

Examining the effectiveness of municipal reuse centers in Nova Scotia: Benefits and Best Practices

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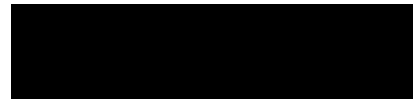
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Abstract

One of the major environmental challenges of today is the overconsumption of resources and excessive waste. Municipal reuse centers offer a potential solution, as they work to extend the lifespan of objects otherwise destined for landfill. There are three (3) municipal reuse centers in Nova Scotia, however their impact has yet to be determined. In this study, the impacts of municipal reuse centers on diversion and financial implications of waste management in Nova Scotia were explored. Consultative interviews took place with waste managers in regions with and without reuse centres to gain an understanding of the current waste management practices, as well as the most recent waste tonnages and operational costs. A literature review was completed to compare strategies of reuse centers in other jurisdictions. The results of this study were inconclusive in their application to the Nova Scotian context. However, due to limited empirical data availability, it was not possible to attribute the differences to the reuse center. The study identified the need for further investigation of the material flow patterns of bulky waste within the seven Nova Scotian waste management regions, as there is currently a lack of available data to accurately measure the impacts of reuse centers. Recommendations regarding potential strategies to more accurately measure the impacts of reuse centers are offered with the aim to better support the decision-making process by policy for bulky waste with reuse potential.

1.0 Introduction

1.1 Motivation

Since the rise of the industrial revolution, the human economic system has traditionally been linear, as humans take resources from the environment, as humans make products, and at their end of life, dispose of them (Korhonen et al., 2018). Recently, there have been a rise in resource recovery through reuse, recycling and composting efforts (Song et al., 2014), but resources are being consumed at a rate that is 50% faster than they can be replaced, and by 2030, our demand for resources will exceed what two planets could produce (Esposito et al. 2018). What is as significant as the use of resources for production, is the limits to the assimilation capacity of the planet to manage the resulting waste. The most common end of life of modern material in most (but not all) parts of the world is the landfill. In the short-term landfills appear to be an adequate solution, as they keep waste contained; however, in the long term, landfills have serious consequences for the environment and human health (Mukherjee et al., 2015). As the human population grows and the demand for consumer goods increases, it is predicted that an increase in waste generation will follow (Haas et al., 2015), establishing the need for increased waste diversion strategies.

This issue of excessive waste is of concern to the Province of Nova Scotia. In a waste audit completed by Divert Nova Scotia it was found that in 2017, of the 375,258 tonnes of waste generated each year in Nova Scotia (Statistics Canada, 2018) approximately 248,180 tonnes is sent to the landfill each year. (Avery et al., 2017). The rest of this waste is diverted through alternative streams (recycling, organic collection). Furthermore, a report completed by AECOM Canada indicated that Nova Scotia is running out of landfill space, suggesting a need for greater waste diversion in the province (Gorman, 2019). However, a significant proportion of waste

currently sent to landfills could have been disposed of through alternative streams such as organic or recycling collection, or prevented at the source (Avery et al., 2017)

Municipal reuse centers present a potential waste diversion solution for Nova Scotia, as these centres work to extend the life span of goods that would have otherwise been landfilled, retaining energy and materials in the economic system. Evidence of success for such operations has been documented in jurisdictions outside of Nova Scotia. Currently three reuse centers operate in the province in the following locations: Valley Waste Resource Management transfer station in Kings County, the Baddeck transfer station in Victoria County, and the Guysborough Landfill in Guysborough County. However, their effectiveness is yet to be examined, revealing a need for greater understanding of their impact. This information may lead to grounds for the implementation of municipal reuse centers on a wider scale across the province. This study seeks to examine the environmental, social and economic benefits of municipal reuse centers in Nova Scotia, as well to understand strategies that enhance the reuse potential of such operations.

1.2 Background

Municipal solid waste consists of materials that have been discarded from residential and commercial sources (Vergara & Tchobanoglous, 2012) that are no longer valuable to the owner (Thürer et al., 2017). Proper municipal waste management plays an important role in increasing overall waste diversion, as municipalities are involved in the development of infrastructure to manage and deal with waste (Vergara and Tchobangolous, 2012). Common waste diversion strategies include recycling, and composting services, as well as strategies to reduce waste at the source through municipal policies. Although these strategies are in place, studies have indicated that municipalities must move past recycling and move towards strategies that enhance reuse and waste prevention (Song et al., 2015). Municipalities have the potential to lead to more

sustainable and circular waste management (Vergara and Tchobangolous, 2012), but municipal waste management can be challenging and costly due to the heterogenous nature of the waste materials (Vergara and Tchobangolous, 2012).

A municipal reuse centre accepts materials that have reuse potential and have been donated by the public, or actively removed from the municipal waste stream (Zacho et al., 2018). This includes any item that still has value and can be reused as is or for an alternative purpose; after collection, these items are placed on display and are sold at the center (Zacho et al., 2018). Such items are typically sourced from those that have been sent to landfills and have moved past opportunities for alternative reuse options (i.e. thrift stores, online reuse platforms such as Facebook Marketplace). The reuse centers also often sell items that are not commonly found at thrift stores (Fortuna and Diyamandoglu, 2017a). As these items otherwise would have been destined for a landfill, the municipal reuse center presents an opportunity for waste diversion (Zacho et al. 2018).

Circular economy has at its foundation a view of waste management that aims to recover resources as an alternative to waste generation. The aim is to reduce, reuse, and recover materials within the span from production to consumption to end of life. Circular economy takes place on small (companies, consumers) and large scales (cities, nations, global) and aims to enhance sustainable development (Kirchherr et al., 2017). Implementing activities for circular economy has the potential to reduce the consumption of new materials by 53% by 2050 from 2015 levels (The Ellen Macarthur Foundation, 2015a); it is an effective concept for solid waste management.

Reuse is at the core of the circular economy, as it aims to put items at the end of their life to alternative use. It is defined as the practice of exchanging surplus goods of value, that have been previously owned and used. Reuse will help to propel the circular economy, as it retains as

much energy and materials within the system, and avoids the “grave” destination for items (Esposito et al., 2018). The benefits of reuse schemes have been identified in the literature (Cooper & Gutowski, 2017).

The ‘waste hierarchy’ is a tool used to evaluate the effectiveness of each waste management strategy (European Commission, 2015). According to the hierarchy (Figure 1), reuse is the second most effective strategy for waste diversion, as it involves the direct use of products, rather than breaking them apart into their components. Products oftentimes have higher value than the materials they are made out of (The Ellen MacArthur Foundation, 2015b), so reuse schemes present an opportunity for highest value at product end-of-life. However, reuse may be limited due to toxicity, consumer perceptions or other environmental attributes (The Ellen MacArthur Foundation, 2015b). Municipalities can capture some of this benefit through the integration of reuse centers into their solid waste strategies to further enhance rates of waste diversion. This has been demonstrated in several locations across the US, including the County of Hawai’i, HI, the Town of New Paltz, NY, and Ithaca, NY.

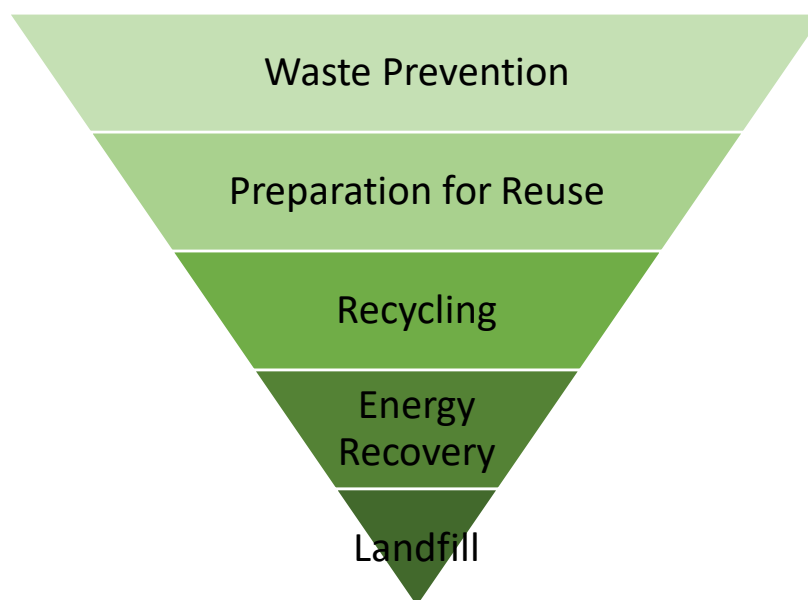


Figure 1 A pyramid depicting the waste hierarchy, as described by the European Commission (2019).

1.4 Study Introduction

The purpose of this study was to examine the potential benefits linked to the operation of municipal reuse centres in Nova Scotia (Valley Waste, Victoria County and Guysborough), and the potential for enhanced benefit through the introduction of reuse centres in other NS jurisdictions. Environmental benefits were defined in terms of the waste diversion potential, and the creation of novel reuse opportunities. Social benefits were assessed qualitatively by identifying any positive impacts on quality of life locally and contributions to charity. The economic benefits were assessed through the lens of waste management cost savings. Finally, strategies and best practices that have shown to enhance reuse and diversion rates in other jurisdictions were identified.

The research questions for this study were:

- What is the potential for municipal reuse centers in Nova Scotia to increase waste diversion and facilitate reuse activities?
- What are the financial implications of municipal reuse centers in Nova Scotia compared to current waste management practices?
- How do reuse centers in Nova Scotia contribute positively to the local socio-economic conditions?
- Are there strategies/best practices from other jurisdictions that could be applied to enhance the waste diversion opportunities that can be realized at municipal reuse centers in Nova Scotia?

The objective was to identify any environmental, social and economic benefits of municipal reuse programs and thus provide a potential incentive for encouraging the implementation of similar programs across the Province. In turn, higher rates of waste diversion, social advantage, and lower waste management costs could be observed.

The examination of reuse center operations in other jurisdictions provides insight regarding best practices for such centers. Best practices are defined as strategies used in other jurisdictions leading to high rates of waste diversion that may result in a similar outcome if applied in Nova Scotia. Any recommendations emerging from this examination would be intended to help improve upon the current operations of municipal reuse centers in Nova Scotia and provide guidance for the development of additional reuse centers in other Nova Scotian municipalities.

1.5 Summary of Approach

The methods for this study included: a) consultations with regional solid waste coordinators at the various municipal solid waste centres across Nova Scotia – both those with a reuse center on site and those without; and b) a systematic literature review examining effective strategies for municipal reuse centers in jurisdictions outside of Nova Scotia.

Consultative interviews¹ were completed with operational staff at Nova Scotian municipal waste centres to gain insight and [where possible] quantitative data regarding: a) current operational practices of the reuse centers; b) the quantity of waste with reuse potential²

¹ Consultative interviews in this context are defined as interviews that are completed with the intention of collecting information that the interviewee holds due to their professional position. Opinions are not sought, but instead the interviewee is viewed as a source of quantitative and operational data. Research ethics is not required in this context.

² Items with reuse potential includes all durable goods and bulky waste made of materials that can be used more than once without incurring structural damage. This can be applied to both products as a whole and when broken into their components (Cooper & Gutowski, 2017).

entering the landfill at each type of waste management site; and c) the cost of dealing with waste with reuse potential.

The literature review involved a systematic investigation of municipal reuse operations in jurisdictions outside of Nova Scotia. A wide range of search terms were used, and data was collected from a variety of sources including: scientific databases (Google Scholar, Web of Science, Scopus) and government reports.

2.0 Literature Review

This section provides an overview of current waste management practices and the harmful environmental impacts associated with waste generation. It also seeks to rationalize reuse as a waste management strategy and investigates the benefits of incorporating reuse into waste management practices as identified within the literature. The journals most frequently referenced in this review include: The Journal of Cleaner Production, Conservation and Recycling, Resources, and the Journal of Industrial Ecology. The primary focus was on the environmental implications of excessive waste, circular economy, the concept of reuse, and the effectiveness of various waste diversion strategies. Reuse schemes – namely municipal reuse centers - were explored in depth to understand the benefits, barriers and perceptions surrounding reuse as a waste management solution. Knowledge gaps regarding reuse schemes in Nova Scotia were also identified.

2.1 The Problem with Current Waste Management Strategies

Human consumption of natural resources has led to adverse environmental consequences. The rate at which humans are consuming resources is 50% faster than we can replace them. Thus, the earth's natural resources are being depleted, leading to harmful environmental consequences. However, resource scarcity could be mitigated by utilizing longer term

sustainability solutions (Esposito et al., 2018). Resource consumption is increasing, largely as a result of factors such as the growing human population and increasing middle and upper class. Additional factors driving the increase in resource consumption include technology changes, manufacturing processes, and dietary changes (Kalmykova et al., 2016). Consequently, there is an increasing demand for resources, also resulting in greater volumes of material waste (Haas et al., 2015). Much of this waste is unnecessary, as many materials still have value but are discarded either due to a lack of reuse/recycling alternatives, or simply a lack of care. Such materials could be reused, even if the original consumer no longer has use for the product (Barr et al., 2013).

Landfills lead to negative environmental consequences compared to alternative waste management solutions. Such systems are unsustainable, as they contribute more greenhouse gases compared to alternatives such as recycling, reuse or incineration. (Modoi et al., 2013). In the short term, landfills seem like an adequate solution, as they enclose waste materials and separate them from the surrounding environment. However, in the long-term, landfills lead to negative consequences for the environment and human health. Common impacts associated with landfilling includes soil and groundwater contamination by highly toxic leachates (Mukherjee et al., 2015; Vaverková et al., 2019). Once waste has entered the landfill, it can no longer be used in the production cycle. Consequently, the extraction of new virgin resources are required for the production of new goods to replace those destined for landfill (Castellani et al., 2015). This process is both energy intensive and damaging to natural ecosystems (Zink & Geyer, 2017). Landfill space is also becoming increasingly scarce, posing a land use issue (Vaverková et al., 2019). Landfills typically have the highest economic and environmental associated costs of any waste management strategy, suggesting that alternatives such as recycling and reuse will likely

provide higher economic benefits in the long term (Modoi et al., 2013). Due to the harmful consequences commonly associated with landfills, waste management alternatives should be implemented.

2.2 Circular Economy

The circular economy is an emerging materiality strategy with the goal of eliminating waste throughout a product's lifecycle. The goal of the circular economy is to minimize resource inputs, waste, emissions by closing material and energy loops at various scales (Figure 2). It is achieved through design, maintenance, repair, remanufacturing, refurbishing and recycling of materials rather than extracting raw materials for each new product (Geissdoerfer et al., 2017). The circular economy is designed to recover all resources and in turn, eliminate waste. When products reach the end of their life, all materials should re-enter the economic system, so that no waste is generated (European Commission, 2019). Due to the negative environmental impacts of increasing consumption with limited resources, the circular economy should consider economic, social and environmental factors in order to impact all aspects of sustainability (Plastinina et al., 2019). The circular economy also aims to retain product value for as long as possible while maximizing resources already in use (Figure 2). Products are built to last, and should not depreciate in value or deteriorate over time (The Ellen Macarthur Foundation, 2015a). The circular economy is a strategy that should be deployed at a wider scale in order to address sustainability issues and maximize resources currently in use instead of contributing to the overexploitation of natural resources (Figure 2).

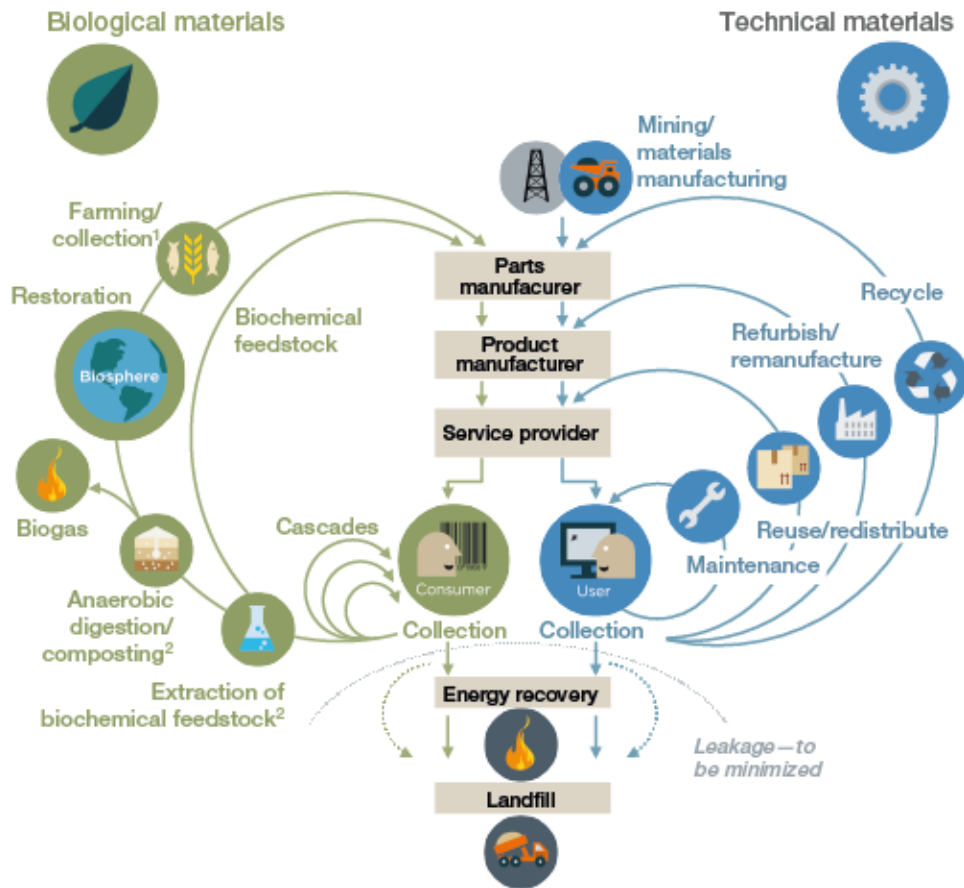


Figure 2 System diagram illustrating the flow of materials through the circular economy (The Ellen Macarthur Foundation, 2015b)

2.3 The Waste Hierarchy

As noted previously, the waste hierarchy is a tool for evaluating waste management strategies. Strategies most effective for environmental protection and reducing resource and energy consumption are found at the top of the hierarchy, with reuse being the second most effective strategy. From the most effective to least, the hierarchy of strategies is as follows: waste prevention, reuse, recycling, energy recovery, landfill (European Commission, 2019).

Currently, most *recovered* materials are recycled; however, more effective waste management alternatives exist. Recycled material often does not meet quality standards for the market for producing new goods; it can also be associated with poor labour practice and

localized pollution (Gregson et al., 2015). To reuse products that are currently recycled at end of life would allow for materials to move up the waste hierarchy and for more resources to be recovered (Milios & Dalhammar, 2020). As noted in Figure 1, reuse is one of the most effective waste management strategies according to the waste hierarchy and should be thoroughly explored before resorting to alternative waste management strategies such as incineration, landfilling, or even recycling.

2.4 Reuse

Reuse is defined as the practice of exchanging surplus goods which have social and/or financial value; such goods have been previously owned and used prior to the exchange (Gregson et al., 2015). It is a non-destructive process that allows for a second use for solid materials without breaking components apart, so that product functionality and embedded energy are retained (Cooper & Gutowski, 2017). Reuse is recommended as a strategy to propel the circular economy, as it involves retaining materials and products currently in use rather than sourcing new ones (Smol et al., 2020). Products that can be reused effectively be used include those retain structural integrity and functionality after being used several times. This applies to both products as a whole and when broken apart into their components (Cooper and Gutowski, 2017). Examples of such products include furniture, craft supplies, construction and demolition materials (C&D), home decor, toys and books, textiles, some electronics, etc. (Finger Lakes Reuse, 2020, Recycle Hawai'i, 2009).

Rising positive public perceptions and demand will likely increase the rate of reuse in the future (Milios & Dalhammar, 2020). The market for second-hand goods is growing, providing high potential for effective reuse schemes. Due to changing public perceptions related to the second hand market, there has been an increase in demand for second hand items, as more people

seek used products (Zacho et al., 2018). Consumers have also gained positive feelings of pride when purchasing items used. This has largely been a result of economic uncertainties brought on by the Covid-19 pandemic and the prioritization of sustainability initiatives when making purchase decisions (ThredUp, 2020).

2.4.1 The Benefits of Reuse

A review of literature reveals various environmental benefits linked with the reuse strategies such as a decrease in waste generation and [potential] decreased levels of production through the displacement of resources (Yokoo & Kinnaman, 2013). The reuse of materials can lead to lower energy and material throughput compared to new items. Although there are positive impacts associated with reuse, the sale of reuse must displace the sale of new products in order to be an effective strategy (Cooper & Gutowski, 2017). The extent to which second-hand sales lead to a decrease in the sale of new items reflects consumers choice; the potential to reduce consumption is only realized through avoiding new material (Zink & Geyer, 2017).

Reuse is also a part of an effective climate strategy, as it has potential to reduce carbon emissions, impacted by waste diversion goals and effects of reuse on product substitution (Fortuna & Diyamandoglu, 2017b). Overall, reuse is an effective waste management strategy, so long as it reflects a reduction in overall consumption of new materials.

There is uncaptured value contained within discarded materials; thus, there is potential for this value to be recovered through activities such as reuse. Uncaptured value is defined as the benefits not yet utilized from a product, and should be considered from economic, social and environmental value points (Yang et al., 2017). The highest potential to capture values is through reuse, as entire products are retained instead of breaking them apart into their components (Zacho et al., 2018). Resource recovery is often a low value activity, so it is important to capture

as much value as possible once a product is at the end of its first life; reuse is preferable to its alternatives (Gregson et al., 2015). For products made of high value materials, this is most effective (Yang et al., 2017). If there is potential for high level of value capture, reuse practices should be adopted over alternative waste management strategies.

Reuse schemes can frequently lead to positive social benefits such as job creation (employment of reuse center managers, those who prepare items for reuse) and providing functional products to people who face economic hardships, as used items are often sold at prices lower than new. This in turn, improves overall quality of life (Zacho et al., 2018). Reuse can build social capital as it leads to charitability, and fosters ties between individuals and the community (Gregson et al., 2015). Reuse also allows people to feel better about discarding end-of-life materials. Individuals often feel a sense of guilt when throwing things away, as most people are concerned about the environmental impacts of generating excessive waste (Meng et al., 2019). Reuse can also improve public health and safety, as it reduces pollution levels associated with landfilling (D'Onza et al., 2016). Ultimately, the practice of reuse can build social capital and contributes to the wellbeing of individuals.

Reuse operations can also be a cost effective waste management strategy; the revenue generated from the sale of reused products generally covers the cost of operation, making it a cost-neutral solution (Zacho et al., 2018). However, the use of secondary materials for production may lead to cost savings for producers (Minunno et al., 2020). Waste materials with reuse potential have high value compared to other types of waste, indicating that there are financial benefits that come from the diversion of such items, rather than letting them sit in the landfill (Recycle Hawai'i, 2009). Although there is little profit to be generated from the sale of

used items, there is economic benefit resulting from cost neutrality and overall economic prosperity (Zacho et al., 2018).

2.4.2 Barriers to Reuse

Barriers to reuse exist and can be sufficiently challenging to prevent reuse schemes from being implemented. Existing social and economic barriers including: peer pressure, societal preferences, desire for image orientated products, and the low price of new [typically imported] consumer goods (Curran & Williams, 2010). Although second hand goods may be available, in some cases new technology, more efficient products, or residual environmental impacts linked to the use of old products (e.g. refrigerators with freon) negatively impacts the marketability. However, it should be noted that the components of the old product may still have reuse potential (Cooper & Gutowski, 2017). Although research suggests that reuse is an effective waste management strategy, it is not a typical element of most waste management systems. As a result, there is an overall lack of knowledge and a lack of financial support for reuse options within municipal solid waste management (Zacho & Mosgaard, 2016).

2.4.3 The Role of Municipalities in the Facilitation of Reuse

Municipal government structures play an important role in reuse facilitation. Firstly, municipal governments typically managed solid waste resource infrastructure; through good system design, municipalities can implement the operational procedure and strategies required to maintain and recover resources (Ertz et al., 2019; Vergara, 2011). However, solid waste management and reuse can be challenging for governments; municipal solid waste is typically highly heterogeneous, making it hard to sort (Vergara, 2011). Collaboration between municipalities and reuse organizations need to exist in order to ensure efficient flow of materials and enhanced reuse opportunities (Zacho et al., 2018). It is evident that municipalities have

potential to develop effective structures for reuse through the solid waste management strategies they implement.

Preparation for reuse is a process undertaken by municipalities in order to allow for reuse of materials that have entered the waste stream, often as the last resort before landfilling or incineration. Preparation for reuse are the processes undertaken to refurbish a product, which typically includes collection, cleaning, inspection, safety and function testing, and repair (Gusmerotti et al., 2019). Preparation for reuse is important for municipal waste managers to incorporate in their waste management strategies because it can generate benefits such as achieving circular economy goals. More specifically, it allows for product cycles to be optimized as components and product materials are kept at the highest utility (Gusmerotti et al., 2019). However, although preparation for reuse can lead to increased waste diversion, there are economic costs associated with the processes. Preparation for reuse involves time, labour, and machinery, which can decrease the profits made from the sale of second hand goods (Zacho et al., 2018). There are also factors that can decrease the intensity of preparation for reuse processes, such as careful collection storage and overall treatment of products at waste management centers, which may also lead to an increase in the products with reuse potential (Messmann et al., 2019). Preparation for reuse is therefore, an effective tool for waste diversion at municipal waste management sites.

2.5 Municipal Reuse Centers

A municipal reuse center is a municipally operated site that takes items destined for the landfill, prepares them for reuse and re-sells them. Several municipal reuse centers have proven to be effective waste management strategies, as they enhance waste diversion, lead to waste

management savings and uplift social capital. The successes of several reuse centers have been identified, and are discussed in the following sections.

2.5.1 Recycle Hawai'i (The County of Hawai'i, Hawai'i)

Recycle Hawai'i operates (8) reuse centers at transfer stations within the county. The reuse center has identified high diversion rates as a result of the implementation of the reuse center. The reuse center contracts out management at (7) of these centers and are run using assistance from solid waste managers and volunteers. The reuse center has a diversion rate of 4% of items with reuse potential that are received at the transfer stations (Recycle Hawai'i, 2009). The center also uses the revenue generated at the centers to fund operations and provide waste reduction and education programs, which helps to build community and enhance further waste reduction. The materials sold at the centers have a combined value of \$5.8 million (USD), meaning that the reuse center helps to prevent lost value when items are sent to landfill (Recycle Hawai'i, 2009).

2.5.2 Finger Lakes Reuse (Ithaca, NY)

Finger Lakes reuse is located in Ithaca, NY. The reuse center is operated as a collaboration between the municipality and the Finger Lakes non-profit organization. Although it is a mid-sized town with a population of 30,569, in 2019 alone 521 tonnes of material at (2) reuse centers was diverted. This makes up a total of 3% of the waste landfilled (15,565 tonnes) (Finger Lakes Reuse, 2020). The reuse center has also documented several social benefits, including providing \$51,505 (USD) in materials donated to 280 households, the creation of 9 new jobs (and increasing the total staff to 50), providing job and skills training, and offering repair services to the community (Finger Lakes Reuse, 2020). The reuse center breaks even each

year for its operation costs, as a result of the sale of items, grants and donations (Finger Lakes Reuse, 2020).

2.5.3 Town of New Paltz Reuse (New Paltz, NY)

The Town of New Paltz, NY has a population of 7,165 inhabitants. Although this town is small in size, this has not limited the success of the reuse center. The reuse center was implemented in 2011 and led to a 15% reduction of the waste stream (54 tonnes in total). By 2012, an additional 5% of waste had been diverted (20% of the waste stream, 92 tonnes in total) (Petit, 2014). Social benefits have also been observed such as providing items to people in need, providing a tool share library and operating repair workshops, which help to improve overall quality of life. As a result of the reuse center implementation, there has also been a reduction in the need for landfill space and a reduction in transportation costs, indicating that economic benefits have been observed as well (Town of New Paltz Recycling Center, 2010).

2.6 Solid Waste Management in Nova Scotia

Nova Scotia has implemented structures in order to achieve reuse operations in the province and divert waste. Some municipalities have implemented reuse centers as a waste diversion strategy to give products a “second life”. The province is also committed to developing education and raising awareness about reuse and waste reduction (Government of Nova Scotia, 1995). In 2017, there was 248,180 tonnes of waste in Nova Scotian Landfills. Goods with the potential to be reused make up components of many of the major categories of landfill composition. These categories include: Fiber (13.3%), Plastics (21%), Textiles (9.2%), and Other (13.7%). However, the percentage of waste products with reuse potential (from within the various categories) has not been determined. There is still work to be done to increase reuse schemes in Nova Scotia and reduce the levels of durable goods in Nova Scotian Landfills.

2.7 Knowledge Gaps

Although evidence suggests that municipal reuse centers are an effective waste management strategy in several jurisdictions, benefits of reuse in Nova Scotia have not yet been documented. The waste audit completed by Avery et al. (2017) indicated the composition of Nova Scotian landfills. The Nova Scotia Solid Waste Strategy indicated that there was desire for reuse operations within the province, and that a few reuse centres are in operation (Government of Nova Scotia, 1995). The benefits of reuse in Nova Scotia and the waste diversion potential have not yet been identified. Further research should be conducted in order to determine the benefits and best practices for municipal reuse centers in Nova Scotia.

2.7 Conclusion

This literature has identified the benefits of reuse as a waste management strategy and the role of municipalities in the implementation of reuse schemes. The benefits of reuse have been well documented in terms of social, economic and environmental benefits. Reuse has been identified as one of the key elements for achieving a circular economy and a reduction of waste generation. Items that can be reused are those that have retained functionality after multiple uses and have not incurred damage. Municipalities also play a key role in waste management and have the power to implement infrastructure that will help advance reuse strategies on a local level. Municipal reuse centers have been implemented as a policy strategy to facilitate reuse at municipal landfill sites and transfer stations as a last resort for waste items before landfilling or incineration. There is very little research pertaining to municipal reuse centers and no research pertaining to reuse operations in Nova Scotia. This literature review has identified the need for further research to be conducted surrounding municipal reuse centers in Nova Scotia.

3.0 Methods

3.1 Study Area and Population

The study took place in the waste management regions in province of Nova Scotia. Nova Scotia has seven (7) waste management regions which are further divided into 27 municipalities and/or counties responsible for waste collection. There was a focus on waste management sites, including transfer stations and landfills with a reuse center. Three (3) waste management sites operate a reuse center, including the Baddeck transfer station (Victoria County, Region 1), Valley Waste Resource Management Transfer Station (Kings County, Region 5) and Guysborough Landfill (Guysborough County, Region 2). The other municipalities/county waste management sites were also observed to compare with the sties with the reuse centers (Figure 3).

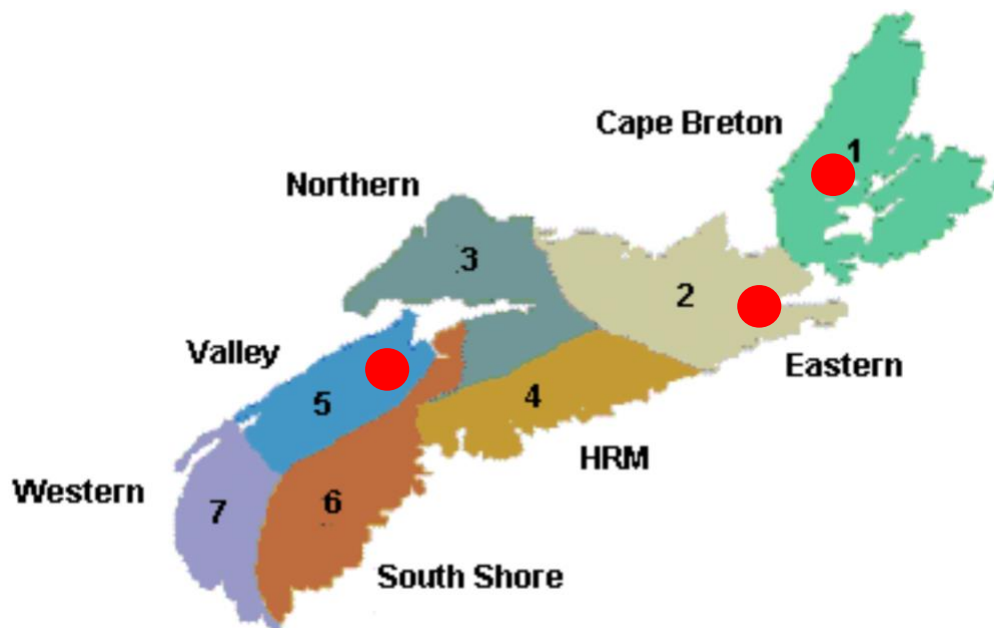


Figure 3 The waste management Regions of Nova Scotia, Canada. The red dots indicate the locations of municipal reuse centers in the province

3.2 Data Collection

There were two stages involved in the research process for this study. The first stage involved consultative interviews with regional solid waste coordinators in Nova Scotia with a focus on the quantitative characteristics of the operations. The intent was to gather data about the amount of the various waste streams at the different locations, the cost of operation, and specifics of the operational process from curbside collection through to disposal or diversion. The second stage involved a literature review of reports from municipal reuse centers in other jurisdictions, in order to gain insight into strategies that have proven to enhance waste diversion elsewhere and may be amenable to Nova Scotia.

3.2.1 Stage 1: Consultative Interviews

One-on-one structured phone interviews involved operational personnel (typically the site manager) within the various municipal solid waste sites in NS, both those that currently operate reuse centres and those that don't. Interviews were chosen as the method of data collection because they allowed for clarification of questions throughout the interview (Palys, 2008). Interviews also typically have a higher response rate, and so it was anticipated that all necessary data could be collected using this process (Palys, 2008). The questions were structured to obtain specific pieces of data and information about the operational process and material flow within the facility; the opinions and beliefs of solid waste managers were not queried. Respondents were asked a series of pre-established questions that allow for a limited number of response categories (Qu & Dumay, 2011). This enabled empirical data collection pertaining to the specific practices of reuse operations. Additionally, the same questions were asked of each respondent, ensuring the responses from each interview to be comparable (Qu & Dumay, 2011). The interviews were conducted over the phone; travel was not required for either the interviewer or

participant. Additionally, due to the threat of Covid-19, phone interviews offer a safe option for everyone involved. The interviews were recorded (with permission obtained from the respondent) to allow for transcription to occur during the data analysis process.

The interviews with the solid waste managers from the sites with the reuse centers highlighted the current practices of municipal reuse centres in NS and provided quantitative data about the material throughput of the various streams. This allowed for comparisons in diversion rates and costs between the municipal waste sites with and without a reuse centre through statistical analysis, to determine if there was a significant difference in the waste volumes of the two groups. The questions for those sites with a reuse centre focused on elucidating the following information:

- Rationale for establishing the reuse centre
- Current volume and percent make up of existing solid waste stream
- Historical waste volumes from before and after reuse center implementation
- Percentage of goods sold at reuse centre diverted directly from landfill
- Percentage of goods sold at reuse centre received by donation
- Amount and final destination of unsold goods
- Operational costs and revenues (reuse centre)
- Operational costs and revenues (landfill)
- Job creation
- Alternative reuse organizations in surrounding areas

The interviews with solid waste managers at sites without the reuse centers queried the following:

- Total throughput and make-up of solid waste sent to landfill
- Final destination of durable goods collected
- Volumes and makeup of the subset of material designated as durable goods
- Cost of dealing with durables (processing, shipping, transportation)
- Cost of landfill operation
- Occurrence of cost recuperation

The interview questions were pilot tested through an iterative process during the first 2-3 interviews. More specifically, throughout the interviews, the researcher was able to clarify questions to ensure they were well understood by the respondents, thereby ensuring relevant data was collected. In the case that data were missing by the end of the interview, the respondents were asked follow-up questions over email to ensure the completeness of the data obtained. The rigour of the methods for this study have been determined using pre-existing studies (Cope, 2010; Qu & Dumay, 2011; Xiao & Watson, 2017).

Additional data was obtained from the Nova Scotia Environment DATACALL. This information was used to provide additional values for total waste landfilled in each region and waste disposal costs that were not obtained through the interview process.

3.2.2 Stage 2: Literature Review

The literature review focused on operational practices of municipal reuse centers in jurisdictions outside of Nova Scotia, with the intent to determine effective strategies that have led to observed social, economic and/or environmental benefits. Based on current operational practices and the identification of obstacles for implementation (i.e. economic barriers, staff

requirements, geographical considerations, etc.), the amenability of such practices to the reuse centers in Nova Scotia were determined

The methods for the literature review have been adapted from the methods described by Xiao and Watson (2017). Both grey literature and scientific databases were included in the search; grey literature was sourced from government directories, operational materials, Google scholar, custom Google searches and Novanet. The databases used to search for scientific literature included: Google Scholar, Web of Science, Scopus, Ebscohost and Proquest. Key search terms such as *municipal OR local authority AND reuse center OR donation center* were used in order to focus the search. The next step in the literature review was to screen for inclusion. This was done by reading the abstracts and summaries of each study or report that appeared in the search, and determining if they were relevant to the research (Xiao & Watson, 2017). From there, articles deemed relevant were further evaluated. This included reading of the screened papers in full (Xiao & Watson, 2017); relevant data was then extracted.

3.3 Data Analysis

The data was analyzed using a mixed methods approach. Quantitative analysis entailed a statistical analysis of the waste volume and operational costs associated with each site in order to compare municipal waste disposal realities at sites both with and without a reuse centre. The mean and standard deviation were determined for the following categories for both types of sites:

- Per unit operational cost and landfill cost
- Total volume of items with reuse potential sent to landfill

A t-test was then completed for each category to determine if there was a significant difference in waste diversion rates and operational cost between the sites with the reuse center and sites without. This was established as a proxy for any environmental and economic benefits resulting

from the implementation of the reuse centers. A regression analysis was also completed, which revealed observable trends in the total waste values over time, from before reuse center implementation and after. This helped to determine if the reuse center had led to a decrease in waste generation in each region with a reuse center.

Qualitative analysis was conducted using *A posteriori* coding for both the literature review and interviews. First, the interviews were transcribed from the recordings taken during the interview. The practices of each reuse center were then outlined, and similarities and differences between each site were compared. The practices were then compared to the literature to determine if any assumptions could be made about the effectiveness of each practice.

Next, the themes determined from the codes in both the literature review and the interviews were compared to determine similarities and differences between municipal reuse center operations. The codes from the interviews described the current operational practices of the reuse centers in Nova Scotia, while the literature review documented the findings of previous studies. The intent was to determine if there are effective practices in other jurisdictions that could enhance any of the observed benefits at reuse centres in Nova Scotia.

4.0 Results and Discussion

4.1 Reuse Centers in Nova Scotia

There are currently three (3) reuse centers operating in Nova Scotia. Through consultative interviews, it was found that each reuse center uses a different set of operational practices. This section will describe each reuse center and the strategies adopted at each site. This information was obtained from the consultative interviews portion of each region.

4.1.1 The Last Re-Sort Reuse Center at Valley Waste Resource Management

The Last Re-Sort Reuse Center at Valley Waste Resource Management transfer station is located in Kentville, Nova Scotia and serves Kings County, which has a population of 62,846 inhabitants and a population density of 28.6 inhabitants per km². Kings County is classified as a rural area (Statistics Canada, 2016). Last Re-Sort is hosted in a building that has an area of 186m², with access to power and electricity. Physical operations have also expanded beyond building interior to include the exterior as well, operating in the transfer station parking lot for additional accommodation.

Last Re-Sort was established in 2012, but temporarily shut down in 2020 due to Covid-19 restrictions. It historically opened on Saturday mornings year-round and was first implemented as both a waste diversion strategy and a safe alternative to scavenging at the landfill. All items sold at the reuse center are diverted from the waste stream that arrives at the transfer station, where all materials (useful or not) are charged a tipping fee based on mass. Items that make their way to Last Re-Sort are priced at an estimated market value and include: scrap lumber, windows and doors, household items and decor, paint, toys, books, craft and party supplies, office and school supplies and sports equipment. Items not accepted include: textiles, fabric-covered furniture, weapons, child car seats, and flammable materials. A limited quantity of electronics are accepted.

4.1.2 Victoria County Reuse Center

The Victoria County Reuse Center is located at the Baddeck Transfer Station in Baddeck, Nova Scotia. It serves the entirety of Victoria county, which has a population of 7,089, and a population density of 2.5 inhabitants per km². Victoria County is classified as a rural area (du

Plessis et al., 2001) and is one of the four counties of waste management Region 1 (Cape Breton). The reuse center operates out of a non-heated building that has an area of 360m².

The reuse center was established in 2018 and is open on Saturday mornings from April to November each year. Similar to the Last Re-Sort, the center was developed as part of a strategy to increase waste diversion and provide a safe alternative to scavenging. In this case, most of the items sold at the center are collected through donations (90-95%); only 5-10% comes from material diverted at the transfer station. Items accepted at the center include: scrap lumber, windows and doors, household items and decor, paint, toys, books, craft and party supplies, office and school supplies and sports equipment. Goods not accepted include: textiles, weapons, child car seats, and flammable materials. Another difference is this centre operates on a pay-what-you-can system. There are no paid staff involved in the operations. Rather, various non-profit organizations run the sale days for four (4) consecutive Saturdays as a fundraising opportunity, keeping any revenue that is generated.

4.1.3 Guysborough County Reuse Center

The Guysborough County Reuse Center is located at the Guysborough Landfill site in Guysborough, Nova Scotia. It serves the county of Guysborough, which has a population of 7,625, and a population density of 1.9 inhabitants per km². Guysborough is one of the three counties that makes up waste management Region #2, and is classified as a rural area (du Plessis et al., 2001). The reuse center is operated out of a non-heated building that is 720m² in size.

The reuse center was established in 2006 and is open during the operating hours of the landfill. The reuse center began as a way to increase waste diversion at the landfill site. It operates as a swap station; residents drop off items as donations and can take items home at no cost. There is one employee who works to remove salvageable items from the landfill to be

placed in the reuse center. However, there has been no monitoring of the volume or percentage of material throughput represented by such “diverted” materials. Items accepted at the center may include: scrap lumber, windows and doors, household items and decor, paint, toys, books, craft and party supplies, office and school supplies and sports equipment. Items not accepted at the center include: weapons, child car seats, and flammable materials.

4.2 Environmental impacts

4.2.1 Waste Diversion

The impact of the reuse centers on waste diversion was analyzed by observing trends in the total waste per capita over time in each region with a reuse center, and the comparison of total waste per capita between regions with and without a reuse center. Table 1 depicts the total waste per capita (mt) from 2011 to 2020 at Valley Waste (Kentville, NS). Noting that the reuse center was implemented in 2012, the trends in waste generation after program implementation was analyzed. Population values were obtained from the Canadian Census (2011; 2016) and estimates made by the Nova Scotia Department of Finance (2013; 2014; 2015; 2017; 2018; 2019; 2020). The population value for 2012 was estimated using the average of 2011 and 2013 values (Table 1). The trend in waste generated per capita from 2011 to 2020 is illustrated in Figure 4. Statistically, there was weak correlation between the year and the total volume of waste landfilled at Valley Waste ($R^2=0.3335$), suggesting that there has not been a significant change in the total amount of waste landfilled per capita at Valley Waste from 2011 to 2020, despite the introduction of the Last Re-Sort in 2012. The total waste may have also been impacted by several socioeconomic factors such as: education and environmental awareness of residents (Han et al., 2018), gender and age structure of the population (Talalaj & Walery, 2015), and changes in income level and overall economic well-being (Vieira & Matheus, 2018) accessibility (Satori

et al., 2018) and consumer perceptions (Milios and Dalhammer, 2020). which were not investigated in this study. Tracking of items that go in and out of the center did not take place, indicating that the impact of the reuse center on the total tonnage of waste landfilled at Valley Waste could not be determined. However, staff estimated that 90 tonnes of waste was diverted in 2019, based on the extrapolation a measurement from 2012 of the weight of items sold. If this estimation is correct, it would indicate that 0.39% of total waste had been diverted. Since the landfill makeup of waste with reuse potential is unknown, it cannot be determined what proportion of waste in this category had been diverted.

Table 1 Total waste landfilled per capita at Valley Waste in Kentville, NS (2011 to 2020).
Source: Valley Waste, Census of Canada (2011; 2016), Nova Scotia Department of Finance (2013; 2014; 2015; 2017; 2018; 2019; 2020)

Year	Population	Total Waste Landfilled (mt)	Total Waste Per Capita (mt)
2011	60,589	20,620.00	0.340
2012	60,816	21,015.00	0.347
2013	61,043	20,545.00	0.337
2014	60,983	19,998.00	0.328
2015	60,817	20,123.00	0.331
2016	60,600	22,461.00	0.371
2017	61,061	23,279.00	0.381
2018	62,573	25,174.00	0.402
2019	62,788	23,320.00	0.371
2020	62,846	22,040.00	0.351

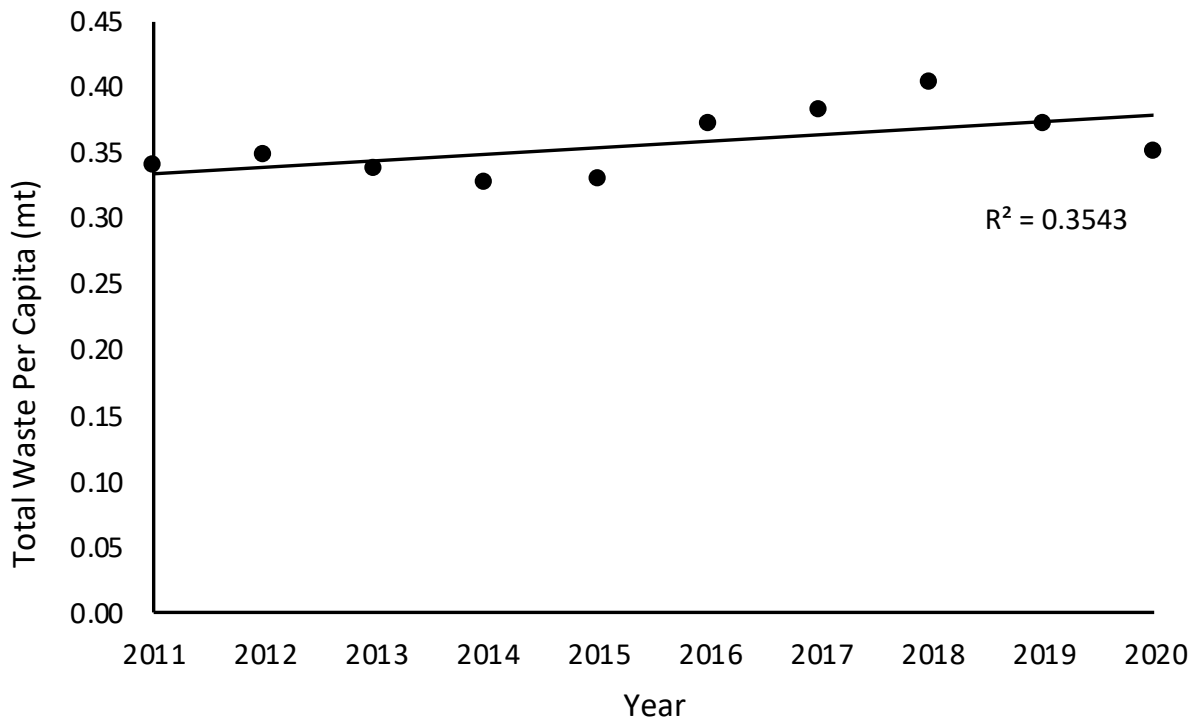


Figure 4 Total waste landfilled (tonnes) per capita at Valley Waste in Kentville, NS (2011 to 2020). Source: Valley Waste (2021); Census of Canada (2016), Nova Scotia Department of Finance (2013; 2014; 2015; 2017; 2018; 2019; 2020).

Table 2 shows the total waste landfilled per capita at the Baddeck Transfer Station in Victoria County, NS from 2017 to 2020 and demonstrates waste volumes over time from program introduction to present. The reuse center was implemented in 2018, so the trends in waste generation after program implementation have been observed. Population values were obtained from estimates made by the Nova Scotia Department of Finance. The trend in total waste landfilled per capita in Victoria County from 2017 to 2020 is seen in Figure 5. There was a strong negative correlation between the year and the total tonnes of waste landfilled per capita at Victoria County ($R^2=0.946$), suggesting that there was a trend of decreasing waste landfilled per capita between 2017 and 2020. However, since no inventory was completed and there was no tracking of the volume of items that go in and out of the center, it is not possible to determine

how much waste was diverted from the landfill as a result of the reuse center. External factors were not considered in this study including: the level of education and environmental awareness of residents (Han et al., 2018), gender and age structure of the population (Talalaj & Walery, 2015), and changes in income level and overall economic well-being (Vieira & Matheus, 2018). Such influences may have led to the reduction in total waste, rather than the reuse center. Therefore, it cannot be determined if there has been a waste diversion benefit observed at the Victoria County Reuse Center as a result of the center’s implementation.

Table 2 Total waste landfilled (tonnes) per capita at the Baddeck Transfer Station in Baddeck, NS (2017 to 2020). Source: Victoria County Waste Management; Nova Scotia Department of Finance (2017; 2018; 2019; 2020)

Year	Population	Total Waste Landfilled (mt)	Total Waste Per Capita (mt)
2017	6,672	3,345	0.501
2018	7,151	2,976	0.416
2019	7,109	2,891	0.407
2020	7,019	2,456	0.350

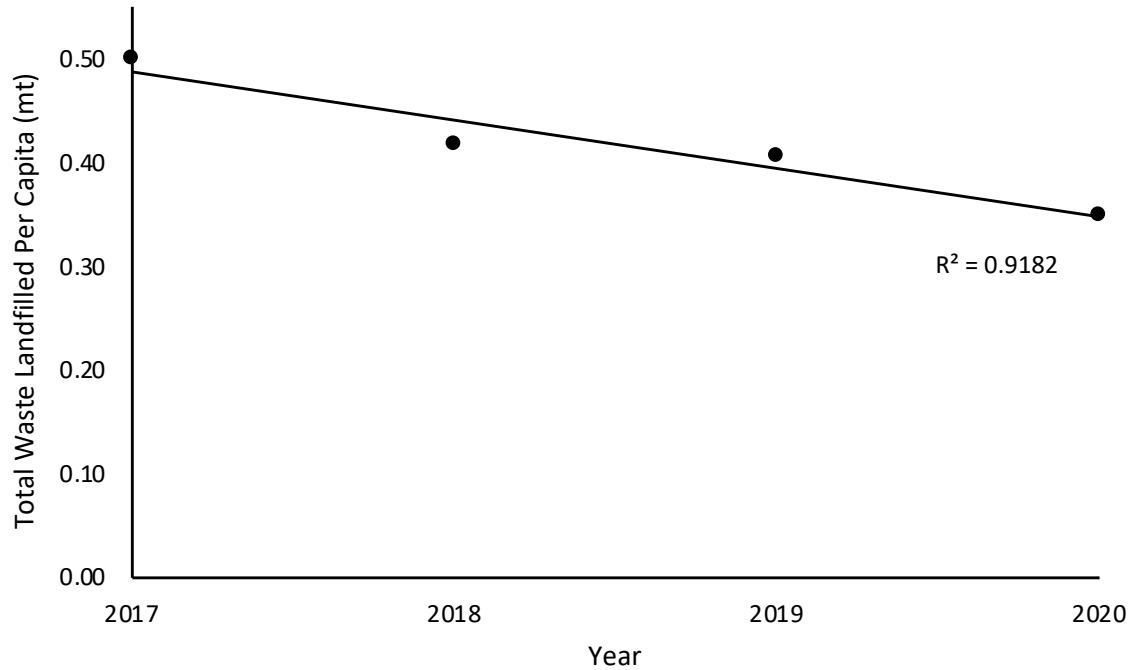


Figure 5 Total waste volume (tonnes) per capita at Baddeck Transfer Station in Baddeck, NS (2011 to 2020). Source: Victoria County Waste Management (2021); Nova Scotia Department of Finance (2017; 2018; 2019; 2020).

The total waste landfilled per capita (mt) at Guysborough Landfill (collected from exclusively residents of Guysborough County, NS) from 2006 to 2020 is demonstrated in Table 3. The reuse center was implemented in 2006, so the results indicate if there have been trends in waste generation since the introduction of the program. The population values were obtained from the Canadian Census Data (2006; 2011; 2016) and estimates made by the Nova Scotia Department of Finance (2008; 2009; 2010; 2012; 2013; 2014; 2015; 2017; 2018; 2019).

Population values were not obtained, so estimates were made based on the average changes in population size from other years. Since Guysborough is a landfill site, it receives waste from other counties (CBRM, Inverness, Richmond, Port Hawkesbury, Antigonish, Pictou) in addition to the waste collected from Guysborough County residents. Since the reuse center primarily sources items from donations made by residents of Guysborough, only waste generated in the

county were included in this analysis, as it is likely that the waste sent to the Guysborough Landfill had little impact on the reuse center operations. Additionally, the waste arriving from other regions is consolidated before arriving at the landfill, meaning that it would be impossible for items with reuse potential to be sorted to be exchanged at the reuse center. There was a moderate positive correlation between the total waste landfilled per capita (mt) between 2006 and 2020 ($R^2=0.5057$) (Figure 6). Values from 2006 to 2012 show little variation from the trendline, whereas values from 2013 to 2020 are very far from the trendline, showing considerable variation. Thus, there was no clear trend for waste volume landfilled per capita in Guysborough County. Due to the fact that there is no tracking of the quantities of items exchanged, it is not possible to determine the influence of the reuse center on the waste generation. As stated previously, it is likely that there were several external socioeconomic factors not considered in this study that may have influenced the waste volumes. At this time, the proportion of waste that has been diverted from the reuse center cannot be determined.

Table 3 Total waste landfilled (tonnes) per capita from residents of Guysborough, NS at the Guysborough Landfill (2006 to 2020). Source: Guysborough County Waste Management; Census of Canada (2006; 2011; 2016), Nova Scotia Department of Finance (2008; 2009; 2010; 2012; 2013; 2014; 2015; 2017; 2018; 2019)

Year	Population	Total Waste Landfilled (mt)	Total Waste Per Capita (mt)
2006	9,058	888.07	0.098
2007	8,900	1016.1	0.114
2008	8,742	1438.44	0.165
2009	8,622	1,769.30	0.205
2010	8,444	1,955.39	0.232
2011	8,143	2,341.96	0.288
2012	8,299	2,391.34	0.288
2013	7,936	5,277.12	0.665
2014	7,627	3,659.24	0.480
2015	7,354	2,689.80	0.366
2016	7,625	3,595.00	0.471
2017	7,337	4,281.60	0.584
2018	7,495	2,423.77	0.323
2019	7,372	2,176.75	0.295
2020	7,151	4,227.06	0.591

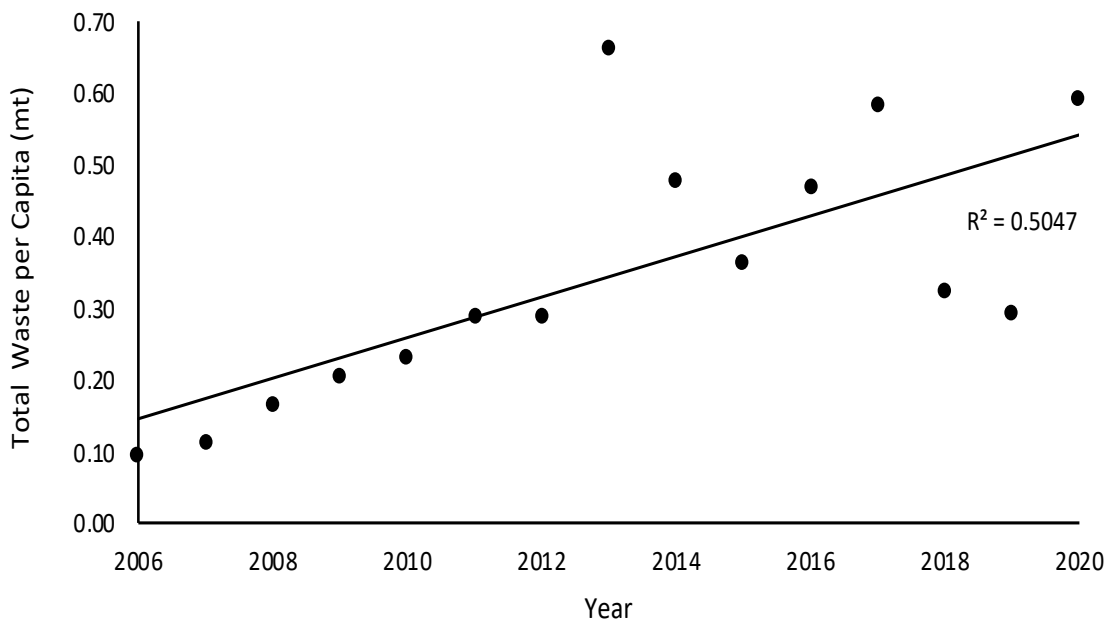


Figure 6 Total waste volume (tonnes) per capita from residents of Guysborough, NS at Guysborough Landfill (2011 to 2020). Source: Guysborough Waste Management (2021); Canadian Census Data (2016), Nova Scotia Department of Finance (2010-2020).

Table 4 shows the total waste landfilled per capita in regions with and without a reuse center from the 2018/2019 fiscal year³. The regions without a Reuse Center includes: CBRM, Inverness, Richmond, Port Hawkesbury, Antigonish County, Cumberland, Colchester, East Hants, HRM, Annapolis County, Cheste, Lunenburg (town), Lunenburg (county), Queens, Barrington, Shelburn, Clark's Harbour, Windsor, West Hants, Clare, Yarmouth, and Digby. Regions with a Reuse Center includes: Victoria County, Valley and Guysborough. As illustrated in Figure 7, there was no significant difference ($t(7)=0.20025003$, $p>0.05$) between the total waste landfilled per capita in regions that currently have an operating reuse center ($M=0.349969469$, $SD=0.00922209$) and regions that do not ($M=0.393346849$, $SD=0.20117716$). There was an overall lack of available data regarding the make-up of the waste stream in Nova Scotia. Additionally, several regions have additional waste that is collected through private companies, and such values could not be obtained from this study, reducing the accuracy of this analysis. There was no information pertaining to the proportion of waste that has reuse potential in the Nova Scotian waste stream, and an examination of this was beyond the scope of this study.

³ A fiscal year refers to the 12-month calendar schedule used for financial reporting, which runs from April 1st to March 31st each year.

Table 4 Total waste landfilled for regions with/without a reuse center from the 2018/2019 fiscal year. Source: Nova Scotia Environment DATACALL; Census of Canada (2016).

Region	County/Town	Annual Total Waste 2019 (mt)	Population (2016)	Total Waste Per Capita	
Regions Without Reuse Center	1	CBRM	31,798.93	94,285	0.337
	1	Inverness	5,870.17	17,235	0.341
	1	Richmond	2,452.00	8,964	0.274
	1	Port Hawkesbury	600.19	3,214	0.187
	2	Antigonish County	3,912.64	14,937	0.262
	2	Antigonish Town	2,910.01	4,364	0.667
	2	Pictou	10,699.43	43,748	0.245
	3	Cumberland	7,276.86	30,005	0.243
	3	Colchester	17,268.81	50,585	0.341
	3	East Hants	5,584.36	22,453	0.249
	4	HRM	130,231.51	403,131	0.323
	5	Annapolis County	3,563.17	20,591	0.173
	6	Chester	3,311.15	10,310	0.321
	6	Lunenburg Town	706.93	2,263	0.312
	6	Lunenburg County	10,039.48	34,553	0.291
	6	Queens	3,066.57	10,351	0.296
	6	Barrington	3,036.23	6,636	0.458
	6	Shelburne	1,758.53	6,572	0.268
	6	Windsor	706.93	3,648	0.194
	6	West Hants	3,851.35	15,368	0.251
7	Clark's Harbour	461.31	758	0.609	
7	Clare	3,203.96	8,018	0.400	
7	Yarmouth	6,952.76	24,419	0.285	
7	Digby	3,204.37	9,305	0.344	
Regions With Reuse Center	1	Victoria County	2,197.63	7,089	0.310
	2	Guysborough	2,186.21	7,625	0.287
	5	Valley Waste (Kings County)	21,261.67	60,600	0.351

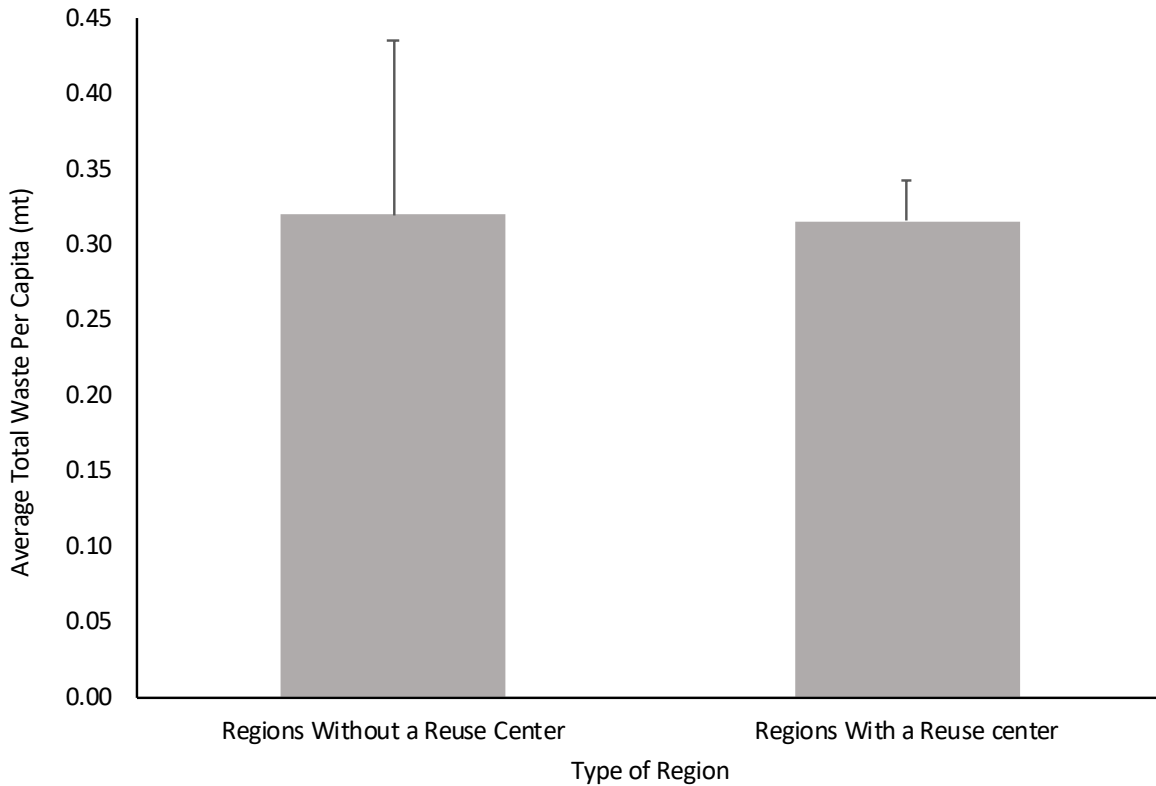


Figure 7 Average total waste landfilled for regions with/without a reuse center from the 2018/2019 fiscal year. Source: Nova Scotia Environment DATACALL.

Overall, it was not possible to draw conclusions about the impact that each reuse center on waste diversion. More information pertaining to waste with reuse potential is required to make a thorough analysis.

4.2.2 Reuse Potential

From the data obtained from the consultative interview portion of this study, it was determined that each reuse center accepts a wide variety of items that do not have alternative pathways for reuse, such as thrift stores or direct resale (i.e. kijiji.com) since these items are often salvaged directly before landfilling. The most common items found at thrift stores include clothing and books. Furniture may be found at thrift stores, but not all (Fortuna & Diyamandoglu, 2017a). Since the reuse centers at Victoria County, Valley Waste and

Guysborough each accept all types of items so long as they are not banned, such operations offer reuse opportunities for items that are less commonly found at thrift stores. It was also noted that each of the reuse centers do not accept textiles, indicating that they have a different focus than thrift stores, and sell different types of items, thus increasing reuse potential for additional items. This practice is similar to successful reuse centers such as those in New York state. The Town of New Paltz Reuse (New Paltz, NY) has exhibited a 15% reduction of the waste stream, and Finger Lakes Reuse (Ithaca, NY) has successfully diverted 3% of the waste stream. In both jurisdictions, furniture, appliances, office equipment, toys, household items, garden supplies, tools, books, construction and demolition (C&D) material, and craft supplies are the main types of materials that are accepted and have been diverted from the landfill. (Finger Lakes Reuse, 2020; Town of New Paltz Recycling Center, 2010). Such materials are not commonly found at traditional thrift stores and are consistent with the findings of Fortuna and Diyamandoglu (2017a), indicating that there has been an enhancement in reuse opportunities for these types of items, which has led to the notable rates of waste diversion in these locations. Thus, the similar practices between the Nova Scotian reuse centers and the New Paltz and Finger Lakes Reuse centers allows for the assumption that the Nova Scotian reuse centers are enhancing reuse potential within their respective regions. However, the items that are collected at the transfer station may be soiled or damaged during the collection process, which may limit reuse potential.

The acceptance of a wide variety of materials can also lead to *upcycling*. Upcycling adds value to items that would otherwise be considered waste, and allows for second hand materials to be used as an alternative to raw materials, thus enhancing resource efficiency (Bridgens et al., 2018). More specifically, at the Valley Waste reuse center, staff have noted that customers have a specific interest in C&D materials. These items can be used for home renovations, by artists for

projects or in schools for educational purposes. The reuse of C&D waste presents an area of high waste diversion potential. In Nova Scotia, C&D waste makes up 9.2% of the total waste makeup of landfills (Avery et al., 2017). It is evident that the focus on these materials may allow for the addition of value to items sold at the center, and increased resource efficiency.

Data from the consultative interviews also revealed that each reuse center pulls material directly from the waste stream, so it can be inferred that this leads to an extension of the life for both the salvaged material and for the landfill. The practices at the Valley reuse center represent high benefits in this area since they accept items that are brought as waste to the transfer station, which are then sorted and brought to the reuse center. Waste materials brought to waste collection points (such as transfer stations) consist of items that cannot be picked up through curbside collection, which may include bulky waste, electronic appliances, and C&D waste. Each of these materials have immediate potential to be reused, and presents less heterogeneity of waste materials compared to curbside collection (Messmann et al., 2019). Thus, the collection strategy at Valley Waste is an effective means to collect high volumes of goods with reuse potential. Victoria County only sees 5-10% of their materials pulled out from the transfer station, meaning that very few items are pulled directly from the waste stream. It is also not possible to measure the impact of the Guysborough reuse center, as the quantity of waste pulled from the landfill cannot be estimated. Both Guysborough and Victoria county accept donations as a source for the items sold at the store. This may be an effective option for reuse in these areas, since there are no alternative reuse stores or programs in these regions. This suggests that the reuse centres serve as an effective way to facilitate reuse in these areas.

4.3 Social impact

4.3.1 Improving Quality of Life

The data obtained from the consultative interviews identified that all three reuse centers offer goods at a cost that is significantly lower than the price of a new item. Valley Waste reuse center prices items based on their estimated value, while Victoria county has a pay what you can system which allows for items to be purchased at a very low price. For example, it was noted that a washing machine was once purchased for only a few dollars, as this was the price that the customer could afford. As previously noted, at the Guysborough reuse center, there is no cost for the exchange of goods, meaning that customers are able to access items without financial burden. Such practices suggest that all three centers increase accessibility of items to people in need, which in turn can be linked to an increase in quality of life. This result is supported by the findings of Zacho et al. (2018) and Osterley and Williams (2019), which reported that the provision of affordable goods contributes to overall improvements in quality of life. It has been reported that the child poverty rate in the regions where the reuse centers are located are 34% (Annapolis), 34.9% (Cape Breton) and 23.1% (Guysborough) (Frank et al., 2020). There is a significant proportion of the population in these regions living in poverty, so the low cost of items at the reuse centers can offer some relief to those who may otherwise go without.

4.3.2 Accessibility in Rural Areas

All three reuse centers are located in rural communities; as noted, there are no additional reuse or “second hand” shops in the Guysborough or Victoria County areas. However, there are several reuse options within a small radius of the Valley reuse center located in Kentville. These include thrift stores, pawn shops and used clothing stores. Despite the existence of such reuse options, the reuse center provides a different selection of items compared to thrift stores (Fortuna

& Diyamandoglu, 2017a), allowing for enhanced accessibility to additional types of used items in Kentville and surrounding areas of Kings County. As a result, residents are able to access second hand items such as construction demolition materials, craft supplies, art materials and home goods that may have otherwise been significantly challenging to obtain. Each region also has a low population density, which would require many residents to travel far distances in order to access used items if using other means to access used goods such as online marketplaces or “Kijiji”. It has been reported in the literature that access to services in rural communities is an topic of concern, and that better access to resources is essential for rural development (Boucher et al., 2008). It can be assumed that the reuse center provides accessibility to those residents that live within a reasonable travel distance; however, the low density will still influence the center’s accessibility for residents who live further away.

4.3.3 Charitable Contributions

It was also revealed in the data from the consultative interviews that neither the Guysborough, nor the Valley Waste reuse centers have partnerships with external charitable or not-for-profit organizations and therefore do not offer any direct benefit to such organizations in those regions. However, the reuse center in Victoria County makes significant impacts for non-profit organizations in surrounding areas. The sales of the reuse center are overseen by different organizations, and each organization gets to keep all of the revenue during the time they operate the center. The types of charities involved include: animal shelters, community health organizations, and youth programs, each making considerable contributions to the community through their initiatives. The reuse center has raised a total of \$23,000 (CAD) for 16 different organizations throughout the two years it has been in operation, representing a considerable funding source for non-profit organizations. For example, in the UK, reuse centres or *charity*

shops supply 18.7% of income for charities, demonstrating the importance of the sale of second-hand goods in generating the financial support for such organizations (Osterley & Williams, 2019). Similar programs in Nova Scotia have proven to benefit charitable organizations as well. The Dalhousie University (Halifax, NS) reuse operation raises \$6000-\$10000 for charity each year (Halifax Dump and Run, 2019). The similarities between these two programs indicate that reuse operations in Nova Scotia directly benefit the community.

4.4 Economic Impact

4.4.1 Waste Management Costs

The solid waste manager at Valley Waste indicated that the cost to operate the Valley reuse center is \$55,000 (CAD) per year, with the bulk of the expenses being linked to labour costs. In 2019, for example, the revenue of the reuse center was ~\$50,000 (CAD), meaning that the reuse center essentially broke even. Although there has been no profit generation, reuse center operations at Valley waste offer little financial liability. At the other two sites it was articulated that, while there are no formal operation costs associated with the reuse centers, there would be implicit costs associated with employees at the landfill site undertaking to divert materials from the landfill stream. Costs such as space, utilities and equipment are negligible because resources already used/owned by the reuse center are utilized. Labour requirements are also negligible because there is no staff oversight at the reuse centers. However, similar to the Valley center there are no direct financial implications related to the reuse center operations. This is consistent with the findings in literature, for example the New Paltz Reuse Center (2010), where there are neither profits generated, nor negative financial implications. There is also likely that there is a cost benefit from not putting items in the landfill, but since the waste diversion rate was not determined, the quantification of this benefit was not determined.

The cost of waste disposal for the 2018/2019 fiscal year from each region in Nova Scotia at sites with and without a reuse center is shown in Table 5. Data was obtained from the 2018/2019 Municipal DATACALL for the Nova Scotia Department of Environment. Regions without a reuse center include: Inverness County, Port Hawkesbury, Richmond County, Antigonish County, Antigonish Town, Mulgrave, Pictou, St. Marys, Amherst, CJSMA, Colchester County, Cumberland County, East Hants, Halifax Regional Municipality, Region 6 and Region 7. As seen in Figure 8, the average waste disposal costs were compared between sites with and without a reuse center. There was no significant difference ($t(18)= 0.19356477$, $p>0.05$) observed in the landfill costs for regions that have a reuse center ($M=\$103$, $SD=49.56$) and those that do not ($M=\$174.78$, $SD=49.56$). This suggests that the reuse centers do not have a significant impact on landfill costs, reinforcing the notion that reuse centers are oftentimes a cost neutral operation. An important consideration is the fact that the cost breakdown was not determined for this study, as the consultative interview participants were unable to access this data. The components that make up the landfill costs in sites with and without a reuse center may impact the financial benefit of the reuse center, which likely led to the wide variation in landfill costs across the regions in Nova Scotia.

However, it cannot be determined if reuse centers have a *positive* impact on operating costs in each region. There has been significant value capture as a result of the reuse centers in other jurisdictions. At the reuse centers operated by the County of Hawai'i, it was identified that the value of reusable waste totalled \$5.8 million (USD), which made up two-thirds of the value of total waste landfilled, even though it only makes up 5% of total waste volume. Literature suggests that there is considerable value to be captured through the salvage of reusable materials (Zacho et al., 2018) and that landfilling is the most expensive waste management strategy

(Modoi et al., 2013). This research has offered evidence to indicate that it is likely that the reuse centers in Nova Scotia are also value capturing operations. Moreover, the cost neutrality and value capture opportunities of the reuse centers position them as preferable waste management options. However, to articulate the exact economic implications for expanding the use of reuse centres in Nova Scotia, better tracking of throughput (materially and financially) will be necessary.

Table 5 The landfill costs (per tonne) in each municipality of Nova Scotia for the 2019/2020 economic year. Data was collected from the DATACALL provided to Environment Nova Scotia.

	Region	Cost (\$)
	CBRM	\$138
	Inverness County	\$135
	Port Hawkesbury	\$77
	Richmond County	\$126
	Antigonish County	\$124
	Antigonish Town	\$83
	Mulgrave	\$144
	Pictou	\$174
Regions Without A Reuse Center	St Marys	\$133
	Amherst	\$220
	Cumberlerland	\$165
	Colchester County	\$122
	Cumberland County	\$259
	East Hants	\$146
	HRM	\$356
	Region 6	\$155
	Region 7	\$182
	Annapolis County	\$407
Regions With A Reuse Center	Victoria County	\$167
	Valley Waste	\$98
	Guysborough	\$46

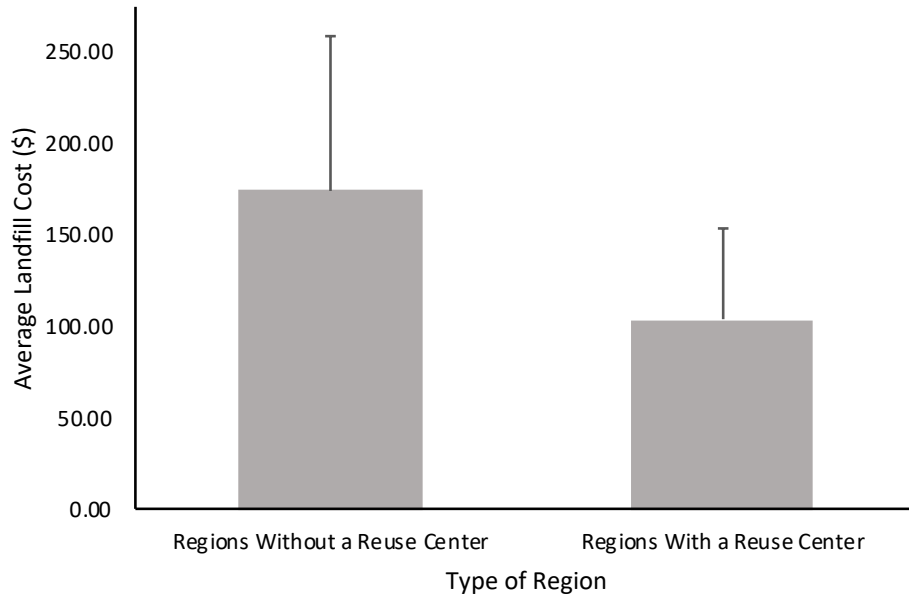


Figure 8 The average landfill cost in 2018/2019 for regions in Nova Scotia with/without a reuse center.

4.5 Strategies to Enhance Reuse Center Success

4.5.1 Waste Management Tracking

In order to better understand the costs and benefits of each reuse center, accurate tracking and inventory of goods should be implemented. Successful reuse centers such as those located in the County of Hawai'i (Hawai'i, USA) and Finger Lakes Reuse (Ithaca, NY) have tracked and documented the types and quantities of reusable items both in the waste stream and brought to the center, as well as thorough measurements of the proportion of total waste with reuse potential (Generalitat de Catalunya & Agencia de Residus de Catalunya, 2020; Recycle Hawai'i, 2009), allowing for an understanding of the effectiveness of the reuse centers in these locations. If the quantity of total items brought to the centers was compared to the quantity of goods with reuse potential that may have previously been landfilled at each site, it would be possible to determine if the reuse centers actually had a beneficial impact on waste diversion. So, by gaining an

understanding of: a) the percentage of “reusable” materials that are diverted to existing reuse centres; and b) the current proportion of waste that has reuse potential in those regions without a reuse centre – policy makers will have a better understanding of the waste diversion potential in Nova Scotia, and thus the opportunity presented by reuse center implementation.

4.5.2 Marketing Tools

Marketing has been documented as a key factor to the success of reuse centers in several locations. At the New Paltz Reuse Center in New Paltz, NY, marketing strategies include onsite signage, local advertising and online advertising. The reuse center was highly visible to passers-by, so signage including directional arrows to draw in users was used. They also created a logo and colour scheme for visual recognition and incorporated design schematics to make the center aesthetically appealing and to keep a continuous flow of goods in and out of the center and increase patronage (Town of New Paltz Recycling Center, 2010). Similar strategies are used in both Hawai‘i and Ithaca (Finger Lakes Reuse, 2020; Recycle Hawai‘i, 2009), suggesting that advertising is a key element underpinning reuse center success. Such tools/strategies could be implemented at each Nova Scotian Reuse Center to increase traffic (if necessary). However, the Victoria County and Guysborough reuse centers both operate without a budget, and the budget of the Valley reuse center is dedicated to staffing costs. With that being said, the increased patronage that would result may cover the cost of implementation; such considerations would require further investigation. At the Victoria County and Guysborough sites it would be necessary to create a budget line for such activities; clear evidence of the reasonable possibility of economic benefit would be required.

Online platforms that can facilitate reuse and/or exchange can serve as an additional method for facilitation of second-hand sales. There are several online strategies that have been

used to sell items from various reuse stations. The New Paltz reuse center utilizes an online “Freecycle” network, which provides the public with the opportunity to access goods destined to landfill and thus increasing waste diversion (Town of New Paltz Recycling Center, 2010). Finger Lakes has an online store, where used material can be purchased online and picked up or delivered to customers (Finger Lakes Reuse, 2020). Both of these platforms serve as effective strategies to increase the quantity of waste diverted and increase opportunities for reuse, as they allow for new ways for customers to access goods. The Freecycle strategy may be useful for the Victoria County and Guysborough reuse centers, as it would more easily allow for free online advertisement and may lead to increased sales/collection. The online store may be a strategic option for the Valley Waste reuse center, as it would allow for increased access for customers to purchase items. Additionally, since the operations have ceased due to the Covid-19 restrictions, an online store may serve as a safe way to restart the center’s operations.

4.5.3 Collaboration with External Organizations

Collaboration with external organizations has led to the success of many reuse centers in other jurisdictions. Finger Lakes (Ithaca, NY) is a non-profit organization that partners with local authorities to access waste that is sent to the landfill. The organization takes the material and oversees all the activities at the reuse center. In 2019, not only was a significant quantity of waste diverted (522 tonnes), but 9 new jobs were also created, increasing the number of staff members at the center. Finger Lakes also worked with 172 new volunteers, donated \$51,505 (USD) in materials to 280 households in need, and provided job and skills training to locals (Finger Lakes Reuse, 2020), providing social and economic benefits to the community.

Contracting out the reuse center operations allowed for the responsibility to be taken off of the local authority, placing it on those whose focus is dedicated to the reuse center. Evidently, the

Finger Lakes Reuse Center has led to environmental, social and economic benefits as a result of the collaboration between the municipality and the non-profit organization.

This strategy has potential both at the existing reuse centers in Nova Scotia, and as a mechanism to support the development of new reuse operations in other jurisdictions. It was indicated by all three reuse centers that their operations are limited by lack of space, limited operation hours, and staffing requirements. Through creative collaboration, such limitations could be overcome. For example, at the Valley Waste and Guysborough Reuse Centers, a partnership could be initiated between the municipalities and non-profit organizations. The staff/volunteers at both reuse centers indicated that there were limitations to their operations impacting operating hours, staff, size of the reuse building and building utilities, and thus preventing the reuse centers from reaching their full potential. Through collaboration with non-profit organizations, the reuse centers would be able to shift the responsibilities to the non-profits whose focus would be the reuse center activities. The collaboration may also lead to increased sources of funding, which would guide the expansion process.

As noted, there are existing partnerships between the Victoria County Reuse Center and 16 non-profit organizations, who oversee the sales at the center and retain all of the revenue made from sales. Since the model of the Victoria County reuse center serves to act as a source of funding for the non-profit organizations, the collaboration model of Finger Lakes may not be effective, as this model would require the revenue generated to go towards the reuse center operations rather than the charities. A potential solution could be to model the reuse center after a thrift store or charity shop, where a significant portion of revenue is donated to non-profit organizations, while also using a portion of the revenue for reuse operations (Osterley & Williams, 2019).

4.5.4 Volunteer Programming

At the Finger Lakes and County of Hawai'i reuse centers, several volunteers work to support their initiatives (Finger Lakes Reuse, 2020). At Finger Lakes, volunteers collaborate with staff to run the reuse center. The reuse center expands operations each year, generating more revenue (~2,000,000 in revenue in 2020 compared to ~1,000,000 in revenue in 2018) and diverting more waste (521 tonnes in 2020 compared to 381 tonnes in 2018) over time (Finger Lakes Reuse, 2020). In the county of Hawai'i, the reuse centers are primarily run by volunteers, with support from transfer station staff. The work of volunteers has directly led to program expansion and the implementation of (8) reuse centers across the county (Recycle Hawai'i, 2009). Thus, it can be inferred that support from volunteers has played a major role in the success of these reuse centers. One of the major limitations cited by all three reuse centers in Nova Scotia from the consultative interviews was the lack of available staff to dedicate time to the reuse center. This obstacle could be overcome if the centers began incorporating volunteer programming into their initiatives. Literature also suggests that volunteer work positively impacts volunteers in terms of personal satisfaction, relationships, and obtaining new skills (Manetti et al. 2014). The volunteer programming would therefore lead to additional social benefits, as it would improve the volunteers' quality of life. Volunteering is a common practice within organizations across the province of Nova Scotia (Imagine Canada, 2015), so it is likely that volunteer programs could easily be incorporated into reuse center practices. However, the reuse centers are located in rural areas with a low population density, which may be a factor impacting residents' ability to take part in a volunteer work.

4.5.5 Educational and Social Programming

As evidenced by Finger Lakes Reuse and The Town of New Paltz Reuse Center, additional educational and social programming for locals is offered with the aim to raise awareness about waste reduction and promote community growth and security. At Finger Lakes, job skills training for youth and those experiencing unemployment was created to help such individuals find suitable and enjoyable employment opportunities. A fixer's collective repair program was also created, where groups of experienced volunteers offer repair services for customers (Finger Lakes Reuse, 2020). Similarly, the Town of New Paltz Reuse Center implemented a repair café program to facilitate the repair of broken items and delivers monthly workshops about waste reduction strategies (Town of New Paltz Recycling Center, 2010). Such initiatives benefit both the community and enhance environmental benefits. Individuals are more likely to have higher quality employment when they have access to job training, which can overall improve their quality of life. (Boreham et al., 2016). The repair programs also increase customers' access to items and enhances waste diversion, as these items would have otherwise been landfilled (Zacho et al. 2018). Benefits of educational workshops have been evidenced, as they allow customers to engage with environmental initiatives. Evidence suggests that environmental education is a major determinant for pro-environment behaviours (Varela-Candamio et al., 2018), so it is likely through workshop participation, individuals would adopt pro-environmental practices related to waste management, potentially leading to higher rates of waste diversion in the long-term.

While it is likely that social and educational programming would lead to similar benefits in Nova Scotia, the operations of each reuse center are too limited in scope for such programs to be implemented. There are currently no financial opportunities or staff who would be able to

dedicate their time to implement such initiatives. However, if collaboration with external organizations or volunteer programming was incorporated into the operations of the reuse centers as suggested in sections 4.5.3 and 4.5.4, it would be possible for such initiatives to take place.

4.5.6 Diversified Methods of Waste Collection

The reuse centers in Catalonia, Spain have demonstrated success, with a diversion rate of 2% from various reuse initiatives. The materials sold at the centers are obtained through three different streams including: collection containers in public spaces, door to door collection and bulky waste collection. It was found that separate collection systems for reusable waste products allow for higher waste diversion potential, as it allows for reusable goods to be sorted out from other types of waste. (Generalitat de Catalunya & Agència de Residus de Catalunya, 2020). Separate collection has also been identified as one of the key strategies for a move towards the circular economy, as it can eliminate contamination and toxic materials from entering the stream for reusable waste materials and reduce product damages (The Ellen MacArthur Foundation, 2015b). Increased solid waste separation reduces the heterogeneity of waste materials, allowing for efficient waste to resource strategies (D'Onza et al., 2016). Such programs operate in a similar way to the separate collection systems of recyclables and garbage in each region of Nova Scotia.

Currently, the reuse centers in Nova Scotia have limited points of access to reusable goods. At Valley Waste, items pulled from the waste stream, and at the Guysborough and Victoria County Reuse centers items are [predominately] obtained from donations. Enhanced bulky waste collection services would allow for increased separation of reusable goods in each region. This would in turn, increase the number of waste items that could be sold or exchanged at the centers, and thus diverted from the landfill. This could also raise profits, contributing to reuse

center expansion. The cost of additional collection services may be a barrier to this strategy, as waste collection and transportation make up the highest proportion of costs for waste management systems (D'Onza et al., 2016). This may be particularly challenging at the Victoria County and Guysborough reuse centers, where there is no revenue generated. However, costs typically decrease as the proportion of separated waste increases, and a higher rate of waste diversion may lead to savings that would make the service feasible (D'Onza et al., 2016). There are also municipalities within the province that offer specific bulky waste pickup (Colchester, Antigonish, CBRM), presenting an opportunity for these regions to implement a reuse center, since bulky waste is pre-sorted. A similar system could also take place in the regions with reuse centers, with bulky waste collected going directly to the reuse centers to be sorted. This strategy may be limited by resident behaviour, as the efficacy of waste sorting behaviour is dependent on individual motivation and intention to sort their waste (Zhang et al., 2019). However, since residents of Nova Scotia have already adopted sorting habits for recycling and garbage collection services, they may be inclined to separate reusable waste as well.

4.5 Limitations

The most significant limitation for this study was the lack of available data. There are only three (3) municipal reuse centres in Nova Scotia, which are located in regions that do not necessarily reflect the conditions found at other solid waste management sites throughout the province. Moreover, NS is a small province, with a limited population; this limits the number of facilities that can be studied. There is also a limited amount of data that was obtained from each region, as this information is not currently tracked. The missing information includes: the annual quantity of waste with reuse potential, the composition of waste at each site (including the quantity of reusable items), the cost breakdown for each waste management site, the total

quantity and volume of items brought to each center annually, the total quantity and volume of items sold at each center annually. This lack of available data meant that precise conclusions could not be determined surrounding the benefits of the municipal reuse centers in Nova Scotia. There is also an apparent paucity of literature available specific to this topic. Finally, there is limited publicly available information about landfill composition in Nova Scotia; it is unknown at this time the level of granularity available from the waste management sites regarding the composition of the waste streams. In 2017, Divert Nova Scotia completed a waste audit detailing the waste composition in each landfill in the province, but this is the only currently identified source of information on this topic.

5.0 Conclusions and Recommendations

The results of this study have suggested that environmental, social and economic benefits exist as a result of the municipal reuse centers in Nova Scotia. The reuse centers in each region have presented an expanded set of reuse options for the residents of rural areas, and for materials that would not otherwise be reused. The reuse centers also contribute to improved quality of life and appear to be a cost neutral waste management strategy. However, there is a serious lack of data surrounding the composition of the materials streams destined to landfill, the total waste volumes for reusable items, and the cost breakdown at each solid waste facility in Nova Scotia. As a result, the precise benefits of municipal reuse centers in Nova Scotia cannot be determined at this time. Several strategies to address such gaps – both at the existing reuse centers as well as those sites that currently do not have such operations - have been determined. These include: improved tracking and measurement of the material stream entering the landfill site that has reuse potential, improved marketing strategies, new collaborations with external organizations,

specific “donation/drop-off” locations open to the public and scheduled [separated] collection services for reusable goods.

Given these preliminary findings, it is recommended that municipalities investigate the potential for reuse centers to be implemented on a wider scale across Nova Scotia; there are no obvious negative consequences for their implementation. However, a greater understanding of their waste diversion potential is essential to achieve a comprehensive and effective waste reduction strategy. Future research in this area could seek to identify if there would be equal potential for waste diversion at reuse centers in both rural and urban environments, as this study focused on rural areas of Nova Scotia. An analysis of the reuse rates through other sources within the province (thrift stores, online platforms, etc.) may also be beneficial to understand the current rate of waste diversion through reuse platforms in Nova Scotia.

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8.0 Appendices

8.1 Appendix A: Consultative Interview Questions

8.1.1 Consultative Interview Type 1: Municipal Waste Management Sites With Reuse Center

1. How long has the reuse center been in operation?
2. What was the rationale behind establishing the reuse center?
3. What is the volume of durable goods in the solid waste stream at _____ waste management site?
4. What is the percent makeup of the solid waste stream at _____ waste management site?
5. Where are the durable goods sold at the reuse center sourced from? (i.e. donations, waste collection, landfill, junk yard)
6. What percentage of goods sold at the reuse center are diverted directly from the landfill (i.e. Taken from the curb in a garbage truck, from a junk yard, from the landfill)
7. What percentage of goods sold at the reuse center are sourced from donations?
8. What is the process of preparation for reuse for items sold at the reuse center?
9. What quantity of goods at the reuse center that go unsold?
10. What is the final destination of goods that go unsold at the reuse center? (i.e. back to the landfill, sent to another location)
11. How much does it cost to operate the reuse center annually?
12. How much revenue does the reuse center generate?
13. How much does it cost to operate the municipal landfill?
14. How much revenue does the municipal landfill generate?
15. How many employees work at the reuse center?

16. What types of positions do employees at the reuse centers hold?
17. What other reuse organizations exist in the municipality of _____? (i.e. thrift stores, charities, online reuse platforms)

8.1.2 Consultative Interview Type 2: Municipal Waste Management Sites Without Reuse Center

1. What is the volume of durable goods in the solid waste stream at _____ waste management site?
2. What is the percent makeup of the solid waste stream at _____ waste management site?
3. What is the final destination for durable goods once collected? (i.e. landfill, junk yard)
4. What is the average quantity of durable goods are collected on a monthly basis?
5. What is the cost breakdown of durable waste management? Costs should include: shipping, transportation, processing, storage.
6. What is the annual cost of landfill operation?
7. Are any costs associated with landfill operation recouped?