may also involve covering some portion of the cost of disseminating printed informational material. Though large-scale retailers are unlikely to require municipal organizational support, mid-sizes establishments such as Maine Hardware and Aubuchon Hardware may benefit from municipal organizational or administrative support in establishing a reuse and resale component to their operation. In lieu of such support, the city might also consider some tax or other relief in order to spur a higher degree of reuse in existing C&D related enterprise.

3.5. Electronic Waste (E-Waste)

3.5.1. E-Waste Disposal Ban

Maine's product stewardship law regarding e-waste, enacted in 2004 and amended in 2009, requires that manufacturers of a wide range of electronics cover the costs of the recycling of their product at the end of its useful life. The law requires municipalities to provide an e-waste collection site or collection event for their residents, permitting a fee to be charged for the collection of this waste. Riverside Recycling is Portland's e-waste collection facility, charging a wide range of fees depending on the e-waste in question (Riverside Recycling).

While this program has been largely successful, with 49 million pounds of e-waste recycled statewide between 2006 and 2013 and one of the highest per capita disposal rates for e-waste in the country (Maine DEP Waste Management, 2013), the cost to the consumer for e-waste recycling is still a significant disincentive to participation. Portland's "e-card" program allows Portland property owners to dispose of ten items free of charge, including electronic waste. However, because the time and effort required to obtain a card are additional barriers to participation and the program is limited to property owners, the simplest option for most residents is to place small electronic devices in their garbage for convenient curbside collection.

Two approaches to diverting electronic waste in Portland would address this issue. The first would be to offer free curbside e-waste recycling (see Chapter 3.5.2). This approach would come at great cost to the city. The second approach would be to ban the disposal of e-waste in the garbage, effectively mandating repair, reuse, or recycling of such products. This approach would require residents to shoulder the cost of e-waste management at the Riverside Recycles facility, with manufacturers covering the cost of recycling.

Because the ban would increase the cost to residents of e-waste disposal, it will naturally result in unchanged participation rates without adequate enforcement and outreach. This has been the most common shortcoming of municipal e-waste disposal bans (Milovantseva & Saphores, 2013, pp. 8-16), although not universal. North Carolina's e-waste disposal ban in 2010 doubled collections of e-waste in the year following its adoption, despite the fact that no enforcement action had yet been taken (Koch, 2011). The challenge to municipalities is in finding a balance between enforcement and education that achieves maximum diversion for the least cost.

Because enforcement would require visual inspection of the contents of garbage left for curbside collection, it will require visual assessment by municipal employees (either current collection workers or new enforcement personnel), which would require replacing the existing Blue Bags with transparent garbage bags. Public resistance to clear bags can be stiff, as most consider their household waste to be a private matter. If this public resistance can be tempered, such a ban will likely have unintended effects, as households divert wastes they consider private away from "public" curbside garbage collection. Education and outreach is the simpler approach and can be effective to some degree by itself, as the North Carolina case shows. Yet education without enforcement runs up against the barrier of added cost to the resident.

Ultimately, a ban such as this might be effective, but may only be considered cost effective if rolled into a more comprehensive ordinance excluding a greater range of materials from disposal as garbage. In this case, the same level of investment in education and enforcement that would be necessary for a successful ban on e-waste disposal would achieve higher diversion rates for a wider range of waste resources.

3.5.2. Curbside Collection of E-Waste

When residents of a city want to participate in a recycling program and they must bring their recyclable material to a location that is distant from their residence, many residents choose not to recycle at all. This is because when making a choice as to whether to recycle or not, the perceived value of recycling to the resident must exceed the cost to the resident of participation in the recycling program. These are not necessarily financial costs and benefits. Recycling has intrinsic ethical value to many, and the feeling of having done something 'good' is a merit of participation. To the same extent, the time and effort of loading and transporting recyclables generated at home to a remote location constitute a very real cost. If perceived costs exceed perceived benefits, it is unlikely that a resident will recycle. In order to reduce the perceived costs of recycling to residents, many municipalities have extended curbside collection service for recyclable materials to residents. By reducing the costs of participation for all residents, the perceived benefits of recycling will exceed the perceived costs for a greater portion of the population, thus increasing participation in recycling behavior overall. This will likely result in an increased citywide recycling rate. Economic theory anticipates this to be the case, and indeed it is; municipalities that have extended curbside collection of recyclables to their residents have seen dramatic increases in their municipal recycling rates.

It follows then that when recycling of electronic waste is promoted either through measures ranging from an education and outreach campaign to Maine's existing Extended Producer Responsibility laws (see Chapter 3.6.1.1) to an outright disposal ban, higher costs to residents in the form of transportation and management of the materials will reduce participation in the e-waste recycling program. Some municipalities have elected to take the same approach with e-waste that they have taken with other recyclable material, collecting electronics in curbside collection.

The approaches taken to curbside collection of electronics vary among participating municipalities. Two principal types of collection predominate. In Huntington, New York (Town of Huntington, Long Island New York, 2014), and Napa County, California (Napa Recycling and Waste Services, 2013) residents must call or use an online form to schedule a pick-up with the municipal solid waste service. In Sonoma County, California (Sonoma County Waste Management Agency), Davenport, Iowa, and Bettendorf, Iowa (Waste Commission of Scott County, 2015), residents can place electronic waste in their curbside bin for collection with the rest of their recyclable waste. Municipalities also differ in what type of electronics they accept for curbside collection. While e-waste in Davenport and

Bettendorf is defined as anything with a screen and a circuit board, Sonoma County does not accept any item larger than two feet in any dimension, and also excludes TVs, computer monitors, and other devices with screens from collection with the regular curbside collection, with such larger items requiring a scheduled pick-up.

While the costs of scheduled pick-up are potentially higher for the municipality, they are also higher for residents. Though not as substantial as the perceived cost of transporting the e-waste to a designated drop-off location, the act of scheduling a pick-up by phone or Internet is an effort that will inhibit some residents from participating in recycling efforts. When included in regular collection, the costs of collection to both the municipality and the resident are reduced; yet at the same time, the costs of sorting out electronics from other types of recyclable material at the sorting facility will be higher. The degree to which the net cost of a scheduled pick-up collection scheme differs from the net cost of inclusion in regular curbside collection is unknown and would require a pilot study for the municipality to make an informed decision about which approach to pursue.

3.6. Extended Producer Responsibility (EPR)

3.6.1. Expand Take Back programs

3.6.1.1 Local Take-back Program

Maine's Framework Legislation for Producer Responsibility has set the stage for one of the nation's most comprehensive take back programs. Currently covered are mercury thermostats, compact-fluorescent light bulbs, rechargeable batteries and cellphones, electronic devices, and mercury auto switches, and the program will soon be extended to include architectural paint (Bureau of Remediation and Waste Management, 2015). The State has established non-rechargeable batteries and carpet as future priorities as take back programs expand. Under the programs, manufacturers and retailers of these products are required to provide facilities for the recovery of the target materials, and are given some leeway in terms of how those facilities are provided. The fee for management of the target material is assessed directly to manufacturers, who then pass the added cost onto retailers, who subsequently integrate the fee into the sale price (PaintCare, 2015). These retailers voluntarily maintain a drop-off box or other location in their store to receive the materials, with no remuneration for providing this service other than increased activity at their stores (with the potential for a concurrent increase in sales).

On a voluntary basis, a number of area businesses have instituted take-back programs in alignment with both their environmental values and their bottom line. For example, Smiling Hill Farm in Gorham sells its milk in refillable glass bottles with a $2 deposit. Yet in order to adopt take-back programs on a wider scale, particularly for those oriented towards reuse rather than recycling, businesses must be able to reach beyond a niche market. Local municipalities can establish local take back policies that apply to certain products manufactured or sold by city businesses.

One of the most successful examples of a rigorous local take back policy lasted for 23 years in Prince Edward Island, Canada. Litter control regulations developed in the early 1970's required that beer be sold exclusively in refillable containers, with cans prohibited. In 1984, the province expanded the existing regulations to require that all carbonated beverages be sold in refillable containers (GrassRoots Recycling Network). A glass bottle recycling and remanufacture facility provided a local source of bottles, while Seamans local bottling company provided about 100 jobs. A graduated deposit system similar to Maine's, but with deposits several times larger, ensured that the bottles would be returned in acceptable condition. Indeed, the province saw a 98% return rate for these containers.

The success of Prince Edward Island's policy was based on the fact that it was designed to protect preexisting local industries, the bottling and beverage industries, from national and international competition. Though it ultimately succumbed to pressure from lobbying from international bottling companies, the regulation had provided jobs (The Guardian, 2008) and had dramatically reduced the island's litter problem. Similar, though less restrictive, regulations in Quebec have maintained nearly a 75% market share for beer sold in refillable containers. The strength of Portland's microbrewery industry and the devotion of their customers might provide a firm basis upon which a city-scale take-back program could be developed. A maximum non-refillable bottle quota can be required of bottlers operating in the city, as a percentage of total beverage sales. This would establish a refilling market with a client base already willing to participate, provide jobs, and ensure the flexibility necessary for overcoming resistance from national industry interest groups. Of course, such a program would need to be developed in cooperation with the industry concerned, in this case Portland's bottling industry. Costs to the municipality would be from an annual or semi-annual audit of sales to ensure businesses were meeting the standards set by the regulation.

Though bottle refilling is the most prominent example of successful local take-back programs, it is certainly possible to apply the same principles to another product. To a great degree, the choice of the ideal product for a local take back program depends on the willingness of local producers or retailers to participate. If the program does not find its strongest advocates among the businesses to which the program applies, it is unlikely that such a law will stand up against market and political pressure from outside the city.

3.6.1.2. Reusable Transport and Shipping Packaging/ Packaging Take Back

To most people, packaging is the covering in which an individual product can be found, on a shelf in a retail location: plastic potato chip bags, cereal boxes, the nearly indestructible plastic shell around many electronic devices, or the plastic film and Styrofoam tray housing fruit in the supermarket. Yet for all of this visible waste, there is a comparable amount of waste that is invisible to consumers. The wooden shipping pallets, cardboard boxes, polystyrene blocks and peanuts, and plastic film in which consumer products are transported from their point of manufacture to their point of sale constitute a significant volume of waste nationwide. Yet because product distribution networks are regional, national and international, municipal actions to minimize this hidden waste are limited. To make matters more complicated, because of the hidden nature of this waste, public awareness or discontent with the overabundance of this waste is extremely limited.

In Europe, some national scale legislation aimed at minimizing transport and shipping waste has been met with relative success. Germany has adopted stringent standards governing packaging waste: any producer of waste is responsible for its take back and management and if a single responsible producer is not identifiable, management is assumed by any producer of that type of packaging waste, with all producers of that type paying into a pooled recycling and reuse management fund. One year after the adoption of the legislation, 63% of businesses surveyed indicated that they had stopped using composite materials in their packaging, and 66% had redesigned their packaging (Nakajima & Vanderburg, 2006).

At the local scale, fewer strong examples exist. The most compelling is the business assistance support program undertaken by Alameda StopWaste, the public solid waste management authority for Alameda County, California. The agency has partnered with a trade organization, the Reusable Packaging Association, to develop a multifaceted assistance program targeted at reducing transport waste. This has taken the form of a website with a wide range of support materials, case studies, a cost comparison tool, webinars, and workshops both in Alameda and at other on-site locations around the country. In addition, the partnership awards grants worth up to $30,000 as material assistance to businesses seeking to reduce their shipping waste (Alameda County Waste Management Authority & Alameda County Source Reduction and Recycling Board, 2013; Alameda StopWaste, 2014). Because much of the direct technical assistance provided by the partnership is conducted by experienced industry professionals, participating businesses tend to be more receptive to the advice proffered.

In addition to the website, training and technical support, and financial assistance, the agency has developed a model policy as a direct action that can be taken by municipalities, an "Environmentally Preferential Purchasing" policy. By setting guidelines or standards that limit the types of products that can be purchased by the municipal government, the municipality reduces the environmental impact of its own day-to-day activities and provides a model for other area businesses to follow. Portland is already familiar with this sort of policy: the city has enacted a LEED certification requirement for municipal buildings (City of Portland) and city parking enforcement employees and police officers use bicycles during the summer as part of an alternative transportation policy (City of Portland). The model policy would apply to all businesses that sell products directly to the municipality for municipal use and reads as follows:

> 3.1.5 Request vendors eliminate packaging or use the minimum amount necessary for product protection. Vendors shall be encouraged to take back packaging for reuse. A vendor's willingness to take back packaging will be used as part of the consideration in the bid process (Alameda StopWaste, 2014, p. 2).

As a potential client of institutional size, the municipality's adoption of an ordinance such as this can contribute to creating a regional standard for transport packaging. Any changes made to accommodate the city's purchasing guidelines would likely be carried on with smaller clients as well. The range of cost to the municipality for the development of this assistance program is quite broad. With significant engagement with an industry partner such as the Reusable Packaging Association, cost to the city would be significantly lower than if it were uniquely responsible for maintaining the program. Because industry partners have a stake in the success of the program, they may be amenable to carrying a disproportionate share of the program's costs.

Because the program is voluntary it must be sold exclusively on its merits, which are likely to fluctuate as markets for a variety of shipping materials vary over time. This makes the program quite vulnerable to external economic forces. However, mid- to long-term cost savings are well documented by the Reusable Packaging Association, and a cost-calculator that takes current materials prices into account can help ensure that it is not a question of if businesses change their shipping processes to reduce or eliminate waste, but when that change would be most cost effective.

3.6.2. Labeling

3.6.2.1. Zero Waste Certification

In order for consumers to make educated choices, they must have access to information about a product. Yet gathering reliable information about a product can be a significant barrier to making a rational decision. This is particularly true when seeking information concerning the *processes* by which that product was made and not information about its material composition. For a consumer to gauge the degree to which a product's manufacture avoids the generation of waste and prioritizes the waste hierarchy, the barriers to making an informed purchase are significant.

Certification under a certain set of standards by a body with accepted legitimacy is a way for consumers to become informed about the hidden processes of product manufacture without having to seek out the information themselves. Several types of certification labeling programs exist. Some are designed to show that the product meets a specific standard, such as the 'EnergyStar' or 'Certified Organic' labels, while others are designed to rate the quality of a product on a spectrum, such as the LEED building standard. Some certification programs have been developed with a great deal of transparency and are widely trusted, such as the Forest Stewardship Council's certification for wood and paper products from sustainably harvested wood resources. However, some private industry-driven ecolabels have proven to be less transparent and have met with criticism from environmental circles, as doubt has been cast on their veracity (Stoiber, 2012).

There are also those who question both the impact of such labels on the price of goods and their fairness to companies. These accusations of inequity are particularly pointed in regards to the developing world, where most lack access to the certifying bodies and where compliance would cost more than potential gains from certification. A central issue is that the certification costs to an applicant business are typically a flat fee, which may constitute a manageable sum for large businesses but are far out of range for a small or mid-sized business with thinner profit margins. Though intended as a fair price, this tends to amount to preferential treatment of large businesses (Vitalis, 2002).

Because Portland's businesses are largely small to mid-sized, this barrier to certification is one that the city can help overcome. Few certification labels specifically addressing waste reduction and diversion currently exist. Europe's first was launched in January 2015 (Geater, 2015) and the U.S. Zero Waste Business Council Certification program was initiated in 2012 and is still in its incipient stages (U.S. Zero Waste Business Council, 2014). As such labels expand in the future, the city can establish a support fund to help Portland businesses afford the certification costs. The city could help businesses chose which label would be most appropriate and could pay for all or a percentage of the certification costs.

Chapter 4

Recommendations

	Low Cost	High Cost
Low Impact	***3.1. MSW Collection Strategies*** 3.1.2.1.3. Curbside Collection Containers - Bags 3.1.4.2. Support for or management of reuse website 3.1.5.3. Ban self-haul disposal at ecomaine and Riverside ***3.2. Commercial Recycling and Organics*** 3.2.1.7. Social marketing program for outreach / education 3.2.1.8. / 3.2.2.2 Require tonnage reporting from private haulers 3.2.1.9. Options for residential recycling service routes to add small businesses 3.2.1.10. Cooperative approaches to decrease costs to business 3.2.1.11. Hauler must offer recycling of certain materials 3.2.2.1. Require that haulers offer organics collection service ***3.3. Tourism related*** 3.3.1. Large venues/events ***3.4. C&D Recycling*** 3.4.3. Take back program for used building materials at "Home Depot" type centers	***3.1. MSW Collection Strategies*** 3.1.2.1.1. Curbside Collection Containers - Larger Open Bins 3.1.3.2. Hard to Compost Wastes (Animal Waste/ Diapers) 3.1.4.1. Municipal/ Quasi-municipal/ Municipal Partnership Reuse Center ***3.2. Commercial Recycling and Organics*** 3.2.1.14./ 3.2.2.4 Offer rebates and/or grants for program launch 3.2.2.3. Increase program for school organics collection ***3.5. E-Waste*** 3.5.1. E-Waste Disposal ban ***3.6. EPR*** 3.6.2.1. Zero Waste Certification
High Impact	***3.1. MSW Collection Strategies*** 3.1.1.1. Changing waste collection to Every-Other-Week (EOW) while maintaining weekly recycling and organics collection 3.1.5.1. Pay-As-You-Throw (PAYT) Systems ***3.2. Commercial Recycling and Organics*** 3.2.1.1. Encourage recycling of targeted materials 3.2.1.2. Mandate that haulers integrate cost of recycling into solid waste collection fees 3.2.1.3. Universal mandatory commercial recycling and/or ban on disposal of recyclables 3.2.1.4. Mandatory recycling for certain business types, certain materials 3.2.1.5. Triggered mandates 3.2.1.6. Increased MSW tax or surcharge 3.2.2.5. Targeted programs to capitalize on institutional volume 3.2.2.6. Embed fees for high volume sources of organic waste 3.2.2.7. Mandate organics extraction/Ban organics in MSW ***3.4. C&D Recycling*** 3.4.2. Green Building Code Recycling Mandate ***3.5. E-Waste*** 3.5.2. Curbside collection of E-Waste	***3.1. MSW Collection Strategies*** 3.1.1.2. Universal Waste disposal ban – Organics and Recyclables 3.1.2.1.2 Curbside Collection Containers - Roll-out containers 3.1.2.2. Disposal ban for recyclables in residential waste 3.1.3.1. Residential Organics Collection Strategies 3.1.5.2. Two-tiered and Multi-tiered commercial garbage/organics/recycling rates ***3.2. Commercial Recycling and Organics*** 3.2.1.12. Technical Assistance from Municipality 3.2.1.13. Incentives for Haulers ***3.3. Tourism related*** 3.3.2. Public Space Recycling ***3.4. C&D Recycling*** 3.4.1. Disposal Ban for C&D recyclables ***3.6. EPR*** 3.6.1.1. Local Take Back Program 3.6.1.2. Reusable transport and shipping packaging/ Take Back of packaging

In order to design a waste strategy that is both adequate and viable, a balance of cost, impact, burden of responsibility, and political tenability is essential. Too narrow a focus on the residential waste stream risks squandering opportunities to achieve much higher diversion rates, while solely forcing businesses to adapt to stringent diversion guidelines while freeing residents from any such burden would be inequitable and thus meet strong political resistance from the business community. Adopting a number of high profile policies without considering their cost would put the longevity of those policies in doubt. While financial costs to the municipality are important, care must also be taken to consider the impact of policies on non-monetary considerations; policies that prioritize public health or environmental welfare can reduce their long-term costs, making a policy that may have appeared to be a wash a net gain for the city.

While waste reduction policies can be applied piecemeal, and have an impact doing so, a strategy oriented towards achieving Zero Waste in Portland should take a systemic approach. Every policy has its weaknesses and to the extent that is possible, each policy's shortcomings may be supplemented with a complementary policy or policies. In order to best assess the forty-four policies detailed in Chapter 3, all of the policies were sorted into a "Cost/Impact Matrix," remaining organized by target sector. Since more than four or five policies would be unwieldy in their application, both administratively and politically, five policies were selected from the grid to build two alternative policy suites.

Low hanging fruit, those policies that promise a greater increase in the diversion rate at a relatively low cost, form the basis of each suite, with two such policies each. Both a high-impact, high cost policy and a low-impact, low-cost policy were included in each policy suite, with an additional policy chosen from one of those two groups. Policies with a high cost and a low impact were avoided in these recommendations; however, it is important to reinforce that the fact that they were avoided here does not suggest that they cannot be important parts of a comprehensive strategy. The perception of other benefits, particularly of broad public support, can justify the adoption of policies from this group. Portland's political, social and economic landscapes are ever changing, and reassessment of the policy tools available under new conditions is important to maintain a waste diversion and management strategy well-adapted to Portland's unique characteristics. The incorporation of policies targeting a wide range of sectors was a central policy selection criterion.

These policy suites do not include Portland's existing policies, but they might well have been included. For the reasons detailed in Chapter 2 and in Chapter 3.1.5.1, Portland's Pay-As-You-Through blue bag disposal system is key to communicating to residents the costs of their behavior and helps to decouple waste generation from increasing wealth. Portland's recent adoption of a requirement that owners of multifamily apartment buildings provide adequate on-site facilities for recycling also promises to dramatically increase participation in Portland's recycling efforts. These policies should continue to receive the full support of city leadership.

Suite A	
3.1.1.1.	Changing waste collection to Every-Other-Week, while maintaining weekly recycling and organics collection
3.2.1.4.	Mandatory recycling for certain business types, certain materials
3.3.2.	Public Space Recycling
3.2.1.8.	Require Tonnage-Reporting from Private Haulers
3.1.4.2.	Support for or management of reuse website

4.1. Policy Suite A

3.1.1.1. Changing waste collection to Every-Other-Week while maintaining weekly recycling and organics collection

The shifting of a collections program to Every-Other-Week (EOW) garbage collection while maintaining weekly collection of recycling and organics collection is the most powerful policy tool currently available in terms of both increasing the diversion rate and decreasing total waste tonnage to the landfill and incinerator. Organics and recyclables are collected on a weekly basis, while non-organic, non-recyclable waste is collected every other week. Collection can be undertaken with split-body collection vehicles, bagged organics and recyclables in existing vehicles, or with dedicated collection vehicles for organics collection aside from those used for trash and recycling. Portland, Oregon saw a 38% decline in total waste collected during the first year of the program. At the same time, the collection schedule has led to a 279% increase in organics collection compared to that collected under voluntary programs existent prior to EOW garbage collection. Portland, Maine could exceed a 50% recycling rate solely with the application of this policy. As Portland faces the obsolescence of its current collection vehicles, purchase of split body vehicles instead of new single body vehicles would enable a switch to EOW collection without upfront capital costs beyond what would be necessary for continuation of the existing collection program. In the interim, the use of bags for organics and recyclables in the interim would enable greater diversion by assuming slightly higher operating costs while avoiding any substantial capital investment (thus remaining more flexible and adaptive to new policy initiatives).

3.2.1.4. Mandatory recycling for certain business types, certain materials

Once a commercial waste characterization has been conducted, a city may choose to target three to five of the material classes that make up the greatest portion of the waste generated by businesses and ban their disposal as garbage by commercial generators. Businesses subject to the ban may be those disposing of more than a certain volume of the target recyclables, those generating the most waste overall, or those over a certain threshold of gross yearly receipts. Because the scale of this approach is more limited than a universal mandate, both fiscal and political costs are less. However, because the largest businesses may be shouldered with a disproportionate share of the mandate's cost, political resistance from the city's largest businesses may be notable without additional assistance from the city towards achieving compliance. Direct costs to the municipality are limited to the potential hiring of new staff for enforcement of the mandate, and the waste characterization study that is key to effectively selecting which materials to target.

3.3.2. Public Space Recycling

Though not exclusively targeted towards tourists, making recycling available in public places is one of the last easily adopted strategies available to municipalities seeking to increase their recycling rate when other common programs and policies have already been addressed. If successfully adopted, a public recycling initiative promises to enable recycling practice to follow residents outside of the home, as well as provide recycling facilities to visitors to Portland. Though largely dependent on municipal funding for the purchase of recycling barrels, as well as municipal employees for collection, the success of the program is contingent on much more subtle factors. Even if the barrels are bought and serviced by the city, without sufficient forethought as to their placement, coloration, type, signage, size and shape of opening, and other factors, the recyclables gathered can be so contaminated with non-recyclable trash that the waste gathered cannot be recycled. Engagement with community organizations has been shown to be an effective tool to help familiarize the public with the new recycling containers and to help promote their proper use.

3.2.1.8. Require Tonnage Reporting from Private Haulers

In order to measure the success of its recycling efforts, and justify them in the public eye, a city must be able to gauge the volume and the nature of commercial waste tonnage. Requiring tonnage reporting from waste haulers has been shown to be an effective method for the collection of baseline data, and may prescribed by municipal mandate. Data collection can be implemented in a variety of ways; for example, haulers might be required to report on a monthly, quarterly, bi-annual or annual basis. Numerous advances in modern electronic communication technologies ease the challenge and expense of paper accounting. The construction and management of reporting processes and databases constitute the primary expense of such a program, which is further compounded by administrative facilitation and enforcement work with local haulers. Political resistance comes mostly from haulers opposed to additional regulation. The city employees responsible for this program must be adept at customer relations and be able to build a sense of partnership with haulers in advancing the city's recycling goals.

3.1.4.2. Support for or management of reuse website

A modern version of early scrap sellers and rag pickers, garage and yard sales, thrift shops, consignment shops, Uncle Henry's, and countless online resale websites such as Craigslist and EBay address waste diversion high on the waste hierarchy, at reuse. Yet a significant barrier to disposing properly of the wide and diverse range of items sold by these reuse enterprises is their varied modes of disposal. While there is a clear financial incentive for selling many items through consignment shops and Craigslist, this option is only viable for those items in high demand and in a fine state of repair. For less desirable items, the time and effort required for someone seeking to dispose of an item can be a significant barrier to diversion, especially when sale of an item is not feasible. A comprehensive list of reuse and recycling locations can be an invaluable resource for overcoming this barrier. Each listing contains contact information and a link to the pertinent website. The City should avoid showing preference to any individual business by making the list as comprehensive as possible. Municipal support or facilitation of such a website would help address the most common shortcoming of such lists: continuity. Because reuse enterprises leave and enter the market with relative frequency, the list must be frequently updated, which requires management with some longevity. Municipal support can help maintain that list, while municipal maintenance would all but ensure its permanence.

Suite B

3.2.1.3. Universal mandatory commercial recycling and/or ban on disposal of recyclables
3.4.2. Green Building Code Recycling Mandate
3.1.2.1.2. Curbside Collection Containers – Roll-out containers
3.1.3.1. Residential Organics Collection Strategies
3.2.1.9. Options for residential recycling service routes to add small businesses

4.2. Policy Suite B

3.2.1.3. Universal mandatory commercial recycling and/or ban on disposal of recyclables

A strict ban on any disposal of recyclable materials as waste or a mandate on universal recycling of recyclable materials is by far the broadest and most complete approach to increasing the recycling rate among commercial waste producers at a municipal level. What is actually banned can range from the disposal of recyclable materials exceeding a certain volume to only certain select high volume recyclables. San Francisco and Portland have elected to ban the waste disposal of any volume of any type of recyclable material. Any hauler found to be non-compliant risks the loss of their license. Some cities have chosen to implement such a ban alongside requirements that the cost of recycling services not exceed the cost of waste services, in order to minimize the financial impact on businesses. Visual assessment by ecomaine or municipal employees as private haulers release their load on the tipping floor is a potential method for regular verification of compliance. In the end, both businesses and haulers will shoulder the costs of such a sweeping mandate, but these costs will be spread relatively evenly across the marketplace and are unlikely to have disproportionate impact upon individual businesses.

3.4.2. Green Building Code Recycling Mandate

Several forms of Green Building Codes exist. A municipality adopting a Green Building Code may include among other requirements (e.g. for energy efficiency, insulation, and the use of certain materials) a requirement that builders divert at least 50% of their construction and demolition waste for recycling and reuse. Additional incentives or allowances may be introduced in order to exceed the requirement set in the code. Alternatively, a number of "Green Points" may be required for receipt of a building permit. Among measures that can earn such points are higher diversion and reuse quotas, both for specific elements of a building and for a higher total diversion rate. Since a similar point system is already integrated into the LEED certification program, which Portland currently requires of all municipal buildings, an additional requirement can be added to the existing

Green Building ordinance. The code would require that in order to receive a building permit a project must receive at least one point from LEED v3.0 MR (Materials & Resources) Credit 2 for achieving 50% diversion of construction and demolition waste. Builders would gain another point towards receiving the mandated LEED certification by achieving a 75% diversion rate. Some support from the municipality in directing builders towards best recycling and reuse practices could help facilitate the transition. Enforcement would be facilitated by existing building code officers in the normal course of their permitting processes.

3.1.2.1.2. Curbside Collection Containers – Roll-out containers

Collection vehicles are equipped with a robotic arm that lifts containers from where they are placed on the curb, empties them into the rear of the vehicle, and replaces them curbside. The arm is controlled by the operator of the vehicle, thus requiring only a single employee to perform the task. Specially designed carts are required, with a capacity that greatly exceeds that of the existing collection containers. The upper limit on the quantity of recyclable material residents can put out for curbside collection is increased above likely levels of household weekly generation of recyclable waste. If collection of recyclables is conducted on a weekly basis, it is unlikely that any spillover into the garbage would occur from lack of adequate space in the collection container. As a result, incidental litter (recyclables blown from the existing open containers) would be all but eliminated. The upfront capital cost to the municipality to replace both the existing collection vehicles with vehicles equipped with a robotic arm, and the existing collection containers with the roll out carts, will be significant. The cost of these upfront investments will be attenuated over time through a reduction in tipping fees (from increased diversion rates) and reduced litter cleanup costs, as well as increased property values in neighborhoods currently most affected by litter.

3.1.3.1. Residential Organics Collection Strategies

An effective organics collection program could permit the city to surpass its 50% diversion rate goal with a single policy. The city can either undertake collection itself, with municipal vehicles and labor, or it can contract with private organic waste haulers. Likewise, the city can compost food waste on municipal property or support private haulers in their business practice. Combining these approaches may be an option, by contracting with private haulers to manage a composting facility on municipal property. In the long term, the city may wish to acquire split body collection vehicles with which to collect organic waste and recyclables at the same time, thus achieving greater collection cost efficiency. Many residents may be resistant to the perceived unpleasant nature of separating food waste, so an effective social marketing campaign is necessary to overcome this initial hurdle. Voluntary collection requiring subscription can have lower upfront costs, but as long as the cost to households of organics collection exceeds that of garbage collection, little incentive exists to expand collection beyond those motivated by non-monetary factors. As a result, this approach works best in combination with policies that increase the monetary or non-monetary costs of garbage disposal at the household level. The costs of collection have a large range, depending on whether the municipality assumes responsibility for collection or leaves the task to private haulers. In the long term, if the city elects to assume responsibility for organic waste collection in order to provide a comprehensive collection service, they may consider replacing existing trucks with split-body collection vehicles in order to minimize additional capital investment costs. Use of municipal land under private management of a composting facility may help existing private organic waste haulers achieve economies of scale and provide collection at a lower cost to the consumer, and would cost the city relatively little.

3.2.1.9. Options for residential recycling service routes to add small businesses

Small-businesses often produce little more waste than individual homeowners. One method for increasing recycling rates without additional investment in infrastructure is to permit small businesses producing less than a certain volume of recycling to pay a fee and participate up to a certain volume or weight limit in existing curbside recycling programs, with fees structured to make the system cost neutral to the municipality. Despite the ease with which this program may be implemented, the total volume of waste produced by a city's small businesses is a relatively small proportion of the total commercial waste stream. Although Portland is host to many small businesses, this approach is unlikely to be responsible for any dramatic increase in recycling rates. However, high levels of participation in the program may require the city to expand existing curbside recycling collection service. Because it is oriented towards small businesses, it is an ideal complement to a universal commercial waste ban that might place an undue burden on those businesses with the smallest profit margin.

Appendix A

Chapter 2. "The Why of Waste: GIS Analysis of The Socio-economic Drivers of Waste Behavior in Portland"

Methods, Procedures, and Assumptions

Eight years of continuously collected data, from 2007 to 2014, recording the tonnage of both recyclable material and municipal solid waste (MSW) collected by each municipal vehicle and delivered to the ecomaine recycling and waste-to-energy facility each weekday were used as the basis for analysis. 2007 was excluded from aggregation, since single stream recycling was introduced mid-year and data prior to this point were highly irregular. The City of Portland's Environmental Programs Department has created shapefiles of the five daily collection zone boundaries; these are the basis for the spatial aggregation of recycling and MSW values per time period. In addition to ascertaining the total tonnage values of recycling and solid waste per month and per year, monthly and yearly recycling tonnage was divided by total tonnage for each time period, in order to track the relative percentage that recycling composed of the total waste stream in each collection zone at different points in time. This is referred to as the "recycling rate."

The City of Portland's Tax Assessors Office provided a 2014 tax roll document which details the land and building value of each parcel, each of which is denoted by a street address. The tax roll was joined to a cadastral GIS file maintained by the Portland GIS office, after which the parcels falling in each collection zone were assigned to that zone. A land unit value was attributed to each household by dividing the aggregate building and land value by the number of residential units present in a property, thereby assigning an equal share of the total land value to each household in multi-family units.[3] Thus, a mean land unit value and mean number of dwellings per parcel was defined for each of the five collection zones. Additionally, the tax roll data permitted the calculation of the ratio of dwelling units in single-family detached homes to dwelling units in 2-or more family homes, the ratio of units in single and two-family homes to units in 3-or more family homes, and the ratio of units in single, two or three family homes to buildings with 4 or more units. These three ratios give, at a glance, an understanding of the constitution of the building stock in each area.

Because each collection zone is home to a different number of households, it is important to estimate the amount of waste generated by an average household in each zone. This paints a more useful picture of household waste behavior, a scale that is an important basis for MSW policy, since individual households are collectively responsible for the vast majority of waste managed by the municipality. Total tonnage value of MSW, recyclables, and the sum of the two ascribed to each zone were divided by the number of households

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[3] The underlying goal here was to find an economic indicator that could be aggregated precisely into the collection zones, thus avoiding many of the "ecological problem" related issues of disaggregating and reaggregating census data.

served by municipal curbside collection in each zone in order to find the weight of waste for which each household was responsible in that zone.

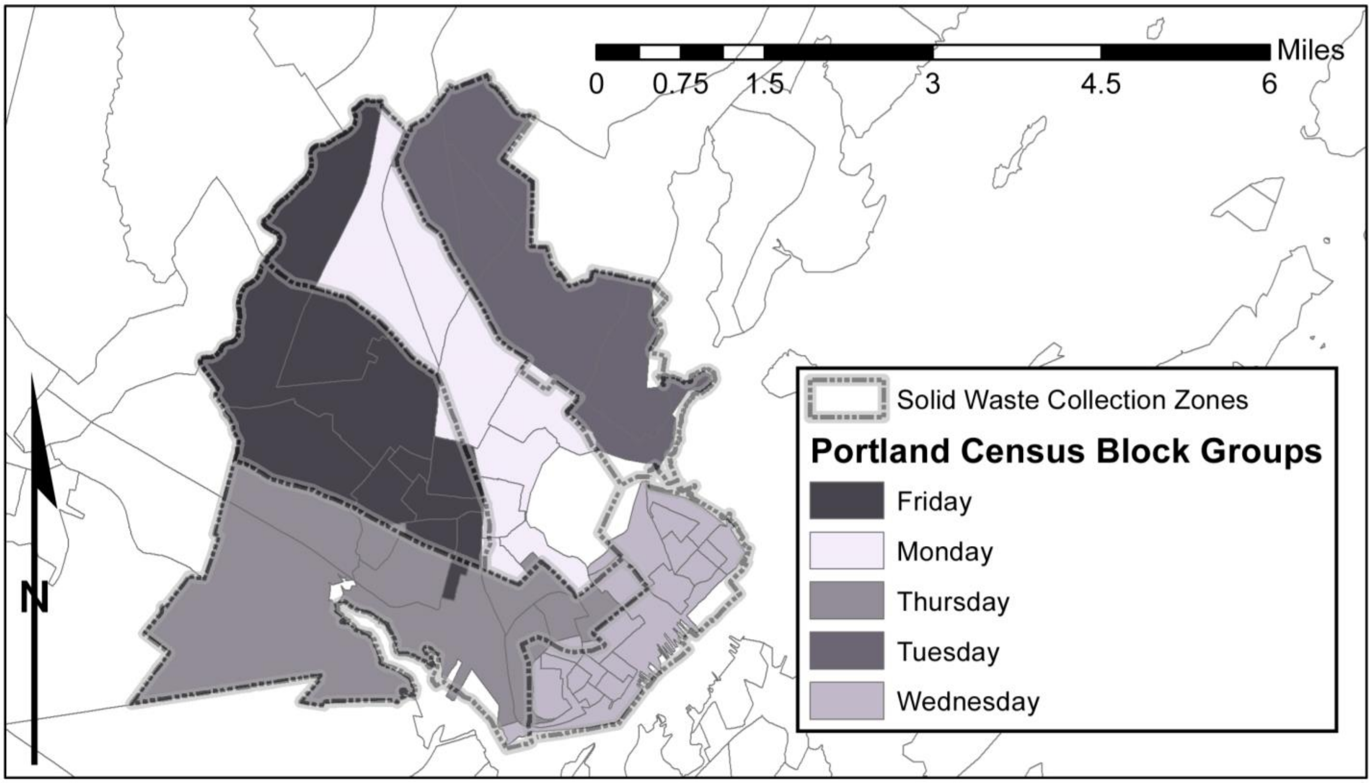
Because the municipality does not keep a precise count of how many households participate in curbside recycling collection each year, several estimation techniques were required in order to create realistic models. Since new housing units are constructed each year, it is not even plainly evident how many housing units the city holds in years not covered by the US Decennial Census. For that reason, a housing unit model was created using the 2000 and 2010 Decennial Census housing unit count as a base, with the 2014 Portland Tax Roll providing the housing unit count for that year. The land use classes that were counted and were excluded from the count are detailed in **Table 2.** Both the Decennial Census and the Tax roll coincide with GIS spatial files, with the Tax Roll specific to the parcel level and the census specific to census block level. Both parcel data and census block data conform very closely to the curbside collection zone boundaries. For each zone, a linear growth rate was assumed between 2000 and 2010 and between 2010 and 2014.

Housing Units counted for following:	Housing Units not counted for following:
Apartments and Rooms	Communication
Bed and Breakfast	Garage and Sheds
Commercial Condos	Land Bank
Eleven to Twenty family	Manufacturing
Exempt benevolent and Charitable	Office
Exempt by Law	Parking Lots
Exempt Governmental	Private Clubs
Exempt Literary and Scientific	Retail
Exempt Religious	Transportation
Five to ten family	Vacant Land
Four Family	Warehouse and Storage
Hotel and Motel	Wholesale
Multi use Residential	
Multi use Industrial	
Multi use Commercial	
Residential Condo	
Rooming Houses	
Seasonal	
Single Family	
Twenty-one plus Family	
Two family	

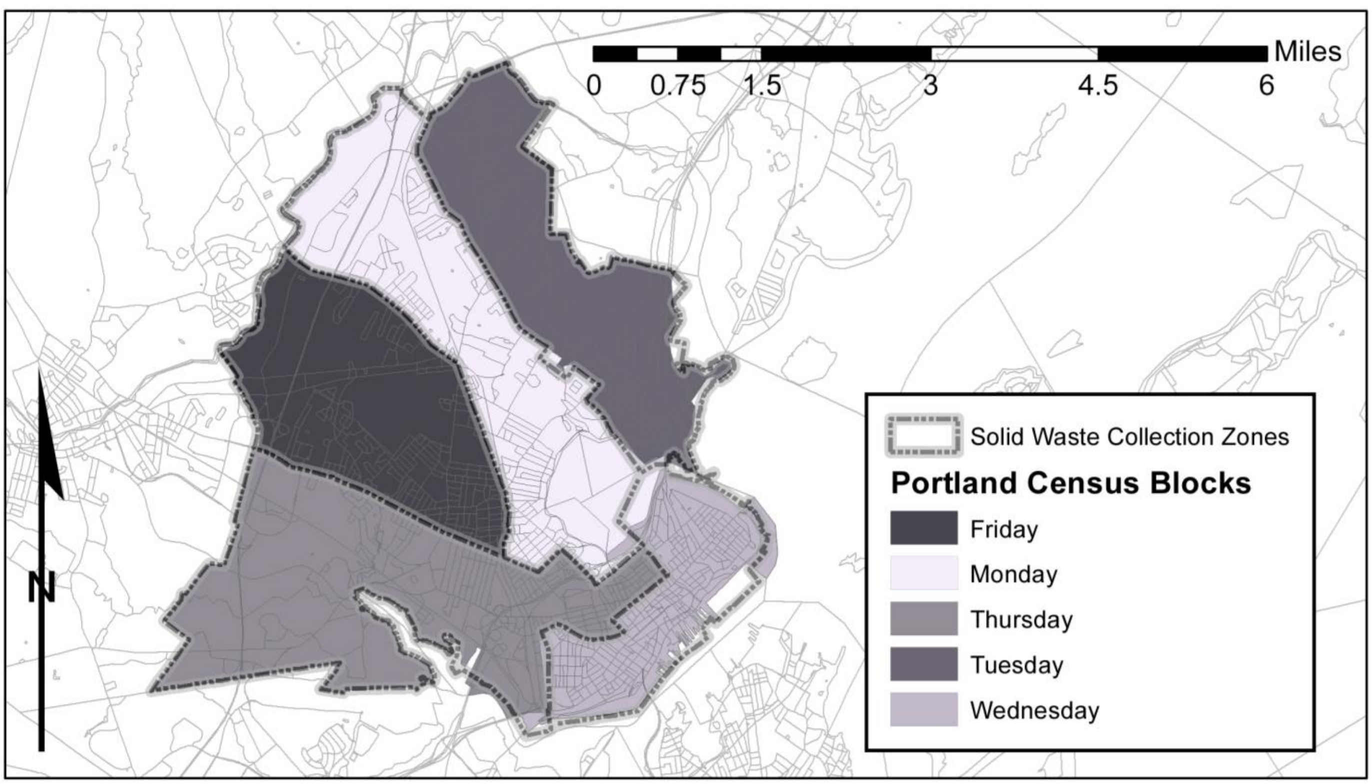
Table 2. Housing units included and excluded from model

To arrive at the number of households in each zone from housing unit data, a vacancy rate is required. Though vacancy rates are included in the Census, the assumption that the growth or decline of vacancy rates that occurred between 2000 and 2010 would continue at the same rate is implausible. Instead, estimated vacancy rates from the American Community Survey (ACS) were used. The conformity of the Decennial Census Blocks used as the basis for the housing unit model to Portland's solid waste collection zones is much closer than that of the census block groups, which are the spatial unit of aggregation for ACS data. Despite greater disconformity of the ACS data with the boundaries by which waste tonnage and housing units were defined, the boundary disconformity is not particularly significant. Even where one large census block group spans both the Monday and Friday collection zones, population density is low enough that the misallocation of roughly half of that block group's housing and economic data is not likely to significantly alter the averages of the two zones in question. The boundary disconformities are shown in **Map 2.**

Figures from four sequential 5-year estimates were used to represent the years each estimate spanned. Thus, the 2006-2010 estimate was used to represent 2008, the 2007-20011 estimate was used to represent 2009, and so on. The average change of the vacancy rate in each collection zone over that four-year period (from 2008 to 2011) was used to project a linear rate of change specific to each zone through 2014. The average of the vacancy rates for the five zones are quite close to the Portland-wide estimates



Boundary Disconformities Between Solid Waste Collection Zones and Census Block Spatial Units



Map 2. Boundary Disconformities Between Solid Waste Collection Zones and Census Block Spatial Units

released by the American Housing Survey for the years of the study, and were thus assumed reliable enough for use in further analysis. The housing unit estimate for each zone for each year was divided by the corresponding vacancy rate from the model detailed above to reach an estimate of total number of households in each collection zone during each year.

In order to ascertain how many households were served by curbside collection in each zone each year, a similar process was used. Curbside collection in Portland is provided to households that desire it; municipal collections vehicles stop to collect bins wherever they are set out along their route on any given day. Condos are generally excluded, but can request service, as can large buildings. The size of a building tends to define which households receive service and which do not. Generally, the larger an apartment building becomes, the less feasible it is for households to set out their waste individually. Taken to the extreme, this is obvious: for a building with 200 housing units, there is simply not enough space on curb for all households to set out their trash and recycling. Troy Moon, Environmental Programs and Open Space Manager for the City of Portland, estimated that the threshold of housing units in a building that would determine whether or not they would participate in curbside waste collection to be about 13. Thus, buildings with fewer that 12 or fewer units would participate while those with 13 or more units would not. He noted that there several buildings with up to 20 units that do participate, but also a number of buildings with fewer than 13 that did not, and therefore estimated 13 to be a likely average.

The 2014 tax roll was then used to calculate the number of housing units in buildings with fewer than 13 units in each zone. This proportion (of units in buildings with fewer than 13 units to units in buildings with 13 or more units) was assumed to remain stable across the study period. The number of housing units in each zone during each year (as estimated in the housing unit model detailed above) was then multiplied by the proportion of housing units in buildings with fewer than 13 units for each zone, then divided by the corresponding value in the vacancy rate model. The resulting figure is the estimate of households served by curbside collection during each year in each zone.

The total tonnage of waste and recycling collected in each collection zone during each year was then divided by the estimated number of households receiving curbside collection service for the corresponding zone and year to find the average yearly waste generation for households in each collection zone.

The variables to which household waste generation were compared were median household income, median personal income, median age, high school graduates as a percent of the total population, and college graduates as a percent of the total population. All of the variables except for median age were American Community Survey estimates modeled in the same fashion as the vacancy rate model detailed above, while median age was extrapolated as a linear continuation of observed trends between 2000 and 2010. Household income, personal income, and graduation rate figures for each census block group were averaged with all other census block groups included in the same solid waste collection zone without differential weighting to compensate for population differences between zones. Census block groups are generally sized to include a similar number of households, so the absence of weighting to correct for population differences should not noticeably impact the average values.

Household income was normalized by adjusting for inflation using the Consumer Price Index Calculator available at the website of the United Stated Bureau of Labor Statistics at http://data.bls.gov/cgi-bin/cpicalc.pl. All income figures were adjusted to its corresponding value in 2014 dollars.

Household size was assumed to remain the same over time for all extensive purposes, as no significant change was recorded between the 2000 and 2010 Decennial Census, so the 2010 values were used for all years.

A detailed list of values used for analysis is shown in **Table 3**. A visualization of relative changes in all observed and modeled values over time is shown in **Table 4**. A graph of changing yearly household waste tonnage by solid waste collection zone and recycling rate by solid waste collection zone is shown in **Figure 3**.

The degree to which different variables correlate to each other, the values from all collection zones and all years were compared as groups in order to find their Pearson's R value, a common and well-accepted measure of correlation. The resultant grid is shown in **Table 1.**

$$r = \frac{\sum(x-\bar{x})(y-\bar{y})}{\sqrt{\sum(x-\bar{x})^2 \sum(y-\bar{y})^2}}$$

Pearson's R Formula

A scatter plot of household income and total household waste generation was created, with each year separated by color, in order to establish change in supply elasticity over time. The overall relationship is shown in **Figure 3**, while the changing relationship over time is shown in **Figure 4**.

Variable Factors

Averge Median Household Income - Adjusted to 2014 dollars	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Source	*2006-2010 ACS*	*2007-2011 ACS*	*2008-2012 ACS*	*2009-2013 ACS*	*Linear Model*		
Monday	$ 57,993.02	$ 59,031.66	$ 58,477.18	$ 55,316.01	$ 55,558.09	$ 54,699.54	$ 53,840.99
Tuesday	$ 68,341.59	$ 69,939.20	$ 69,877.10	$ 70,575.59	$ 71,343.35	$ 72,007.34	$ 72,671.33
Wednesday	$ 34,705.49	$ 34,144.48	$ 34,608.08	$ 36,388.87	$ 36,340.17	$ 36,891.54	$ 37,442.91
Thursday	$ 61,795.03	$ 56,536.31	$ 54,235.20	$ 51,112.91	$ 47,333.00	$ 43,898.25	$ 40,463.50
Friday	$ 63,851.28	$ 61,434.39	$ 62,442.81	$ 60,370.69	$ 59,666.46	$ 58,723.12	$ 57,779.79

Average Median Personal Income - Adjusted to 2014 dollars	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Source	*2006-2010 ACS*	*2007-2011 ACS*	*2008-2012 ACS*	*2009-2013 ACS*	*Linear Model*		
Monday	$32,614.49	$33,950.83	$34,656.54	$33,406.26	$34,427.29	$34,735.39	$35,043.49
Tuesday	$32,513.53	$33,202.55	$33,447.05	$33,144.08	$33,610.84	$33,824.46	$34,038.07
Wednesday	$28,127.44	$28,951.72	$27,288.25	$28,817.00	$28,397.41	$28,437.93	$28,478.45
Thursday	$31,508.20	$32,285.87	$30,165.04	$29,608.64	$28,937.06	$28,155.11	$27,373.16
Friday	$31,601.57	$32,297.44	$31,251.82	$31,083.18	$30,908.31	$30,648.23	$30,388.15

Median Age	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Source	*2006-2010 ACS*	*2007-2011 ACS*	*2008-2012 ACS*	*2009-2013 ACS*	*Linear Model*		
Monday	39.1	40.3	40.7	42.2	43.0	44.0	45.0
Tuesday	43.1	42.2	42.5	42.0	41.7	41.4	41.1
Wednesday	36.5	35.1	34.0	33.7	32.5	31.5	30.6
Thursday	37.9	37.1	35.1	34.8	33.4	32.3	31.2
Friday	38.1	38.3	39.9	41.5	42.5	43.7	44.9

High School Graduates as a Percent of Population	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Source	*2006-2010 ACS*	*2007-2011 ACS*	*2008-2012 ACS*	*2009-2013 ACS*	*Linear Model*		
Monday	93%	93%	94%	94%	95%	95%	96%
Tuesday	91%	90%	91%	92%	92%	92%	92%
Wednesday	89%	89%	89%	90%	91%	91%	92%
Thursday	92%	91%	89%	90%	89%	88%	88%
Friday	93%	93%	90%	90%	89%	88%	87%

College Graduates as a Percent of Population	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Source	*2006-2010 ACS*	*2007-2011 ACS*	*2008-2012 ACS*	*2009-2013 ACS*	*Linear Model*		
Monday	53%	55%	55%	53%	54%	54%	54%
Tuesday	50%	48%	52%	53%	54%	55%	57%
Wednesday	51%	53%	55%	55%	57%	58%	59%
Thursday	48%	50%	48%	47%	47%	46%	45%
Friday	54%	52%	50%	51%	48%	47%	46%

Housing Vacancy Rate	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Source	*2006-2010 ACS*	*2007-2011 ACS*	*2008-2012 ACS*	*2009-2013 ACS*	*Linear Model*		
Monday	5.7%	4.5%	5.6%	6.2%	6.2%	6.4%	6.7%
Tuesday	2.8%	4.9%	4.2%	4.6%	5.3%	5.8%	6.3%
Wednesday	9.8%	8.7%	7.5%	8.0%	6.8%	6.1%	5.5%
Thursday	8.8%	8.3%	8.4%	8.1%	7.9%	7.6%	7.4%
Friday	9.3%	7.9%	7.5%	6.9%	6.0%	5.2%	4.4%

Recycling Rate	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Source	*Ecomaine Collection Receipts from Municipal Curbside Collection*						
Monday	37.8%	32.0%	35.4%	40.0%	40.1%	39.3%	38.4%
Tuesday	41.4%	38.0%	35.5%	39.7%	40.7%	39.9%	38.0%
Wednesday	35.5%	33.1%	32.3%	32.5%	34.1%	35.2%	35.3%
Thursday	30.1%	27.6%	30.9%	36.2%	32.4%	36.2%	33.8%
Friday	37.5%	33.4%	35.9%	37.9%	37.2%	37.7%	36.3%

Total Estimated Households	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Source	*HU Model/Vacancy Rate Model*						
Monday	5278	5393	5378	5371	5414	5437	5458
Tuesday	4194	4146	4217	4269	4308	4355	4403
Wednesday	8611	8754	8894	9256	9788	10276	10770

Table 3. Detailed list of values used for analysis

Thursday	6089	6157	6183	6450	6709	6970	7232
Friday	5313	5422	5472	5585	5720	5846	5975

Households Estimated to be Served by Curbside Collection (Households in Buildings With Under 13 Units)	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Source	*(2014 Units in Buildings with fewer than 13 Units as a Percent of Total Units x HU Model)/Vacancy Rate Model*						
Monday	4090	4179	4167	4162	4196	4214	4230
Tuesday	3386	3347	3404	3446	3478	3516	3554
Wednesday	5461	5552	5641	5870	6208	6517	6830
Thursday	4102	4147	4165	4345	4519	4695	4872
Friday	3854	3933	3969	4051	4149	4241	4334

Total Household Waste Generation for Households in Buildings With Under 13 Units	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Source	*Waste Tonnage/Served Households Model*						
Monday	1447.77	1380.01	1358.84	1326.66	1451.67	1386.30	1443.83
Tuesday	1582.03	1557.62	1524.82	1482.71	1547.17	1550.88	1517.21
Wednesday	1123.78	1076.88	1093.16	1055.36	994.07	944.33	919.45
Thursday	1534.19	1529.90	1383.48	1273.28	1270.89	1183.47	1174.90
Friday	1490.21	1442.29	1467.62	1404.61	1445.09	1407.34	1340.03

Total Household MSW Generation for Households in Buildings With Under 13 Units	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Source	*MSW Tonnage/Served Households Model*						
Monday	899.83	938.87	878.05	795.77	869.53	841.62	889.00
Tuesday	927.07	966.05	983.68	893.74	917.49	932.49	941.04
Wednesday	725.07	720.16	740.24	712.05	654.64	612.26	594.73
Thursday	1072.39	1108.25	955.63	812.08	859.07	755.13	778.09
Friday	931.26	960.15	940.65	872.50	907.35	876.09	853.29

Total Household Recycling Generation for Households in Buildings With Under 13 Units	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Source	*Recycling Tonnage/Served Households Model*						
Monday	547.94	441.14	480.79	530.89	582.14	544.68	554.83
Tuesday	654.96	591.57	541.14	588.97	629.68	618.40	576.16
Wednesday	398.72	356.71	352.92	343.31	339.43	332.07	324.72
Thursday	461.80	421.65	427.85	461.20	411.82	428.33	396.81
Friday	558.95	482.14	526.97	532.12	537.74	531.25	486.73

Owner Households as an Estimated Percent of All Households	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Source	*2006-2010 ACS*	*2007-2011 ACS*	*2008-2012 ACS*	*2009-2013 ACS*	*Linear Model*		
Monday	55%	55%	55%	56%	57%	57%	57%
Tuesday	69%	68%	67%	64%	63%	62%	60%
Wednesday	23%	21%	21%	21%	20%	20%	20%
Thursday	43%	38%	39%	40%	38%	37%	36%
Friday	61%	61%	62%	61%	62%	62%	62%

Total Zone Tonnage (MSW and Recycling)	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Source	*Ecomaine Collection Receipts from Municipal Curbside Collection*						
Monday	2960.61	2883.82	2831.46	2760.81	3045.52	2920.84	3053.39
Tuesday	2678.6	2606.84	2595.5805	2554.98	2690.21	2726.63	2696.3
Wednesday	3068.67	2989.26	3083.14	3097.51	3085.38	3077.06	3139.93
Thursday	3146.61	3172.4	2880.92	2766.14	2871.79	2778.2605	2861.9
Friday	2871.4	2836.01	2912.65	2845.25	2997.74	2984.15	2903.66

Estimated Total Housing Units	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Source	*Linear Housing Model from 2000 Census, 2010 Census and 2014 Tax Roll*						
Monday	5598	5648	5697	5727	5770	5810	5848

Tuesday	4316	4359	4402	4476	4550	4623	4697
Wednesday	9551	9583	9615	10060	10505	10949	11394
Thursday	6680	6716	6751	7016	7281	7545	7810
Friday	5857	5885	5913	5998	6083	6167	6252

2014 Portland Curbside Collection Zones	Estimated Number of Housholds	Estimated Overall Vacancy Rate	Owner Households as an Estimated Percent of All Households	Average Median Household Income	Average Median Personal Income	Average Median Age	High School Graduates as a Percent of the Population	College Graduates as a Percent of the Population	Estimated Average Household Size	Average Unit Value of Unit in Building with Fewer than 13 Units	Total Zone Tonnage	Households Estimated to be Served by Curbside Collection (Households in Buildings With Fewer than 13 Units)	Average Waste Per Household (lbs/year)	MSW Per Household (lbs/year)	Recyclables Per Household (lbs/year)	Yearly Diversion Rate	Ratio of Units in Single Family Dwellings to Units in Multi Family Dwellings	Ratio of Units in Single and Two Family Dwellings to Units in Multi Family Dwellings	Ratio of Units in Single, Two, and 3 Family Dwellings to Units in Multi Family Dwellings
Monday	5458	6.67%	57.35%	$ 53,840.99	$ 35,043.49	45.0	96%	54%	2.18	$ 161,998.96	3053	4230	1444	889	555	38.4%	1.14 : 1	1.97 : 1	2.54 : 1
Tuesday	4403	6.27%	60.31%	$ 72,671.33	$ 34,038.07	41.1	92%	57%	2.29	$ 194,238.97	2696	3554	1517	941	576	38.0%	1.96 : 1	3.03 : 1	3.59 : 1
Wednesday	10770	5.48%	19.51%	$ 37,442.91	$ 28,478.45	30.6	92%	59%	1.93	$ 116,465.99	3140	6830	919	595	325	35.3%	0.28 : 1	0.43 : 1	0.73 : 1
Thursday	7232	7.40%	35.95%	$ 40,463.50	$ 27,373.16	31.2	88%	45%	2.24	$ 128,373.31	2862	4872	1175	778	397	33.8%	0.44 : 1	0.62 : 1	0.87 : 1
Friday	5975	4.44%	62.10%	$ 57,779.79	$ 30,388.15	44.9	87%	46%	2.40	$ 155,186.15	2904	4334	1340	853	487	36.3%	0.88 : 1	1.54 : 1	1.97 : 1

2013 Portland Curbside Collection Zones	Estimated Number of Housholds	Estimated Overall Vacancy Rate	Owner Households as an Estimated Percent of All Households	Average Median Household Income	Average Median Personal Income	Average Median Age	High School Graduates as a Percent of the Population	College Graduates as a Percent of the Population	Estimated Average Household Size	Livable Unit Value (#ofUnits/PropertyValue)	Total Zone Tonnage	Households Estimated to be Served by Curbside Collection (Households in Buildings With Fewer than 13 Units)	Average Waste Per Household (lbs/year)	MSW Per Household (lbs/year)	Recyclables Per Household (lbs/year)	Yearly Diversion Rate	Ratio of Units in Single Family Dwellings to Units in Multi Family Dwellings	Ratio of Units in Single and Two Family Dwellings to Units in Multi Family Dwellings	Ratio of Units in Single, Two, and 3 Family Dwellings to Units in Multi Family Dwellings
Monday	5437	6.42%	56.96%	$ 54,699.54	$ 34,735.39	44.0	95%	54%	2.18	$ -	2921	4214	1386	842	545	39.3%	1.14 : 1	1.97 : 1	2.54 : 1
Tuesday	4355	5.79%	61.79%	$ 72,007.34	$ 33,824.46	41.4	92%	55%	2.29	$ -	2727	3516	1551	932	618	39.9%	1.96 : 1	3.03 : 1	3.59 : 1
Wednesday	10276	6.15%	19.94%	$ 36,891.54	$ 28,437.93	31.5	91%	58%	1.93	$ -	3077	6517	944	612	332	35.2%	0.28 : 1	0.43 : 1	0.73 : 1
Thursday	6970	7.62%	36.80%	$ 43,898.25	$ 28,155.11	32.3	88%	46%	2.24	$ -	2778	4695	1183	755	428	36.2%	0.44 : 1	0.62 : 1	0.87 : 1
Friday	5846	5.20%	61.89%	$ 58,723.12	$ 30,648.23	43.7	88%	47%	2.40	$ -	2984	4241	1407	876	531	37.7%	0.88 : 1	1.54 : 1	1.97 : 1

2012 Portland Curbside Collection Zones	Estimated Number of Housholds	Estimated Overall Vacancy Rate	Owner Households as an Estimated Percent of All Households	Average Median Household Income	Average Median Personal Income	Average Median Age	High School Graduates as a Percent of the Population	College Graduates as a Percent of the Population	Estimated Average Household Size	Livable Unit Value (#ofUnits/PropertyValue)	Total Zone Tonnage	Households Estimated to be Served by Curbside Collection (Households in Buildings With Fewer than 13 Units)	Average Waste Per Household (lbs/year)	MSW Per Household (lbs/year)	Recyclables Per Household (lbs/year)	Yearly Diversion Rate	Ratio of Units in Single Family Dwellings to Units in Multi Family Dwellings	Ratio of Units in Single and Two Family Dwellings to Units in Multi Family Dwellings	Ratio of Units in Single, Two, and 3 Family Dwellings to Units in Multi Family Dwellings
Monday	5414	6.16%	56.56%	$ 55,558.09	$ 34,427.29	43.0	95%	54%	2.18	$ -	3046	4196	1452	870	582	40.1%	1.14 : 1	1.97 : 1	2.54 : 1
Tuesday	4308	5.32%	63.26%	$ 71,343.35	$ 33,610.84	41.7	92%	54%	2.29	$ -	2690	3478	1547	917	630	40.7%	1.96 : 1	3.03 : 1	3.59 : 1
Wednesday	9788	6.82%	20.37%	$ 36,340.17	$ 28,397.41	32.5	91%	57%	1.93	$ -	3085	6208	994	655	339	34.1%	0.28 : 1	0.43 : 1	0.73 : 1
Thursday	6709	7.85%	37.64%	$ 47,333.00	$ 28,937.06	33.4	89%	47%	2.24	$ -	2872	4519	1271	859	412	32.4%	0.44 : 1	0.62 : 1	0.87 : 1
Friday	5720	5.97%	61.67%	$ 59,666.46	$ 30,908.31	42.5	89%	48%	2.40	$ -	2998	4149	1445	907	538	37.2%	0.88 : 1	1.54 : 1	1.97 : 1

2011 Portland Curbside Collection Zones	Estimated Number of Housholds	Estimated Overall Vacancy Rate	Owner Households as an Estimated Percent of All Households	Average Median Household Income	Average Median Personal Income	Average Median Age	High School Graduates as a Percent of the Population	College Graduates as a Percent of the Population	Estimated Average Household Size	Livable Unit Value (#ofUnits/PropertyValue)	Total Zone Tonnage	Households Estimated to be Served by Curbside Collection (Households in Buildings With Fewer than 13 Units)	Average Waste Per Household (lbs/year)	MSW Per Household (lbs/year)	Recyclables Per Household (lbs/year)	Yearly Diversion Rate	Ratio of Units in Single Family Dwellings to Units in Multi Family Dwellings	Ratio of Units in Single and Two Family Dwellings to Units in Multi Family Dwellings	Ratio of Units in Single, Two, and 3 Family Dwellings to Units in Multi Family Dwellings
Monday	5371	6.22%	56.50%	$ 55,316.01	$ 33,406.26	42.2	94%	53%	2.18	$ -	2761	4162	1327	796	531	40.0%	1.14 : 1	1.97 : 1	2.54 : 1
Tuesday	4269	4.62%	64.08%	$ 70,575.59	$ 33,144.08	42.0	92%	53%	2.29	$ -	2555	3446	1483	894	589	39.7%	1.96 : 1	3.03 : 1	3.59 : 1
Wednesday	9256	7.99%	21.22%	$ 36,388.87	$ 28,817.00	33.7	90%	55%	1.93	$ -	3098	5870	1055	712	343	32.5%	0.28 : 1	0.43 : 1	0.73 : 1
Thursday	6450	8.06%	39.63%	$ 51,112.91	$ 29,608.64	34.8	90%	47%	2.24	$ -	2766	4345	1273	812	461	36.2%	0.44 : 1	0.62 : 1	0.87 : 1
Friday	5585	6.88%	61.22%	$ 60,370.69	$ 31,083.18	41.5	90%	51%	2.40	$ -	2845	4051	1405	872	532	37.9%	0.88 : 1	1.54 : 1	1.97 : 1

2010 Portland Curbside Collection Zones	Estimated Number of Housholds	Estimated Overall Vacancy Rate	Owner Households as an Estimated Percent of All Households	Average Median Household Income	Average Median Personal Income	Average Median Age	High School Graduates as a Percent of the Population	College Graduates as a Percent of the Population	Estimated Average Household Size	Livable Unit Value (#ofUnits/PropertyValue)	Total Zone Tonnage	Households Estimated to be Served by Curbside Collection (Households in Buildings With Fewer than 13 Units)	Average Waste Per Household (lbs/year)	MSW Per Household (lbs/year)	Recyclables Per Household (lbs/year)	Yearly Diversion Rate	Ratio of Units in Single Family Dwellings to Units in Multi Family Dwellings	Ratio of Units in Single and Two Family Dwellings to Units in Multi Family Dwellings	Ratio of Units in Single, Two, and 3 Family Dwellings to Units in Multi Family Dwellings
Monday	5378	5.61%	55.41%	$ 58,477.18	$ 34,656.54	40.7	94%	55%	2.18	$ -	2831	4167	1359	878	481	35.4%	1.14 : 1	1.97 : 1	2.54 : 1
Tuesday	4217	4.20%	67.03%	$ 69,877.10	$ 33,447.05	42.5	91%	52%	2.29	$ -	2596	3404	1525	589	541	35.5%	1.96 : 1	3.03 : 1	3.59 : 1
Wednesday	8894	7.49%	20.95%	$ 34,608.08	$ 27,288.25	34.0	89%	55%	1.93	$ -	3083	5641	1093	343	353	32.3%	0.28 : 1	0.43 : 1	0.73 : 1
Thursday	6183	8.42%	38.77%	$ 54,235.20	$ 30,165.04	35.1	89%	48%	2.24	$ -	2881	4165	1383	461	428	30.9%	0.44 : 1	0.62 : 1	0.87 : 1
Friday	5472	7.46%	61.57%	$ 62,442.81	$ 31,251.82	39.9	90%	50%	2.40	$ -	2913	3969	1468	532	527	35.9%	0.88 : 1	1.54 : 1	1.97 : 1

2009 Portland Curbside Collection Zones	Estimated Number of Housholds	Estimated Overall Vacancy Rate	Owner Households as an Estimated Percent of All Households	Average Median Household Income	Average Median Personal Income	Average Median Age	High School Graduates as a Percent of the Population	College Graduates as a Percent of the Population	Estimated Average Household Size	Livable Unit Value (#ofUnits/PropertyValue)	Total Zone Tonnage	Households Estimated to be Served by Curbside Collection (Households in Buildings With Fewer than 13 Units)	Average Waste Per Household (lbs/year)	MSW Per Household (lbs/year)	Recyclables Per Household (lbs/year)	Yearly Diversion Rate	Ratio of Units in Single Family Dwellings to Units in Multi Family Dwellings	Ratio of Units in Single and Two Family Dwellings to Units in Multi Family Dwellings	Ratio of Units in Single, Two, and 3 Family Dwellings to Units in Multi Family Dwellings
Monday	5393	4.51%	55.10%	$ 59,031.66	$ 33,950.83	40.3	93%	55%	2.18	$ -	2884	4179	1380	939	441	32.0%	1.14 : 1	1.97 : 1	2.54 : 1
Tuesday	4146	4.88%	68.02%	$ 69,939.20	$ 33,202.55	42.2	90%	48%	2.29	$ -	2607	3347	1558	966	592	38.0%	1.96 : 1	3.03 : 1	3.59 : 1
Wednesday	8754	8.65%	20.94%	$ 34,144.48	$ 28,951.72	35.1	89%	53%	1.93	$ -	2989	5552	1077	720	357	33.1%	0.28 : 1	0.43 : 1	0.73 : 1
Thursday	6157	8.33%	37.89%	$ 56,536.31	$ 32,285.87	37.1	91%	50%	2.24	$ -	3172	4147	1530	1108	422	27.6%	0.44 : 1	0.62 : 1	0.87 : 1
Friday	5422	7.87%	61.09%	$ 61,434.39	$ 32,297.44	38.3	93%	52%	2.40	$ -	2836	3933	1442	960	482	33.4%	0.88 : 1	1.54 : 1	1.97 : 1

2008 Portland Curbside Collection Zones	Estimated Number of Housholds	Estimated Overall Vacancy Rate	Owner Households as an Estimated Percent of All Households	Average Median Household Income	Average Median Personal Income	Average Median Age	High School Graduates as a Percent of the Population	College Graduates as a Percent of the Population	Estimated Average Household Size	Livable Unit Value (#ofUnits/PropertyValue)	Total Zone Tonnage	Households Estimated to be Served by Curbside Collection (Households in Buildings With Fewer than 13 Units)	Average Waste Per Household (lbs/year)	MSW Per Household (lbs/year)	Recyclables Per Household (lbs/year)	Yearly Diversion Rate	Ratio of Units in Single Family Dwellings to Units in Multi Family Dwellings	Ratio of Units in Single and Two Family Dwellings to Units in Multi Family Dwellings	Ratio of Units in Single, Two, and 3 Family Dwellings to Units in Multi Family Dwellings
Monday	5278	5.73%	55.29%	$ 57,993.02	$ 32,614.49	39.1	93%	53%	2.18	$ -	2961	4090	1448	900	548	37.8%	1.14 : 1	1.97 : 1	2.54 : 1
Tuesday	4194	2.81%	68.66%	$ 68,341.59	$ 32,513.53	43.1	91%	50%	2.29	$ -	2679	3386	1582	927	655	41.4%	1.96 : 1	3.03 : 1	3.59 : 1
Wednesday	8611	9.84%	22.66%	$ 34,705.49	$ 28,127.44	36.5	89%	51%	1.93	$ -	3069	5461	1124	725	399	35.5%	0.28 : 1	0.43 : 1	0.73 : 1
Thursday	6089	8.85%	42.74%	$ 61,795.03	$ 31,508.20	37.9	92%	48%	2.24	$ -	3147	4102	1534	1072	462	30.1%	0.44 : 1	0.62 : 1	0.87 : 1
Friday	5313	9.29%	60.67%	$ 63,851.28	$ 31,601.57	38.1	93%	54%	2.40	$ -	2871	3854	1490	931	559	37.5%	0.88 : 1	1.54 : 1	1.97 : 1

Table 4. Change in all variables over time

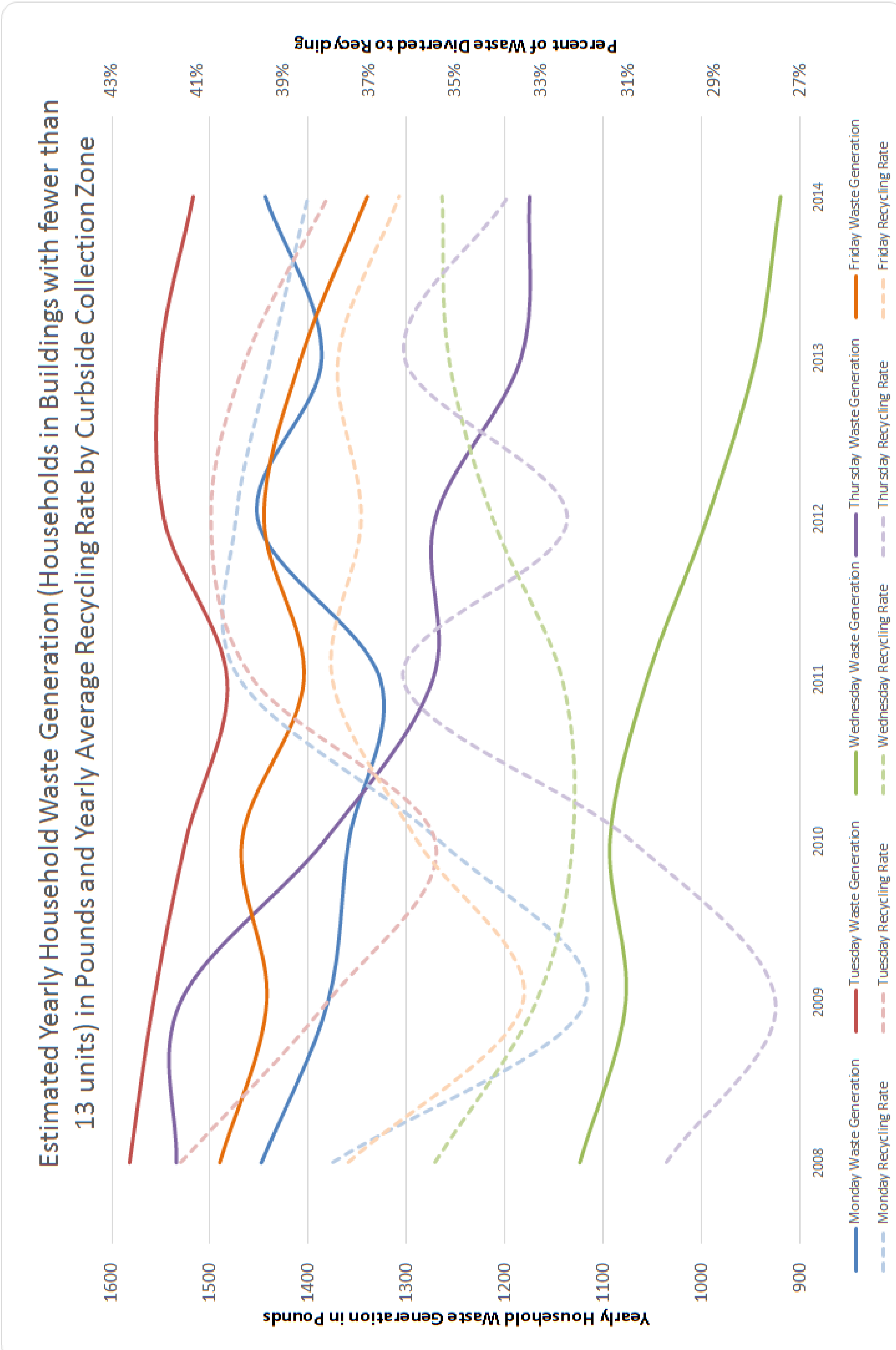


Figure 3. Yearly household waste tonnage by solid waste collection zone and recycling rate by solid waste collection zone

Percent Correlation Between Variables	Average Waste Per Household (lbs/year)	Yearly Recycling Diversion Rate	MSW Per Household (lbs/year)	Recyclables Per Household (lbs/year)	Average Median Household Income	Average Median Personal Income	Owner Households as an Estimated Percent of All Households	Ratio of Units in Single Family Dwellings to Units in Multi Family Dwellings	High School Graduates as a Percent of the Population	College Graduates as a Percent of the Population	Average Median Age
Average Waste Per Household (lbs/year)											
Yearly Recycling Diversion Rate	33.61%										
MSW Per Household (lbs/year)	61.34%	18.57%									
Recyclables Per Household (lbs/year)	87.65%	74.63%	51.86%								
Average Median Household Income	93.31%	45.35%	55.54%	88.93%							
Average Median Personal Income	77.67%	46.51%	55.26%	78.00%	78.40%						
Owner Households as an Estimated Percent of All Households	88.35%	59.37%	51.92%	92.34%	92.04%	78.30%					
Ratio of Units in Single Family Dwellings to Units in Multi Family Dwellings	74.46%	67.25%	39.62%	87.63%	85.95%	77.98%	82.51%				
High School Graduates as a Percent of the Population	29.50%	31.90%	26.37%	36.38%	30.17%	73.86%	29.68%	37.10%			
College Graduates as a Percent of the Population	-26.24%	15.76%	-17.49%	-9.97%	-11.36%	23.53%	-19.35%	12.05%	65.25%		
Average Median Age	76.61%	59.33%	46.62%	83.89%	75.03%	81.37%	86.95%	73.78%	36.43%	-5.65%	

Table 1. Multivariate correlation table

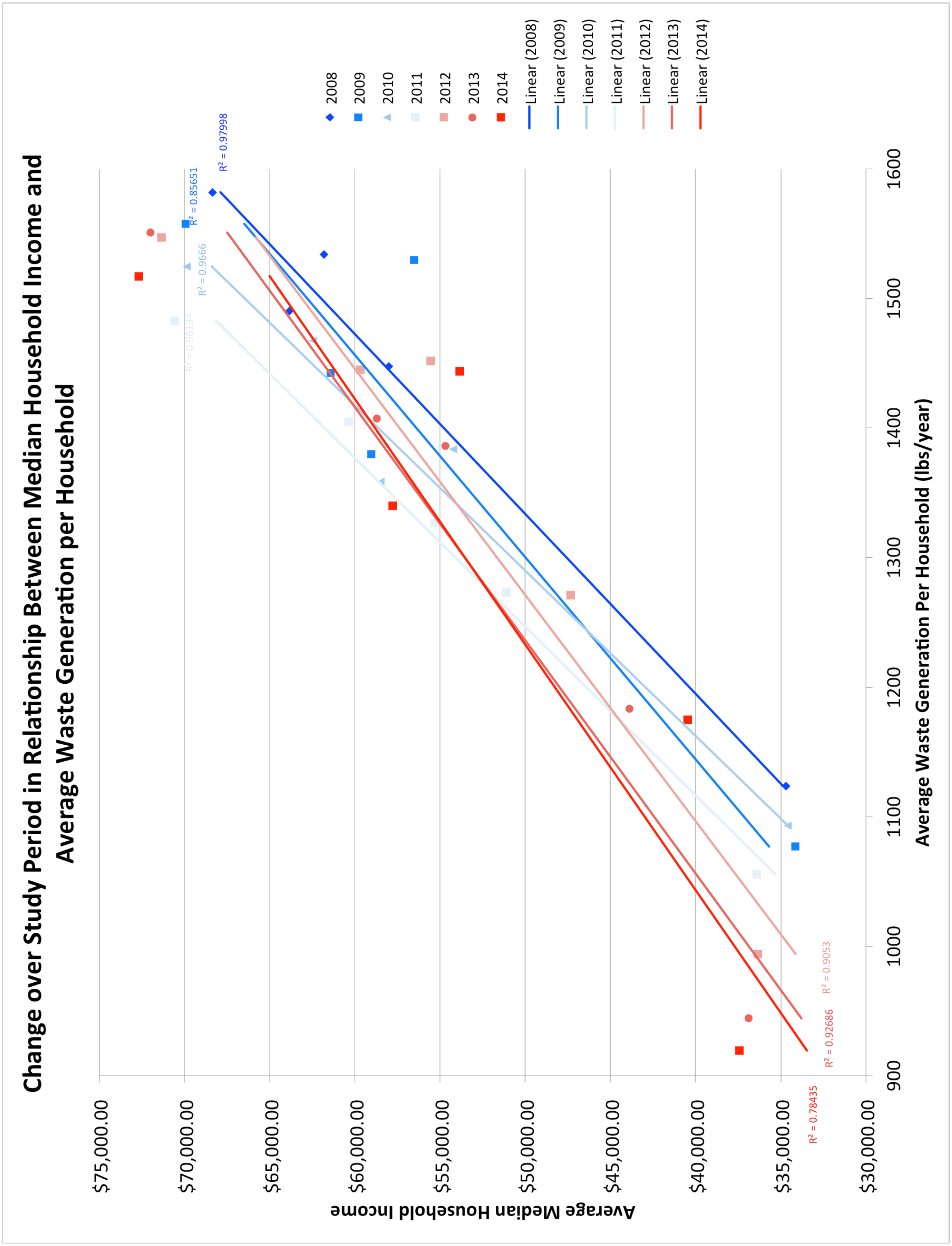


Figure 4. Change in the relationship between household income and waste generation in Portland

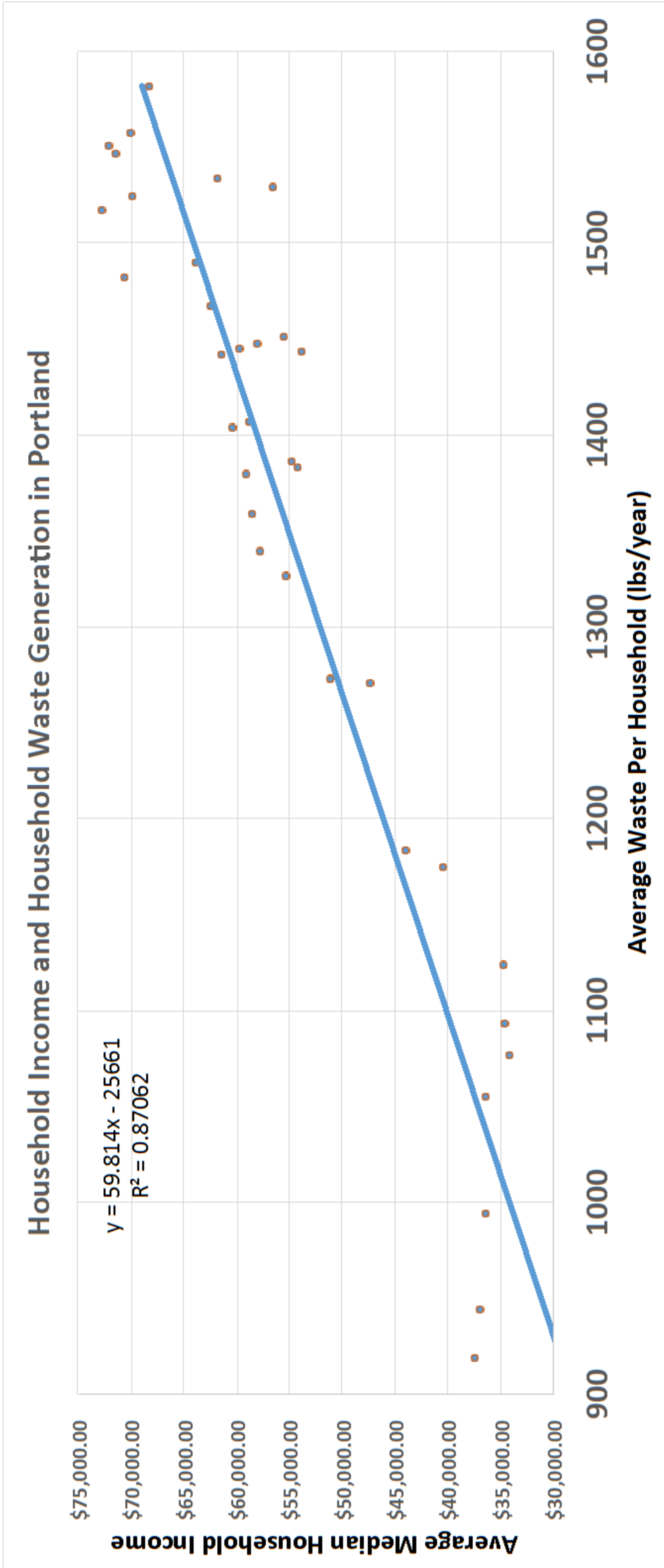


Figure 5. Relationship between household income and waste generation in Portland.

Appendix B

Chapter 3. "Tools of the Trade: a Zero Waste Policy Toolbox for Portland"

Policy Tool Summaries

3.1. MSW Collection Strategies

3.1.1. Collection Frequency

3.1.1.1. Increasing waste collection to EOW while maintaining weekly recycling and organics collection

Type: Policy
Examples: Renton, WA; Tacoma, WA (The News Tribune, 2014); Portland, OR; Hamilton, MA
Objectives: Dramatically increase diversion rates and decrease total MSW tonnage by giving residential households a powerful incentive to remove organic and recyclable materials from their household garbage.
Methods/Approaches: Organics and recyclables are collected on a weekly basis, while non-organic, non-recyclable waste is collected every other week. Collection can be undertaken with split-body collection vehicles, bagged organics and recyclables in existing vehicles, or with dedicated collection vehicles for organics collection aside from those used for trash and recycling. The approach is often employed in tandem with mandatory recycling or organics policies or bans on the disposal of organics and recyclables in household garbage.
Potential/Example Impacts/Limitations: EOW collection of garbage and weekly collection of organics and recyclables has the potential to entirely divert the organic portion of the waste stream, and significantly increase the diversion rate of recyclables. It is likely that Portland would exceed the 50% diversion rate set as a goal for the city. The public may resist the institution of such a significant change to curbside collection, particularly due to the perception that the handling or separation of organic waste is unpleasant and that trash stored for two weeks will produce offensive odors. Organic processing capacity would have to be dramatically increased to cope with the increased volume of organic waste collected. A universal ban on cross contamination of waste streams (see Chapter 3.1.1.2) may be necessary to reduce such contamination.

Costs: Costs of organics management would increase from dramatically increased organic waste diversion. Social marketing, outreach and education would bring their own costs. The collection costs from collection with a split-body collection vehicles are lower than for bagged collection, but with higher upfront investment.
Maximum Marginal Recovery Rate: 59.68% (38.41%, the percent of the MSW stream constituted by organics, plus 21.27%, the percent of the MSW stream constituted by recyclables) (Criner & Blackmer, 2012, p. 20). This rate is based on a Maine-wide study, and is likely to be higher in Portland as ecomaine accepts more recyclables than are broadly accepted in the state, and the current diversion rate in Portland is greater than the percentage of recyclable material identified in the 2011 UMaine study.

3.1.1.2. Universal Disposal Ban on Divertible Materials

Type: Regulation
Examples: Seattle, WA; San Francisco, CA
Objectives: Divert all recyclable and organic material from the residential (and potentially commercial) waste stream.
Methods/Approaches: Ban the disposal of recyclable and organic waste in the garbage through passage of a municipal ordinance and enforce that ordinance with fines or increased fees for non-compliance. The policy should be accompanied by an education campaign to familiarize residents with proper sorting techniques.
Potential/Example Impacts/Limitations: The policy has the potential to significantly reduce contamination of source-separated recyclables and organic material, and is thus a useful companion policy for increasing waste collection to every other week while maintaining weekly recycling and organics collection (see Chapter 3.1.1.1). Administration of the policy is straightforward, but political resistance to the policy is potentially a significant barrier to its adoption.
Costs: Enforcement costs are either those of hiring additional enforcement employees or the additional labor cost from existing curbside collection employees devoting additional time to enforcement activity. In the case that the addition of enforcement activities to collections employees' current responsibilities would exceed the labor capacity of the collections department, the collection zones may have to be revised to reduce curbside pickups to a manageable number, with an additional employees and collection vehicle(s) making up the difference. To the extent that it is possible for enforcement to be assumed by current employees, financial costs of the policy will be minimal.
Maximum Marginal Recovery Rate: 59.68% (38.41%, the percent of the MSW stream constituted by organics, plus 21.27%, the percent of the MSW stream constituted by recyclables) (Criner & Blackmer, 2012, p. 20). This rate is based on a Maine-wide study, and is likely to be higher in Portland as ecomaine accepts more recyclables than are broadly accepted in the state, and the current diversion rate in Portland is greater than the percentage of recyclable material identified in the 2011 UMaine study.

3.1.2. Recycling

3.1.2.1. Container Size/Container Alternatives

3.1.2.1.1 Larger open bins

Type: Policy

Examples: Winfield, KS; Leesburg, VA; Downers Grove, IL; Easton, PA; Penn Township, PA

Objectives: Increase the recycling rate by increasing the size of the container in which recyclables are collected, thus easing the functional volume limit on household diversion of recyclable materials.

Methods/Approaches: The municipality should purchase larger bins to replace the existing recycling bins. Collection would continue with the current vehicles and collections employees.

Potential/Example Impacts/Limitations: The availability of additional space for recyclables, when tied to a Pay-As-You-Throw system (see Chapter 3.1.5.1), may result in an increased contamination rate of recyclable materials with trash, as surplus space for recyclables may be tempting for individuals seeking to avoid their PAYT fees. An auditing system may be necessary if municipal workers observe high levels of contamination, with fines assessed as a disincentive for further misuse of recycling bins.

Costs: The municipality would pay for the larger containers. Municipalities that have attempted to directly pass this cost on to residents have seen very low program participation (EPA, Chapter 5, 1994, p. 59). Costs of the new containers will be mitigated to some extent by a reduced tipping fee from MSW waste disposal and reduced litter cleanup costs. However, these benefits cannot be expected to outweigh the cost of the bins.

3.1.2.1.2. Roll-out Carts

Type: Policy

Examples: La Crosse, WI; Cedar Rapids, IA; Weston, FL; Braintree, MA; Fort Wayne, Indiana; Raleigh, NC; Warwick, RI; Westbrook, ME

Objectives: Increase the recycling rate by increasing the size of the container in which recyclables are collected, thus eliminating the functional volume limit on household diversion of recyclable materials. Dramatically reduce litter in the city.

Methods/Approaches: Replace existing curbside recycling bins with rolling carts and existing collection vehicles with vehicles equipped with a robotic arm suited for collection of the carts. Reduce the number of workers per vehicle to one.

Potential/Example Impacts/Limitations: Loading the cart into the automated collection vehicle takes slightly longer per stop than does manual loading of recycling bins. The availability of additional space for recyclables, when tied to a Pay-As-You-Throw system (see Chapter 3.1.5.1), may result in an increased contamination rate of recyclable materials with trash, as surplus space for recyclables may be tempting for individuals seeking to avoid their PAYT fees. An auditing system may be necessary if municipal workers observe high levels of contamination, with fines assessed as a disincentive for further misuse of recycling carts. Increased availability of space for recyclables may encourage residents to not only divert recyclable material that was previously placed in the trash, but also increase their total generation of recyclable waste.

Costs: The upfront costs of robotically equipped collections vehicles and new rolling carts will be significant. These costs will be attenuated over time through the reduction of tipping fees from increased diversion rates, reduced litter cleanup costs and increased property values in neighborhoods currently most affected by litter.

3.1.2.1.3. Bags

Type: Policy

Examples: 14 Boston neighborhoods (City of Boston Public Works, 2014); Truckee, CA; College Station, TX, Franklin, TN; DeKalb County, GA; Irving, TX

Objectives: Reduce litter and increase collection efficiency by containing recyclable materials in plastic bag currently used for Portland's PAYT bagged trash collection.

Methods/Approaches: Bags can either be distributed through local intermediaries such as corporate partners, alone or in tandem with the existing blue bags, or by mail on a weekly or monthly basis.

Potential/Example Impacts/Limitations: Because the maximum size of recyclables that can be contained in each bag is limited, alternatives must be developed in order to manage large recyclable items such as oversized cardboard boxes. There is some risk that once a bag's capacity has been reached, overflow material may be placed in the trash, particularly if barriers exist for residents in obtaining the bags.

Costs: The cost of the bags is a long-term municipal cost, as attempts to pass on this cost to residents will result in reduced participation in curbside recycling. This cost may be attenuated by reducing the cost of collection (through quicker stop times at each residence), as well as through reduced litter collection costs.

3.1.2.2. Disposal ban for recyclables in residential waste

Type: Regulation

Examples: Seattle WA, Portland OR, San Francisco CA, the State of Wisconsin

Objectives: Divert all recyclable material from the residential waste stream.

Methods/Approaches: Ban the disposal of recyclable material in the garbage through passage of a municipal ordinance and enforce that ordinance with fines or increased fees for non-compliance. The policy should be accompanied by an educational campaign to familiarize residents with proper sorting techniques.

Potential/Example Impacts/Limitations: The policy has the potential to significantly reduce the disposal source-separated recyclables in MSW, and is thus a useful companion policy for increasing waste collection to every other week while maintaining weekly recycling and organics collection (see Chapter 3.1.1.1). Administration of the policy is straightforward, but political resistance to the policy is potentially a significant barrier to its adoption.

Costs: Enforcement costs are either those of hiring additional enforcement employees, or in the additional labor costs from existing curbside collection employees devoting additional time to enforcement activity. In the case that the addition of enforcement activities to collections employees' current responsibilities would exceed the labor capacity of the collections department, the collection zones may have to be revised to reduce curbside pickups to a manageable number, with an additional collection vehicle and additional employees making up the difference. To the extent that current employees can enforce the policy, financial costs will be minimal.

Maximum Marginal Recovery Rate: 21.27%, the percent of the MSW stream constituted by recyclables (Criner & Blackmer, 2012, p. 20). This rate is based on a Maine-wide study, and is likely to be higher in Portland as ecomaine accepts more recyclables than are broadly accepted in the state, and the current diversion rate in Portland is greater than the percentage of recyclable material identified in the 2011 UMaine study.

3.1.3. Organics Extraction

3.1.3.1. Residential Organics Collection Strategies

Type: Policy

Examples: Seattle, WA; Portland, OR; San Francisco, CA; Boulder, CO; Salem, CO; Hennepin County, MN

Objectives: Divert all residential food waste from Portland's municipal solid waste stream.

Methods/Approaches: The city can either undertake collection itself, with municipal vehicles and labor, or it can contract with private organic waste haulers. Likewise, the city can compost food waste on municipal property or support private haulers in their business practice. Combining these approaches may be an option, by contracting with private haulers to manage a composting facility on municipal property. In the long term, the city may wish to acquire split-body collection vehicles with which to collect organic waste and recyclables at the same time, thus achieving greater collection cost efficiency (see Chapter 3.1.2.1.2). Ultimately, the city should also look towards targeting source reduction by employing community-based social marketing techniques to help Portland consumers avoid some of the common sources of food waste (e.g. educating consumers on the difference between a "best by" and a "use by" date or educating consumers in the value of buying smaller quantities of food nearer to the date of consumption).

Potential/Example Impacts/Limitations: An effective organics collection program could permit the city to surpass its 50% diversion rate goal with a single policy. However, many residents may be resistant to the perceived unpleasant nature of separating food waste and may thus create a barrier to implementation of the policy. Though this resistance tends to diminish once residents have experience with the program, an effective social marketing campaign is necessary to overcome this initial hurdle. Voluntary collection requiring subscription can have lower upfront costs, but as long as the cost to households of organics collection exceeds that of garbage collection, little incentive exists to expand collection beyond those motivated by non-monetary factors.

Costs: The costs of collection have a large range, depending on whether the municipality assumes responsibility for collection or leaves the task to private haulers. Use of municipal land under private management of a composting facility may help existing private organic waste haulers achieve economies of scale and provide collection at a lower cost to the consumer, and would cost the city relatively little. In the long term, if the city elects to assume responsibility for organic waste collection in order to provide a comprehensive collection service, they may consider replacing existing trucks with split-body collection vehicles in order to minimize additional capital investment costs.

Maximum Marginal Recovery Rate: 27.86%, the percent of the MSW stream constituted by food waste (Criner & Blackmer, 2012, p. 7).

3.1.3.2. Hard to Compost Materials (Pet Waste/Diapers)

Type: Incentive Program/ Assistance Program

Examples: Toronto, Canada, Portland OR, Minneapolis MN

Objectives: Divert the remaining fraction of organic waste, once easily composted wastes have been diverted.

Methods/Approaches: The municipality can financially or administratively support private businesses encaged exclusively in the management of such wastes, or can develop a large-scale, multi-step management process that separates plastics from organic material and raises the waste to a temperature that kills all pathogens.

Potential/Example Impacts/Limitations: Voluntary participation in diversion of such wastes may be low without the introduction of a companion policy such as EOW garbage collection (see Chapter 3.1.1.1), particularly due to its higher cost to the consumer. Expanded management of hart-to-compost organics on a city-wide scale requires the development of a dedicated, capital intensive facility and must be part of a comprehensive organic waste management strategy.

Costs: The municipality would be responsible for small grants or the cost of administrative support to business offering pet waste and diaper collection services. The cost of both anaerobic and aerobic organic waste processing facilities could have upfront capital costs exceeding $15 million (Northern Tilth, 2013, p. 110; Lewiston Auburn Water Pollution Control Authority, 2013), but would be well adapted to address a much broader issue than simply hard to compost organic waste.

Maximum Marginal Recovery Rate: 3% to 13.96% (2.97%, the percent of the MSW stream constituted by diapers, plus 10.97%, the percent of the MSW stream constituted by remainder/composite organics) (Criner & Blackmer, 2012, p. 7). This rate is based on a Maine-wide study, and it is unknown whether these rates reflect the amount of the waste stream constituted by these materials in Portland.

3.1.4 Reuse Initiatives

3.1.4.1. Municipal Partnership Reuse and Reclamation Center

Type: Assistance Program

Examples: CHaRM: Center for Hard to Recycle Materials at Eco-Cycle – Boulder, CO; UrbanOre - Berkley CA

Objectives: Divert materials for reuse, repurposing or recycling that are unmanageable using conventional techniques.

Methods/Approaches: The municipality can fund or partially fund the development of a reuse and reclamation operation, in an existing building or in a building constructed expressly for that purpose. The building should be colocated with the existing recycling facility in order to easily transfer materials that are not recoverable through deconstruction or repurposing.

Potential/Example Impacts/Limitations: Because of the labor costs involved in processing the materials for reuse, repurposing or remanufacture, a facilities fee and a fee per item is required. These fees are likely to drive down participation rates, even where bans on disposal of certain items help direct residents towards use of the facility. The development of effective EPR policies can shift the burden of resource management from residents to manufacturers, but only if the EPR policies are adopted at an adequately broad scale. If well managed, the program would succeed in diverting from the waste stream materials that are currently not manageable under any diversion program, particularly complex products made out of multiple types of material.

Costs: The cost of the program is quite high, with significant upfront facilities development costs, ongoing operational costs, and considerable labor costs. The costs can be minimized to the extent possible through colocation with existing recycling businesses or municipal or regional recycling facilities such as ecomaine.

3.1.4.2. Support for or management of reuse website

Type: Education/Assistance Program

Examples: Sedona, AZ; Orange County, NC; Austin, TX

Objectives: Increase voluntary participation in existing reuse and recycling programs by reducing the time and effort individuals must invest in order to dispose of a product or material.

Methods/Approaches: The municipality can provide support to a local non-profit or business to create and maintain a comprehensive online list of local reuse and recycling locations, or the project can be assumed by municipal employees.

Potential/Example Impacts/Limitations: This policy is unlikely to have a marked impact on the official diversion rate, as the items it addresses are largely hidden from use due to their long-term in-home storage. Many high quality items are already sold or exchanged in private or informal reuse enterprises. Many existing businesses are selective with regards to quality and have space limitations that define an upper limit to how many items they can accept at any given time. The policy may help them fill their capacity, but may not have a marked impact on helping them expand to meet an increased need.

Costs: The policy's only costs are for creation and maintenance of the online list. This is likely to be a single lump sum, with marginal maintenance costs.

3.1.5. Collection Rate Structures

3.1.5.1. Pay-As-You-Throw (PAYT) Systems

Type: Policy

Examples: Portland, ME and well over 7000 municipalities nationwide (United States Environmental Protection Agency, 2012)

Objectives: Dramatically increase waste diversion and reduce total household waste generation by passing on to residents the cost of waste disposal of each unit of waste.

Methods/Approaches: The city can put a price on the bags in which garbage is placed for collection, on a sticker or tag affixed to generic garbage bags, or on a tiered subscription service.

Potential/Example Impacts/Limitations: Because income-driven consumption is at the root of most household waste generation, levels of waste tend to vary in tandem with broader economic changes, and thus the revenue stream from a PAYT program can decline

when the municipality is finding other sources of funding squeezed as well. Establishing a stable base for the program that can weather economic recessions, either in the form of a small tax on residents participating in curbside collection or a dedicated fund, can help diminish the risks of revenue fluctuation.
Costs: The costs to the municipality are minimal, with many municipalities showing decreases in the overall cost of municipal waste management after a PAYT system was initiated (MassDEP, 2009). Malden, Massachusetts, a city comparable in size to Portland with 56,000 people in 17,783 households, saw a savings of $2.5 million in the first year of the program with near-perfect compliance, a 74% increase in the city's recycling rate and a reduction in total municipal solid waste tonnage by half (MassDEP, 2010).

3.1.5.2 Two-tiered and Multi-tiered commercial garbage/ organics /recycling rates

Type: Policy/Incentive Program
Examples: Wayland, MA; Medway, MA; Granby, CT
Objectives: Reduce total waste tonnage generated and increase diversion rates while maintaining a relatively stable revenue stream.
Methods/Approaches: Create either a two-tiered rate system or a multi-tiered system. Under a two-tiered system, a subscription fee would be charged for a first collection container, with each additional bin or container costing an extra fee. Under a multi-tiered system, a base subscription fee would still be applied, but as the household or business purchased additional containers, the cost of each would increase progressively.
Potential/Example Impacts/Limitations: Users of the system would have a financial advantage in reducing the amount of waste generated: by reducing their rate of waste generation, they will pay for a diminishing level of service, thus lowering their costs. However, the presence of an unchanging base cost will reduce the degree to which a user will see the benefit of their waste reduction efforts.
Costs: Administrative costs of managing this program can be quite high, as each customer may be subject to a different level of fees and service. Yet due to the fact that the base subscription fee is not associated with any level of waste generation, revenues from this program tend to stay relatively stable over time, not fluctuating dramatically as consumption-driven waste declines during economic recessions.

3.1.5.3. Ban self-haul disposal at ecomaine and Riverside

Type: Regulation
Examples: Tacoma, WA
Objectives: Ensure uniform application of comprehensive waste policy by eliminating unfacilitated disposal options.
Methods/Approaches: Prohibit residents from bringing undivertable waste to the city or regional waste transfer facilities (through regional agreement). The employee assigned to the gate of the municipal or regional transfer station would conduct enforcement.
Potential/Example Impacts/Limitations: Because this policy restricts what is likely to be the final loophole in a comprehensive policy, resistance to its adoption may be greater than would be expected for a change of this size. Exceptions for businesses and small haulers may provide for a loophole in this policy that may be challenging to close without hiring additional enforcement personnel. The political capital required for this change may

outweigh the potential payoff; however, if after several years of implementing a comprehensive policy the municipality discovers that a significant amount of private waste is being disposed of by this avenue (in order to escape the added burden of strong waste policy), it may become increasingly politically feasible to close this gap.
Costs: The cost to the municipality of such a ban on private garbage disposal at municipal facilities would be that of enforcement, which might be feasible with existing employees at the facility. The main costs of such a policy would be political ones.

3.2. Commercial Recycling and Organics

3.2.1. Commercial Recycling

3.2.1.1. Encourage recycling of targeted materials
Type: Policy/Education program
Examples: Charlotte/Mecklenburg County, NC; Fayetteville, AR; San Diego, CA; Denver, CO; Kirkland, WA; Portland Metro, OR; Livermore, CA; Alameda StopWaste
Objectives: Increase diversion rate by targeting the lowest hanging fruit, either by targeting certain high volume materials or certain high volume waste generators.
Methods/Approaches: The city should first perform a waste characterization to understand which materials make up the largest percentage of the waste stream and deserve the greatest attention. The municipality can then target those materials or the businesses that generate those materials in the largest volume, by providing educational assistance and training to businesses to help them achieve greater rates of diversion.
Potential/Example impacts/Limitations: This approach does not usually require additional storage or processing facilities. The burden of responsibility is unequally distributed, with only certain businesses targeted by municipal efforts. Because participation is mostly voluntary on the part of businesses, the impact of the policy is likely to be relatively limited. This is particularly true since businesses that produce large volumes of a certain type of recyclable waste, such as office paper, tend to recycle that material already if recycling can reduce their waste disposal costs.
Costs: Municipal training or facilitation would require some investment from the municipality, in the form of labor hours, or the hiring of a dedicated employee tasked with corporate outreach and training.

3.2.1.2. Mandate that haulers integrate cost of recycling into solid waste fees
Type: Regulation
Examples: San Jose, CA; Livermore, CA; Kirkland, WA; Pleasant Hill, CA
Objectives: Increase participation in recycling efforts by all businesses by mandating that haulers integrate the cost of recycling service into existing trash collection service fees.
Methods/Approaches: Haulers would be required, through ordinance or license requirement, to offer recycling collection service and to integrate the cost of offering that service into the price of trash collection service. Recycling collection service would then be offered free of charge, effectively creating the same incentive for businesses to recycle

as currently exists for residents served by curbside collection under the PAYT system. The city would audit hauler records to ensure compliance and would institute an enforcement mechanism such as fines or strikes against a license to operate.

Potential/Example impacts/Limitations: This program would likely result in diversion rates for commercial waste similar to the existing residential diversion rate. For this reason, it would be well adapted to supplement other commercial waste policies. The regulation is likely to be ineffective without an enforcement mechanism. Such a requirement would, by extension, necessitate that recyclables and garbage be hauled by same hauler.

Costs: Primary municipal costs would be for monitoring and enforcement measures. The private haulers would not be saddled with extra costs, as disposal of recyclables at ecomaine is free, but it may eat into haulers' profit margin.

3.2.1.3. Universal mandatory commercial recycling and/or ban on disposal of recyclables

Type: Regulation

Examples: Portland, OR; Seattle, WA; State of Massachusetts; San Francisco, CA; Orange County, NC; Lee County, FL

Objectives: Raise recycling rates by banning the disposal of recyclable materials with trash by mandate, with fines and *in situ* enforcement to address non-compliance.

Methods/Approaches: Some cities have banned any amount of certain materials, while others have banned the disposal of recyclable materials exceeding a certain volume. Fines can be assessed to businesses or haulers in non-compliance, while haulers can be at additional risk of losing their hauling license. Ideally, the price of recycling services offered by haulers to businesses should be less that the cost of garbage collection. Business compliance with a universal mandatory commercial recycling requirement is highest when the cost of recycling services is 50% or less than the cost of garbage collection.

Potential/Example impacts/Limitations: Enforcement of the mandate is essential to its success. Enforcement is often weak, but strong enforcement sees strong results (i.e., 24/7 random inspections). Because Portland has a stake in ecomaine, flow control on a landfill ban would be much easier than at private landfills. However, the fact that many private hauling companies serve multiple municipalities makes the enforcement of such a ban much more complex, as waste collected in one municipality is not differentiable upon inspection from waste collected from businesses in another municipality. Making licensure contingent on compliance may be more effective, but would be certain to be met with stiff resistance from haulers.

Costs: Businesses and haulers shoulder the costs of recycling, while the city assumes the cost of enforcement and inspections.

3.2.1.4. Mandatory recycling for certain business types, certain materials

Type: Regulation

Examples: State of North Carolina; Lee County, FL; Gainesville, FL; Austin, TX; San Diego, CA; Chicago, IL; Honolulu, HI

Objectives: Increase the recycling rate by targeting specific large-volume waste materials for recycling by mandate.

Methods/Approaches: The municipality can require businesses to recycle certain materials that constitute a large portion of the waste stream or can require businesses generating over a certain volume of waste to institute comprehensive recycling efforts and divert all of their recyclable materials. When control is placed on businesses generating more than a certain amount of total waste, a blanket requirement that certain materials be recycled would apply to the private haulers with which those businesses contract. In the first case, a city employee would be required to interface with businesses to facilitate the initiation of recycling efforts. Where compliance of haulers is at issue, enforcement is undertaken using auditing and potential restriction of private hauling licenses. A waste classification is essential to appropriately targeting the highest volume materials.

Potential/Example impacts/Limitations: This approach can be more politically feasible than a more comprehensive mandate, since it only burdens a portion of the business community and some businesses bear a lesser burden than others. For the same reason, businesses may be resistant to further regulation, especially where it targets only certain businesses. Businesses that already generate large volumes of certain recyclable materials may already recycle them in order to reduce waste management costs.

Costs: The city may have to hire personnel for training and enforcement or expand the hours of existing employees. If only certain high volume materials are targeted, the city would be responsible for the cost of the necessary waste characterization study.

3.2.1.5. Triggered mandates

Type: Other

Examples: State of Iowa; Hennepin County, MN

Objectives: Make other programs with less political traction easier to institute by preconditioning them on the failure of more popular programs to meet certain benchmark goals.

Methods/Approaches: The municipality would set certain benchmarks as indicators of program success, such as the attainment of a certain diversion rate, with the understanding that if those benchmarks are not achieved by a certain date, a more stringent policy will be put into effect. This approach can make less politically salient policies appear more acceptable to the public, since it is clear that existing approaches are not as effective as the public had thought.

Potential/Example impacts/Limitations: This approach shows promise, but few examples of successful implementation exist. Measurement and enforcement is key. Benchmarks set unfeasibly high will likely result in deferred action, just as target dates set too far in the future will stymie immediate action. Where there is already sufficient willpower to institute substantial programs, this approach is largely unnecessary.

Costs: The only costs of this approach to the municipality are from measurement of progress towards the target benchmarks (typically through undertaking waste characterizations).

3.2.1.6. Increased MSW tax or surcharge

Type: Incentive program/Regulation

Examples: Hennepin County, MN; Ramsey County; Carver County; Seattle, WA; San Francisco, CA; Alameda StopWaste; Arlington, VA

Objectives: Encourage recycling by increasing waste tipping fees.

Methods/Approaches: Waste management authority increases trash disposal fees to all users, ensuring that fees for garbage disposal exceed those for disposal of recyclables.
Potential/Example impacts/Limitations: The degree to which raising the tipping fee for garbage disposal would increase the diversion rate and total waste reduction depends on how responsive different commercial entities are to a price incentive for waste reduction, as well as the specific nature of each business' operation. Small businesses may be more responsive than large businesses with a larger profit margin. The responsiveness of different waste generators to a fee increase is likely to vary through economic cycles, becoming less effective during growth periods. Raising prices during difficult economic times can create resistance and public backlash. With too substantial a fee increase, there is a risk that waste generators will begin sending their waste to other municipalities or regions. Portland has control over tipping fees at Riverside Recycling, but only a vote in rate increases at ecomaine.
Costs: Diverting waste to recycling may require a significant tipping fee price increase on haulers that would likely be passed on to customers. The cost would be neutral for the municipality, as increased revenues per ton will be balanced by reduced waste disposal.

3.2.1.7. Social marketing program for outreach / education

Type: Education/Assistance program
Examples: Contra Costa County, CA; Alameda StopWaste; Cambridge, MA; San Diego, CA; Seattle, WA; Portland, OR; Kirkland, WA
Objectives: Magnify the impact of other policies and programs by increasing participation through municipal social marketing initiatives.
Methods/Approaches: The city would work to actively promote existing waste diversion programs and promote voluntary waste diversion behavior on the part of local businesses. Because many businesses may be resistant to diversion efforts simply because waste diversion practices are unfamiliar, the city can work to normalize the perception of waste diversion and promote its potential to save businesses money.
Potential/Example Impacts/Limitations: When the perception of barriers to participation in waste reduction, recycling, and composting efforts is unfounded, outreach and education may be somewhat effective. However, their continued funding may be an issue since their impacts are notoriously challenging to quantify.
Costs: Costs to the municipality are from outreach efforts and from the study of potential barriers of other programs. Yet, because the program's impact is hard to measure, cost/benefit is extremely difficult to quantify.
Maximum Marginal Recovery Rate: 1% to 3% additional impact on recycling rate of other program.

3.2.1.8. Require tonnage-reporting from private haulers

Type: Regulation
Examples: King County, Washington; Boulder County, CO; Fort Collins, CO; City of Boulder, CO; Seattle, WA; Portland, OR; San Francisco, CA; Alexandria, VA; Roseville, CA
Objectives: Gather waste tonnage data from private haulers for analysis, in order to better understand the waste stream and be better equipped to develop effective waste policy.

Methods/Approaches: The city can institute a tonnage-reporting requirement through ordinance, city code, or as a precondition of receipt of a license to operate a hauling business in the city. All haulers would be required to submit periodic reports documenting number of customers, facilities used, tons of recyclable material collected. A comprehensive requirement might demand that haulers also assess the makeup of the waste they collect by conducting periodic waste characterizations.
Potential/Example Impacts/Limitations: Because much of the commercial waste stream is either poorly understood or not understood at all, quantification of the total volume and of the composition of waste collected by haulers can facilitate the development of effective policy. However, because this type of recording can present a challenge to trade secrets protection, the city should seek legal council in the development and wording of such a requirement. Because haulers are saddled with the responsibility for measuring and recording data, haulers can be resistant to such regulation.
Costs: The collection of commercial organic waste data by haulers would be cheapest and simplest through the development of an online web portal or database. The database would either require the labor of an existing municipal IT staff person or contracting with a third-party for database management. Cost to the municipality may also include training for both municipal employees and the employees of private haulers unversed in electronic accounting techniques.

3.2.1.9. Options for residential recycling service routes to add small businesses
Type: Policy
Examples: Newport, RI; Waltham, MA; Fayetteville, AR
Objectives: Increase recycling rates by allowing small volume waste producer businesses to participate in curbside municipal recycling pickup. Newport, RI seeks to raise their recycling rate from 23% to 35% with this method.
Methods/Approaches: Small businesses producing less than a certain volume of recycling may pay a fee and participate up to a certain volume or weight limit in existing curbside recycling programs.
Potential/Example impacts/Limitations: Because collection systems infrastructure already exists, the policy is easily instituted. Small businesses make up a large percentage of total businesses and their contribution to the total business waste stream is relatively small. Waste reductions and diversion exclusively by small businesses are unlikely to dramatically increase commercial recycling rates. Thus, this policy has the potential to work well in tandem with other programs targeting large businesses.
Costs: A fee structure can easily be established to achieve financially neutrality for the policy. High levels of participation may require expansion of the existing collection program.

3.2.1.10. Cooperative approaches to decrease costs to business
Type: Policy/Assistance program
Examples: Cambridge, MA; Howard County, MD; Monrovia, CA; Richmond, VA
Objectives: Increase recycling rates of small businesses by creating economies of scale through cooperative agreements among business owners.

Methods/Approaches: The municipality should facilitate a cooperative agreement between small area businesses in the same geographic location and generating similar waste. Waste could be aggregated in a central location or it could all be set out at the same time for collection by a private hauler. A collective contract will reduce the cost of recycling by creating an economy of scale. The municipality can contribute financially to help reduce the cost of recycling collection below that of waste.
Potential/Example impacts/Limitations: The program would be effective only for the small number of small businesses party to the cooperative arrangement, limiting the scope of the program. Because property managers rather than individual businesses may be responsible for waste management, arrangements solely between businesses may not be effective in creating an appropriate cooperative arrangement. Individual businesses may be resistant to taking on responsibilities within the group context, or may feel that they are contributing more than their fair share.
Costs: The cost to the municipality depends on the agreement established with participant businesses. The cost can range from an equal share with participant businesses to assuming the entire cost of the program. The municipality may also cover the labor costs of facilitation of the initial cooperative arrangement by a municipal representative, though they may be able to delegate this responsibility to the Chamber of Commerce or other business and development non-profit.

3.2.1.11. Hauler must offer recycling of certain materials

Type: Regulation
Examples: Santa Barbara, CA; King County, WA; Boulder, CO
Objectives: Increase commercial recycling rates by requiring haulers to offer recycling among their existing hauling services.
Methods/Approaches: Haulers can be required to offer recycling collection services with or without controls on the price of those services relative to the price of garbage collection. Typically, price controls require that the price for recycling service remain equal to or lesser than that charged for garbage collection.
Potential/Example impacts/Limitations: Without price controls, recycling service is often more expensive to businesses than waste collection service. Therefore, voluntary business participation in recycling efforts remains relatively low. Cost controls increase participation by establishing an effective financial incentive for businesses. Enforcement of hauler compliance with the requirement that recycling collection service be offered, as well as compliance with any price controls, would be conducted as annual or semi-annual audits of private hauler records.
Costs: The only costs to the municipality from this policy are those associated with auditing procedures, undertaken by municipal employees.

3.2.1.12. Technical Assistance from Municipality

Type: Assistance Program
Examples: San Bernardino, CA; San Diego, CA; Boulder, CO; Denver, CO; Kirkland, WA; King County, WA; Portland Metro, OR; Livermore, CA; Alameda County StopWaste

Objectives: Assist businesses in minimizing waste generation and increase their diversion rates through consultation with city employees who perform waste characterizations, systems analysis, and ongoing coordination.

Methods/Approaches: Large or complex firms can contract with private consultants to analyze their waste streams. The municipality employee can work with large businesses by conducting waste and systems analyses, directing the business towards appropriate information, case studies, and research, and performing benefit-cost analyses to help chose a waste diversion program that is appropriate for their specific conditions. Many municipalities providing technical assistance have developed a website with general guidance and resources, including printable signs for the office, fact sheets, local recycling and composting options and contact information, and case studies to reach a broader business base. Some level of technical assistance is key to instituting more aggressive business recycling or compositing requirements.

Potential/Example impacts/Limitations: This approach relies upon an investment from the target businesses, the municipality, or both and a long-term commitment by each to the goals set out by the program. A high level of commitment from the municipality promises potentially large waste diversion levels, as a few of the largest businesses in a city can constitute a large percentage of regional business waste generation. However, many of the largest businesses have already employed private consultants in order to glean savings from waste reduction, so exceeding their prior accomplishments may require a significant investment from the city. With limited municipal funds to devote to the initiative, high costs and a high level of time commitment per business could limit the number of businesses to which city workers might devote themselves.

Costs: Success will depend upon skill of consultants/staffer/students to glean further cost savings from waste reduction and diversion efforts.

3.2.1.13. Incentives for Haulers

Type: Incentive program

Examples: Monrovia, CA; South Kingstown, RI; Portland, OR; Santa Clara, CA; Los Angeles, CA; Seattle, WA; San Francisco, CA; Elk Grove, CA

Objectives: Increase commercial recycling rates by incentivizing haulers to voluntarily offer recycling collection service.

Methods/Approaches: The municipality can give incentives to haulers in the form of decreased tipping fees or charges, tax breaks, or reduced licensing fees. The possibility of revenue sharing from the sale of recyclable materials can be used to encourage haulers to work towards certain benchmark goals.

Potential/Example Impacts/Limitations: The reduction of tipping fees for haulers meeting certain goals is perhaps the incentive most easily available to municipalities. However, monitoring of compliance and quantification of success requires the investment of both political and financial capital by the city. Choosing an ideal level to set the incentive, in order to maximize recycling rates while minimizing costs to the municipality, can be quite challenging. Inadequate incentives will make very little impact, just as recycling rates are unlikely to increase any further above a certain level of investment.

Costs: Income lost by reducing tipping fees is largely dependent on the degree to which haulers participate in the program. A successful program is dependent on considerable incentives. Larger incentives encourage greater participation and can compound cost as greater participation pushes up total program expense.

3.2.1.14. Offer rebates and/or grants for program launch

Type: Incentive Program
Examples: Alameda StopWaste, CA; King County, Washington, Boulder, CO; Livermore, CA; State of Indiana; State of North Carolina
Objectives: Increase the recycling rate by enabling voluntary business participation in recycling behavior.
Methods/Approaches: Through grants, businesses may overcome many of the financial or perceived barriers to initiating a program of on-site organics collection. The municipality should broadly advertise the existence of the program, but some municipalities have set limits as to how many grants are available. The city can offer grants to the first respondents to the advertisements until the grants have been exhausted, or can award grants on an annual basis to a limited number of businesses on the basis of the quality of the grant applications. The city can require progress reports from grantees in order to ensure effective recycling practice.
Potential/Example impacts/Limitations: Grants may enable the introduction of recycling programs, but may not ensure their continuation. Without continued support, programs may lapse due to market pressures or lack of interest. Without oversight, businesses may not spend the funds effectively, or on recycling program development at all. However, additional oversight requiring additional time and effort from businesses may make businesses less likely to participate, particularly considering the small size of the grants.
Costs: Most municipalities have given $500 to $2500 of material support per interested business. It can be very difficult to estimate how many businesses may choose to apply for available grants. When capping the number of awards, awards given on the basis of the quality of a grant application may result in more effective recycling efforts, but application review will result in additional costs to the city.

3.2.2. Commercial Organics

3.2.2.1. Require that haulers offer organics collection service

Type: Regulation
Examples: Ann Arbor, Michigan; Santa Barbara, CA; Kirkland, WA; King County, WA; San Diego, CA
Objectives: Increase the diversion of organics from the waste stream by making organics collection an easier and more direct option for businesses.
Methods/Approaches: The requirement could be established most simply as a condition for the receipt of a private hauler license, though enactment of an ordinance or a change to the city code could also be used. An ordinance or code change would also give teeth to effective enforcement of compliance with the requirement. Enforcement can include annual audits, inspections at random intervals, inspections following customer complaints, or any combination of the above.

Potential/Example Impacts/Limitations: The policy will be most effective where the costs of organic collection and hauling are equal to or less than those of trash. Haulers may be resistant to regulation, new licensing requirements, and/or inspections.
Costs: The cost to the municipality would be that of audits and/or inspections. When the cost of waste disposal is low, audits would likely have to maintain a reasonable level of compliance. The cost of enforcement would likely be much lower if the policy was one of several that increased the incentives to haulers and their clients to voluntarily segregate their organic waste.

3.2.2.2. Require tonnage-reporting from private haulers
Type: Regulation
Examples: King County, Washington; Boulder County, CO; Fort Collins, CO; City of Boulder, CO; Seattle, WA; Portland, OR; San Francisco, CA; Alexandria, VA; Roseville, CA
Objectives: Gather waste tonnage data from private haulers for analysis, in order to better understand the waste stream and be better equipped to develop effective waste policy.
Methods/Approaches: The city can institute a tonnage-reporting requirement through ordinance, city code, or as a precondition of receipt of a license to operate a hauling business in the city. All haulers would be required to submit periodic reports documenting number of customers, facilities used, tons of organic material collected (or the number of tons composted/digested, etc). A comprehensive requirement might demand that haulers also assess the makeup of the waste they collect by conducting periodic waste characterizations.
Potential/Example Impacts/Limitations: Because much of the commercial waste stream is either poorly understood or not understood at all, quantification of the total volume and of the composition of waste collected by haulers can facilitate the development of effective policy. However, because this type of recording can present a challenge to trade secrets protection, the city should seek legal council in the development and wording of such a requirement. Because haulers are saddled with the responsibility for measuring and recording data, haulers can be resistant to such regulation.
Costs: The collection of commercial organic waste data by haulers would be cheapest and simplest through the development of an online web portal or database. The database would either require the labor of an existing municipal IT staff person or contracting with a third-party for database management. Cost to the municipality may also include training for both municipal employees and the employees of private haulers unversed in electronic accounting techniques.

3.2.2.3. Support program for increasing organics collection in schools
Type: Policy/Education/Assistance program
Examples: Cambridge, MA; Sonoma County, CA; Central VY Solid Waste District; Laytonville, CA; Portland, OR; Seattle, WA, Clark County, WA
Objectives: Increase organics diversion by targeting area schools, one of the largest generators of food waste and one of the most receptive organizations to the institution of organics diversion programs.

Methods/Approaches: Support schools' organics collection and diversion efforts through organizational support, material support for social marketing, or small grants for signage and collection containers.

Potential/Example Impacts/Limitations: Some schools or "Green Teams" may be resistant to coordinated oversight over an effort that has run quite well up to the present. Reducing the costs of diversion might facilitate expansion of the program's success beyond 80% diversion. Meaningful expansion of social marketing efforts can be expected to have a long-term impact on the waste diversion behaviors of students' extended social and family networks. Contamination of the separated organic waste by inorganic waste is a continuing concern despite program success. Often, the students are less likely to be responsible for such contamination than faculty and staff, so targeting educational efforts at these groups in addition to students may be important to program success.

Costs: The costs of diversion should be deferred entirely, or in great part, through the concordant reduction in waste disposal cost. The cost of signage, collection containers, and social marketing may be either shared by the city and the schools or assumed entirely by the schools, with the city simply facilitating greater program efficiency. In that case, the city would be responsible for program coordination costs.

3.2.2.4. Municipal grants for start-ups

Type: Incentive Program

Examples: Alameda StopWaste; King County, Washington; Boulder, CO; Livermore, CA, State of Indiana; State of North Carolina

Objectives: Increase organics diversion rates by enabling voluntary business participation in organics diversion.

Methods/Approaches: Through grants, businesses may overcome many of the financial or perceived barriers to initiating a program of on-site organics collection. The municipality should broadly advertise the existence of the program, but some municipalities have set limits on the number of grants available. The city can offer grants to the first respondents to the advertisements until the grants have been exhausted, or can award grants on an annual basis to a limited number of businesses on the basis of the quality of the grant applications. The city can require progress reports from grantees in order to ensure effective recycling practice.

Potential/Example impacts/Limitations: Grants may enable the introduction of organics diversion programs, but may not ensure their continuation. Without continued support, programs may lapse due to market pressures or lack of interest. Without oversight, businesses may not spend the funds effectively, or on organic waste collection program development at all. However, additional oversight requiring additional time and effort from businesses may make businesses less likely to participate, particularly considering the small size of the grants.

Costs: Most municipalities have given \$500 to \$2500 of material support per interested business. It can be very difficult to estimate how many businesses may choose to apply for available grants. When capping the number of awards, awards given on the basis of the quality of a grant applications may result in more effective organics diversion efforts, but application review will result in additional costs to the city.

3.2.2.5. Targeted programs to capitalize on institutional volume

Type: Policy/Education

Examples: Cambridge, MA; Boulder, CO; Alameda StopWaste; Ohio Grocery Store Initiative; Portland, OR; Sonoma County, CA; Davis, CA

Objectives: Increase diversion rate for commercial waste by working to increase source separation of organics for the businesses responsible for the largest portion of the city's commercial organic waste.

Methods/Approaches: Municipal employees reach out to provide education, training and technical support to high volume producers of organic waste, such as restaurants, universities, hospitals, and large businesses, to encourage them to contract with a local organic waste hauler, and help facilitate on-site collection of source-separated organic waste.

Potential/Example Impacts/Limitations: The success of this program can help haulers develop new collection routes, increase total tonnage collected, and reduce the cost of collection per ton by achieving economies of scale. It will have little effect on the aggregate operational capacity of haulers (how many tons of organic waste can be composted in a given time period with existing facilities), which may be strained with successful expansion of collection among both commercial and residential clients.

Costs: The municipality would likely be fully responsible for the costs of outreach and training, though these costs could be shared with haulers through a contractual agreement.

3.2.2.6. Incorporate cost of organics waste into trash collection and management

Type: Regulation

Examples: Santa Barbara, CA; Seattle, WA; San Francisco, CA; Livermore, CA; San Jose, CA; Castro Valley Sanitation District

Objectives: Increase diversion of commercial organic waste by providing businesses with a strong financial incentive to do so.

Methods/Approaches: Integrate the cost of organic waste collection and management into the fees for trash collection and management levied upon businesses. The cost can either be embedded into trash fees in its entirety or only in part. A partial incorporation of the fee may add a relatively lower rate for organic waste onto a flat fee. Alternatively, an organic waste allowance proportionate to total waste generation may be permitted, with a relatively lower disposal cost for organics generated in excess of the allowance.

Potential/Example Impacts/Limitations: For food-related businesses, organic waste constitutes a considerably larger portion of their waste stream than for households, and effective price incentives have the potential to dramatically increase diversion rates for that sector. Space limitations for separate storage of trash and compost (not to mention recyclables) may be a significant concern for many businesses, which can be addressed to some extent through municipal technical assistance, though building codes might be adapted to the space requirements in the future. The program will be ineffective without enforcement, so a firm enforcement mechanism should be written into the ordinance.

Costs: Oversight of the program would be more costly with many haulers than with a single franchised hauler or municipal collection, but may not be prohibitive as long as a single and clear set of guidelines are established by ordinance.

3.2.2.7. Mandate organics source separation

Type: Regulation

Examples: Seattle, WA; San Francisco, CA; Western Lake Superior Sanitary District, MN; State of Connecticut

Objectives: Raise organics diversion rate by mandating that all organic material be excluded from trash disposal, with enforcement through fines or rejection of garbage contaminated with organic waste left for collection.

Methods/Approaches: The municipality can mandate that all businesses divert their organic waste from the waste stream, that certain businesses that tend to produce greater volumes of organic waste divert all of such waste, or that certain types of businesses that produce more than a certain amount of organic waste divert organics from their other waste. Enforcement can occur at the place of business or at the transfer station, placing the burden of fees or other penalties on the generators or on the haulers, respectively.

Potential/Example Impacts/Limitations: If the increase in costs is significant, some businesses generating large volumes of organic waste may see a greater incentive to relocate to nearby communities without such a mandate. The risk of this in Portland is relatively low, as demand for food service businesses has proven to be notable enough to accommodate an extremely high number of eateries per capita (Richardson, 2009), but the incentive will be visible in political resistance to the mandate by businesses. Municipal technical support to businesses before and during the mandate's imposition can help diffuse much of this resistance.

Costs: Businesses would bear the costs of organics collection. These costs may be shifted through the use of embedded fees as well as through economies of scale from the dramatic increase in the total tonnage of organic waste to be managed citywide.

3.3. Tourism related waste measures

3.3.1. Large venues/events

Type: Incentive Program/Education/Assistance Program

Examples: State of Wisconsin; New York, NY

Objectives: Extend recycling and composting services to non-residential visitors to Portland, as well as to residents away from their homes.

Methods/Approaches: Recycling and composting services would be adopted by hospitality and event services by city mandate. The municipality should assist those hotels and small inns that require assistance, particularly by facilitating partnerships among establishments to capitalize on common resources (see Chapter 3.2.1.10). For large events, the city should assist organizers in planning appropriate temporary recycling facilities, especially in terms of placement of containers, signage and space management. Some cities include a reference guide on their website as an easy-to-access resource.

Potential/Example Impacts/Limitations: Because tourists generate slightly less waste than local residents per day, their inclusion in an effective recycling program has the potential to dramatically increase diversion rates during the height of tourist season. Because hotels and event businesses are burdened with substantial time limitations, their resistance to additional restrictions on their current waste practice may also be significant.

In light of this, municipal support at the outset of their recycling practice is likely to be meaningful.

Costs: Because of their size, startup grants to hotels and event centers will likely need to exceed the amounts necessary for most businesses. Small inns are likely to be an exception to this and may be a good option for a pilot support program. A recycling mandate for these businesses would have to be enforced; enforcement costs would fluctuate seasonally, and could be moderate during the summer months at peak tourist season.

3.3.2. Public Space Recycling

Type: Policy/ Education

Examples: St. Paul, MN

Objectives: Divert the recyclable portion of the waste that is currently disposed of in public trash cans throughout the city.

Methods/Approaches: An additional recycling barrel would be placed alongside each existing publically placed trashcan. Work with community organizations can help familiarize the public with the program and ensure its proper use.

Potential/Example Impacts/Limitations: Choosing the best containers for the local conditions is key, as is some degree of continuity with similar programs in nearby municipalities. ecomaine might provide a useful regional framework by which such continuity could be established. If successful, the program could divert a high percentage of the recyclable waste currently deposited in public trashcans.

Costs: The municipality would be responsible for the purchase of, installation of, and collection from publicly-sited recycling containers. No dedicated employee would be required, since a municipal collections worker already collects waste from the existing trashcans and could collect recyclables at the same time.

3.4. Construction and Demolition (C&D) Recycling

3.4.1. Disposal Ban for C&D recyclables

Type: Regulation

Examples: Seattle, WA; Orange County, NC; State of Massachusetts

Objectives: Reduce waste generated by construction and demolition projects to a marginal share of the total waste stream.

Methods/Approaches: The city can ban certain common materials generated during construction and demolition from disposal, or employ a comprehensive ban that limits either the percentage of the waste constituted by C&D waste or the total volume of waste subject to a comprehensive ban. Developers and builders would be required to submit an adequate waste management plan and a final waste management report as a basis for receiving a building permit. Noncompliance would result in fines or a denial of the building permit.

Potential/Example Impacts/Limitations: A ban on the landfilling or incineration of construction and demolition waste has the potential to dramatically reduce the waste generated by that industry and encourage both reuse and recycling. Such a policy must be given a strong enforcement mechanism to be effective, especially in making project-

permitting contingent on the development of an adequate waste management plan. A regional approach would be significantly more successful than a municipal approach, since many smaller builders might try to dispose of their waste in neighboring towns rather than meet the requirements of the ban.
Costs: City employees would have to field and approve or reject submitted waste management plans, with the labor hours falling on the planning and zoning boards and the code enforcement office. The enforcement work on-site at the municipal transfer station (rejecting loads of waste with too high a level of contamination) would unlikely increase labor costs.

3.4.2. Green Building Code Recycling Mandate

Type: Regulation
Examples: Boulder, CO; New Castle, NY; State of California
Objectives: Decrease construction and demolition waste by at least half, by requiring diversion as a condition for receipt of a permit.
Methods/Approaches: The issuance of a building or renovation permit can be preconditioned on the receipt of a waste management plan and a commitment to divert 50% of waste from the project for recycling or reuse. A point system can be used in the permit qualification process, which could allow for builders to voluntarily exceed 50% diversion in order to gain additional points towards a permit. Portland's existing LEED certification requirement for projects receiving funding from the city could be amended to require that at least one of the points towards certification come from the construction waste management credit, LEED v 3.0 MR Credit 2.
Potential/Example Impacts/Limitations: Because many construction projects already divert a substantial percentage of their waste in order to reduce waste management costs, the potential for increased diversion may be limited. If the 50% diversion baseline is too close to the existing C&D diversion rate, the added cost for the municipality may not bring a notable increase in the city-wide diversion rate. For this reason, the baseline should be set well above the current industry diversion rate. Because this is not known, a C&D waste characterization for Portland should be the basis for the enactment of this ordinance.
Costs: The cost of diversion would be assumed primarily by developers, with the municipality assuming only the labor costs for waste plan review in the permitting process and several on-site audits.
Maximum Marginal Recovery Rate: 50-85% of C&D waste

3.4.3. Take-back program for used building materials at large or mid-size building supply stores

Type: Incentive Program/Assistance Program
Examples: Home Depot, Lowes, Aubuchon Hardware, Maine Hardware
Objectives: Reduce C&D waste from homeowners and small to mid-size contractors by increasing the prevalence and ease-of-access of take-back and reuse options.
Methods/Approaches: Provide material support for outreach and marketing of private take-back and reuse programs or provide organizational and administrative support for the expansion of an existing building supply store to include used materials for resale. Tax

relief or other financial incentives will encourage the voluntary adoption of the program by retailers.

Potential/Example Impacts/Limitations: The impacts of this policy are likely to be limited in comparison to the cost involved. Larger developers and builders generate the vast majority of construction and demolition waste. Other policies such as a C&D waste disposal ban (see Chapter 3.4.1) or a "Green Building Code" recycling mandate (see Chapter 3.4.2) are more effective in creating a broader market for used building materials and will likely lead to the development of additional C&D reuse enterprises to manage the increased supply. Even though the amount of waste diverted by this policy may be lower than under a more comprehensive policy, building material supply stores have existing infrastructure for the management of C&D waste and can expand current citywide capacity if a more rigorous policy is unfeasible for administrative or political reasons.

Costs: The municipality could share in outreach and advertising costs for the program. Alternatively, the city might provide a monetary incentive such as tax relief, or other non-monetary incentives, to encourage businesses to establish a take-back program. The city might also be responsible for administrative or organizational costs from on-site or other forms of consultation regarding the adoption of a reuse business component.

3.5. Electronic Waste (E-Waste)

3.5.1. E-Waste Disposal Ban

Type: Regulation

Examples: State of Colorado; State of New York; State of North Carolina; State of Pennsylvania

Objectives: Divert nearly all electronic waste to e-waste recycling.

Methods/Approaches: By municipal ordinance, the city can ban the disposal of electronic waste in curbside collection of garbage. Enforcement would be conducted either by existing municipal collections employees or by new dedicated auditing personnel. In order to be able to conduct a visual assessment of the contents of garbage bags left for curbside collection, the existing opaque blue bags would have to be replaced with transparent ones. A strong educational campaign would be rolled out prior to enforcement and maintained over the long term in order to ensure a higher level of compliance.

Potential/Example Impacts/Limitations: Full compliance with the ordinance would increase diversion of e-waste, which is some of the most toxic waste disposed of by residential households. However, high levels of compliance are unlikely without stringent enforcement and a significant investment in education. Residents will likely be resistant to disposing of private waste in transparent bags.

Costs: The costs of municipal enforcement, whether using existing employees or new dedicated personnel, as well as of an adequate educational campaign are likely to be extremely high when compared to the total possible diversion that the policy might offer. For this reason, the ban may be more effectively included in a more comprehensive disposal ban, which would promise a much higher diversion rate for close to the same cost to the municipality.

3.5.2. Curbside Collection of E-Waste

Type: Policy

Examples: Huntington, NY; Sonoma County, CA; Napa County, CA; Davenport, IA; Bettendorf, IA

Objectives: Increase the recycling rate for electronic waste by extending curbside collection to such material, reducing the perceived cost of recycling to residents to encourage voluntary participation.

Methods/Approaches: The municipality can establish curbside collection by scheduled pick-up or simply permit the inclusion of electronic waste in normal curbside collection. The municipality can choose to restrict the range of electronics accepted at curbside to make collection more manageable and reduce costs, or simply permit curbside collection of all types of electronics.

Potential/Example Impacts/Limitations: Extension of curbside collection to include e-waste recycling promises to increase both participation in e-waste recycling efforts and the total tonnage of e-waste diverted from the waste stream. More expensive segregated collection (scheduled pick-ups) reduces sorting cost at the recycling facility, whereas inclusion with the existing curbside collection service will increase sorting cost.

Costs: Where scheduled pick-ups are adopted, both collection and sorting costs will increase, the former more than the latter. Where curbside collection is expanded, collection costs will stay close to the same, while sorting costs will increase to a greater degree. Manufacturers cover the cost of recycling under Maine's e-waste extended producer responsibility law.

3.6. Extended Producer Responsibility (EPR)

3.6.1. Expand Take Back programs

3.6.1.1 Local Take-back Program

Type: Regulation/Policy/Incentive Program

Examples: Prince Edward Island, Canada; Quebec, Canada

Objectives: Move local production and waste management further up the waste pyramid by initiating take back legislation for select industries at the city level.

Methods/Approaches: The municipality should build on existing city industries already participating in voluntary take-back programs to some degree or with a great potential to do so. The city can either require take-back outright or develop a quota system under which a certain percentage of sales are required to be reclaimable, reusable or refillable, typically with a deposit and refund system. The city should work with local partners in the industry in question to develop the text of the regulation.

Potential/Example Impacts/Limitations: Successful programs in the past have achieved return rates of near 100%. Due to the greater labor intensity of reuse and refilling, the number of jobs in the target industry tends to markedly increase. However, political resistance from national and international lobbying groups has proved to be fierce. Prince Edward Island's stringent take-back policy, while based on prime local conditions and

support from the local industry, eventually collapsed under pressure from these groups. A more flexible policy such as Quebec's may help ease some of this external pressure.
Costs: The municipality would be responsible for yearly or semi-yearly audits to ensure compliance with the regulation.
Maximum Marginal Recovery Rate: 99-100% of targeted product

3.6.1.2. Reusable Transport and Shipping Packaging/ Packaging Take Back

Type: Policy/Assistance Program
Examples: Alameda StopWaste, Alameda County, CA; Germany
Objectives: Reduce or eliminate the waste generated in the transportation of consumer goods from the point of manufacture to the point of sale.
Methods/Approaches: Create a technical assistance program, in a similar model to that established by the Alameda StopWaste Partnership, that helps businesses change their transport and shipping materials and practices to reduce or eliminate shipping waste. The city can establish a municipal preferential purchasing policy that uses shipping waste reduction as a criterion for the selection of a vendor for the municipal sourcing of goods.
Potential/Example Impacts/Limitations: The program's success is dependent on the participation of an industry partner, both to lend their expertise to the process, legitimize it in the eyes of participating businesses and to help defray much of the cost to the municipality.
Costs: The cost of the program would be from the creation and maintenance of a website, the provision of technical assistance, and the conduct of outreach to businesses. The degree to which the city would be responsible for these costs depends on the agreement negotiated with the industry partner participating in the organization of the program. It is unlikely that the adoption of an environmentally-preferential purchasing policy would dramatically raise costs, as switching to reusable shipping materials can often save a business money, so no added cost would need to be passed on to the municipality. The degree to which this is true in Portland clearly depends on the makeup of the pool of vendors for any given product.

3.6.2. Labeling

3.6.2.1. Zero Waste Certification

Type: Assistance Program
Examples: U.S. Zero Waste Business Council; Miljönär
Objectives: Assist local businesses in obtaining a Zero Waste certification label, in order to better inform consumers about the waste impact of their business practices.
Methods/Approaches: The city can create an assistance fund for small to mid-sized businesses seeking to inform their consumers of their waste reduction or waste diversion business practice, in order to increase the value of their product to certain consumers.
Potential/Example Impacts/Limitations: The impact of certification and ecolabeling schemes has been shown to be limited. While organic labels increase the value of products up to 15%, environmental labels on products that are not perceived to have direct health impacts on the consumer have lower increases in price, between 1 and 4% (Vitalis, 2002, p. 7). For those businesses already employing waste reduction strategies, the label

promises to increase profits, whereas for businesses needing to make changes to their business practice in order to qualify for the label, the costs of those changes may exceed the benefit from labeling.

Costs: The cost to the city of an assistance fund depends on the expense tied to each specific label. U.S. Zero Waste Business Council Certification costs $750 for initial certification for a business with fewer than 100 employees, and $400 to $750 annually (GrassRoots Recycling Network). If a similar cost structure applies to the Zero Waste label preferred by the city, full compensation could cost a similar amount. Depending on how popular the support program became, the costs could range from very low to moderately high.

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Glossary of Terms

Aerobic Digestion: More conventionally referred to as composting, aerobic digestion is a process of breaking down and converting organic waste material that requires contact with oxygen. Aerobic digestion can refer to one of a wide array of composting methods.

Anaerobic Digestion: Anaerobic digestion is a fermentation process for organic material in an oxygen-free environment. Methane produced as a by-product of the bacterial consumption of the organic waste is collected and is either burned on-site for electrical generation, or is compressed as compressed natural gas (CNG) for use in vehicles that run on CNG, such as Portland's public buses.

Diversion: Diversion refers to redirection of waste away from the lowest rungs of the waste hierarchy. While some refer to diversion as any process that prevents waste from being deposited in a landfill, it is more commonly referenced as any waste management process other than landfilling or incineration. Thus, both recycling and composting are methods of waste diversion. So too is product reuse, though far less quantifiable.

Diversion Rate: The diversion rate is the percentage of total waste that is not processed in a landfill or incinerator. The recycling rate and diversion rate are often used as synonyms, but defined strictly, the diversion rate refers to a much broader scope of waste diverted. The diversion rate can refer to either a percentage of waste as measured by weight or by volume, though diversion rates referring to weight are much more common.

EOW: Every-Other-Week. EOW collection is collection that occurs every other week. Many municipalities engage in EOW collection of recyclables. EOW collection creates a strong incentive for households to place items in the weekly collection bins, regardless of whether or not they were intended for collection. For this reason, some municipalities have pursued EOW garbage collection, while maintaining weekly recycling and organics collection, in order to give an incentive to households to remove all recyclable or organic material from their household waste stream.

Home Rule: Home rule refers to the governmental delegation of authority to local governments to govern and legislate within their boundaries. Municipalities in U.S. states in which municipalities are empowered with home rule authority are responsible for the development of their own waste management policy and legislation pertaining to it. Home rule can pose a challenge to the development of an effective Zero Waste strategy, as it makes economies of scale and intermunicipal continuity much more difficult to achieve. However, it can also be a boon to cities seeking to institute policies that might be less tenable on a broader scale.

Industrial Ecology: Industrial ecology refers to an approach to waste collection and remanufacturing that uses the waste resources sorted from waste collection and uses them as inputs to production in colocated manufacturing facilities. The ideal of this approach is one of closed-loop, or cradle-to-cradle, production, where all waste streams are cycled as inputs to other production processes and where use is maintained at the highest possible level to reduce the loss of value over time.

MSW: Municipal Solid Waste. MSW typically refers to residential garbage collection, though waste collected from public garbage bins is also included.

PAYT: Pay-As-You-Throw programs ensure that costs of waste disposal are commensurate with the amount of waste generated by a household. This can be through a bag program such as that currently in place in Portland, with garbage only collected if it is in designated city trash bags, with those bags available for purchase. This can also be through a subscription service, typically with cart-based rather than bag-based collection, with larger volume carts available for a higher price.

Recycling Rate: The percentage of total residential waste constituted by recyclable material is referred to as the recycling rate. Some cities (having expanded their recycling and diversion policy to include commercial entities in addition to private residences) have enlarged their definition of the recycling rate to refer to the percentage of total waste generated by businesses and households constituted by recyclables collected separately.

Tipping Fee: Tipping fees are charges to users of a transfer station for the deposition of waste material. The amount charged is based on the weight of the garbage deposited. Where municipalities operate a transfer station, the revenue from the tipping fee accrues to the municipality. Where the transfer station is privately operated, or operated by a non-profit such as ecomaine, the city is charged for the waste it generates while tipping fees accrue to the private entity.

Waste-to-Energy: Waste-to-Energy refers to any process of incineration of waste that generates electricity for sale to the public grid. Several different types of incineration exist, with varying degrees of efficiency – gasification, pyrolysis, thermal depolymerization, and plasma arc gasification. Carbon emissions from Waste-to-Energy are roughly equivalent to the weight of the waste burned. Waste-to-Energy processes can recover between 14% and 28% of the energy embodied in the waste burned. The residual ash from the process is placed in an ashfill.

Waste Pyramid: The waste pyramid is a visualization of the waste hierarchy, with the stages of the pyramid sized proportionally to the priority accorded the corresponding approaches to waste management.

Waste Hierarchy: The waste hierarchy is an officially-accepted prioritization of varied approaches to waste management. This priority is given to methods that best preserve the embodied energy of a product, with waste prevention or reduction receiving the highest priority, followed by reuse, recycling, composting, waste-to-energy, and landfilling. In most of the U.S., true approaches to waste management often invert this hierarchy, with a majority of waste landfilled or incinerated and a diminutive portion diverted as compostable material, recyclables, or for reuse. Reduced levels of consumption, though at the top of the hierarchy, often receive no attention at all.

Waste Resource: Since waste is a broad category, defining any product that has exhausted its principle use or has otherwise become unwanted by its owner, it broadly carries a stigma of being useless. Many working in waste management and Zero Waste seek to highlight the value remaining in unwanted materials by shifting the language that is used to refer to these materials. 'Waste resource' is a term that preserves a sense of value in these unwanted products and can be used to shift the dialogue on waste policy to more effectively retain that value.