Review of Waste Management Practices in the Healthcare Sector of Nova Scotia

by

Jamil Sinno

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Dedication Page

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Abstract

In 2014, Capital District Health Authority amalgamated with the other health authorities across the province to become the Nova Scotia Health Authority. Since then, the NSHA has been disposing of their waste based on hospital standard operating procedure. New common waste policies have yet to be put into place. The focus of the new policies should shift from the recycling of waste to the reduction of waste. The waste policies should be introduced to hospital staff using teaching modules. In this report, a case study was performed on the diversion and recycling of expanded and extruded polystyrene foam. The study determined the estimated costs of collecting the foam from the hospitals in Halifax and sending the waste stream to a local vendor. The scope of the case study was then extended to a preliminary analysis of Styrofoam collection and diversion in the HRM through densification.

List of abbreviations used

NSHA	Nova Scotia Health Authority
Divert NS	Divert Nova Scotia
EPS	Expanded polystyrene
HRM	Halifax Regional Municipality
CDC	Centres for Disease Control and Prevention
EPA	Environmental Protection Act
CEPA	Canadian Environmental Protection Act Registry
REgroup	Royal Environmental Group
CSA Group	Canadian Standards Association Group
WHO	World Health Organization
MSW	Medical Solid Waste
JCAH	Joint Commission on Accreditation of Hospitals
H2E	Hospitals for a Healthy Environment
PCB	Polychlorinated biphenyls
VOC	Volatile organic compounds
CCME	Canadian Council of Ministers of the Environment
EPS	Expanded Polystyrene
XPS	Extruded Polystyrene

Chapter 1: Introduction

The amalgamation of 10 provincial health authorities created one entity, the NSHA, which oversees health care in the province of Nova Scotia alongside the IWK. Within the previous separate networks, waste management practices varied. The transition from 10 authorities to the NSHA started in 2015 and is now mostly completed in accordance to the Healthier Together 2016 – 2019 Strategic Plan. With the amalgamation of the NSHA, a list of goals was created to improve on waste management policies once put in place. The third of the goals listed in the plan states “A sustainable health and health service system is promoted through appropriate allocation and management of resources.” In an attempt to complete this goal, a literature review and a look at the different existing policies alongside a case study on Expanded Polystyrene (EPS) were performed.

Problem areas and materials which require diversion to avoid being sent to landfills are construction and demolition residues, textiles, paper products, organic materials, plastics less commonly recycled, and household wastes. These materials are not successfully diverted and therefore immediately landfilled or shipped to a significant distance, incurring extra cost. These materials have therefore been prioritized by Divert NS with the goal of reaching diversion rates similar to properly diverted materials such as organic waste, paper products, packages, electronics, scrap metals and white goods such as appliances, washing machines, dish washers and dryers. While there could be more value added by looking for new and better opportunities to divert the second list of materials, Divert NS has prioritized the list of problematic materials. Table 1 highlights how the quantity diverted of waste diverted in tonnes would have an impact on kg per person.

Table 1.1 Diversion quantities and their impact

Level	Quantities	Impact on kg/person
High	5,000 tonnes or more	5.5 kg/person or more
Medium	1,000 – 4,999 tonnes	1.09 – 5.5 kg/person
Low	100 – 999 tonnes	0.11 – 1.09 kg/person
Nominal	Less than 100 tonnes	Less than 0.11 kg/person

A common mistake made by many Canadians is improper separation of recyclable material and categorization of waste (Patel, 2018). Improper separation and categorization of waste can contaminate a whole load of waste meant for recycling and cause it to be sent to the landfill. The misconception Canadians have with recycling is what occurs after recycling products have been picked up – recyclables do not get sent to a material recovery facility if placed in the wrong waste stream (Patel, 2018). Waste changes as peoples' habits change. The demand for prepared food has led to the increase in plastic containers – specifically black plastic containers. Consumers of plastics may be unaware of the fact that there are seven different types of plastics used for different products (Mertes, 2018). Table 1.2 highlights the seven different types of plastic and whether the respective plastic is recyclable or not.

Table 1.1.2 Plastic recycling code (https://www.qualitylogoproducts.com/promo-university/different-types-of-plastic.htm)

Symbol	Polymer name	Abbreviation	Recyclable
1 PETE	Polyethylene terephthalate	PETE or PET	Yes
2 HDPE	High-density polyethylene	HDPE	Yes
3 PVC	Polyvinyl Chloride	PVC	Yes – if recycler can handle material
4 LDPE	Low-density polyethylene	LDPE	Yes- if recycler can handle material
5 PP	Polypropylene	PP	No
6 PS	Polystyrene	PS	No
7 OTHER	Miscellaneous plastics	N/A	No

In Nova Scotia, the NSHA provides healthcare services to citizens across the province. The NSHA has more than 23,400 employees, working in different healthcare facilities each with their own individual waste disposal and recycling practices. The healthcare facilities are broken down into

8 regional hospitals, 1 tertiary hospital, 8 collaborative emergency centres, and approximately 135 community locations. The NSHA is obliged to deliver the same services for general waste, whether it be organic, biomedical, recyclable or other waste in a financially and environmentally responsible matter and continue to seek improvement on the matter. One of the goals of this thesis is therefore to review the waste management practices at different hospitals and regions of the NSHA and identify best practices.

The thesis is organized as follows. Chapter 2 will deal with the problem statement. A comprehensive literature review will be presented in Chapter 3. Analyses and findings from hospital visits are presented in Chapter 4. Chapter 5 deals with a review of the hospitals' waste policies. Finally, a case study on the diversion of Styrofoam is presented in Chapter 6. The appendices following the report contain additional analyses and pictures of notable observations made during the hospital visits.

Chapter 2: Problem Statement

2.1. General Statement

In attempts to make for a greener province, the diversion of waste has become a topic of focus in the province of Nova Scotia. Waste must be studied from its source to be properly diverted from landfills. In the HRM, the NSHA sends it waste to Otter Lake, a facility located off Highway 103 using REgroup as the main general waste collector. However, waste from hospitals can be contaminated and redirected from the general waste stream and sent to incineration. Contaminated waste is not properly defined throughout Nova Scotia and therefore a lack of consistency is found across the province. To become a greener province with a better system for waste disposal, terms, conditions and guidelines must be clearly defined (Muhlich, Scherrer & Daschner, 2003).

The main issues with the disposal of waste into landfills is the environmental impact, mainly through degradation of the material or transportation. Both these issues affect the environment by increasing the carbon footprint and pollution. The degradation rate of some materials, such as plastic, left in the landfill is slow and the incineration of plastic can release harmful toxins affecting sanitation employees and neighbours. Moreover, transporting waste over long distances uses gasoline and other fossil fuels resulting in negative environmental effects.

Properly diverting waste requires performing cost analyses on the process. The main aim of diversion is to reduce as much waste while maintaining low cost to increase the appeal of diversion. Properly diverting waste emanates from proper separation at the source. Proper separation at the source originates from how much leeway hospital policy definitions allow for optimal disposal of waste (Muhlich, Scherrer & Daschner, 2003) and proper implementation of waste disposal standards. In Nova scotia, there has not been a policy update since the amalgamation of the hospitals in 2015. The last available document for waste disposal in the province dates to 2014 when the NSHA was still referred to as Capital Health.

The following materials listed in Table 2.1 have active recycling markets and have been diverted from Nova Scotia landfills:

Table 2.1 Active recycling waste categories

Category of waste	Including
Organic	• Food waste • Soiled paper products • Yard waste
Paper products	• Corrugated cardboard • Papers
Packaging	• Plastic containers marked 1 and 2 • Metal cans
Electronics	• Old computers • Cell phones • Monitors
Scrap metal/White goods	• Fridges • Washing machines • Dryers • Dish washers

While these materials have successfully been diverted, an assessment of waste practices must be done to determine whether the best diversion practices are currently in place.

There remain to be problem areas in which materials are not recycled or composted. In turn, the material ends up being shipped long distances or in a landfill. Therefore, the following materials take priority in finding a process for diversion. Several of the following materials have low degradation rates and therefore remain in the landfill for many years. Divert Nova Scotia has committed many of its Business Development Programs to diverting this waste. The list of problematic material is given in Table 2.2.

Table 2.2 Problematic, less recycled waste categories

Category of waste	Including
Construction and demolition	• Wood • Wallboard • Asphalt shingles • Flooring
Textiles	• Clothing • Fabrics • Carpets
Category of waste	**Including**
Paper products	• Magazines • Wax cardboard • Laminated boxboard • Milk cartons • Tetra Paks
Organic material	• Plastic lined boxboard • Waxed carboard • Animal waste
Household hazardous waste	• Disposable diapers • Hazardous fluid containers • Motor oil containers
Plastic	• Dairy and food packaging • Automotive fluids • Cleaners

2.2. NSHA Waste Streams

In this section, the different waste streams which the NSHA generates will be presented and discussed. Establishing a proper definition for waste will be derived from the CDC, EPA and CEPA. Using these definitions, a recommendation for a new waste policy will be created. As it currently stands, there is no waste policy in place. The NSHA follows standards procedures on waste disposal put in place by provincial and federal laws. A new waste policy has been in the works since the amalgamation of the NSHA and was supposed to be available in 2018. However, a waste policy has yet to be completed.

In this section, the presentation of each source of waste will be structured as follows:

- Definition
- Source segregation
- Central storage
- External transport and disposal
- Charges

Waste bins have slowly been transitioned to waste bins with four compartments. The compartments include general waste, organics, recyclables and paper.

2.2.1. General waste

Definition

General waste is non-medical and has no risk of contamination (Moayed, 2015). Like household waste, this form of waste ends up in the landfill. Examples of this form of waste is listed in Table 2.3 at the end of this section.

Source Segregation

General waste is stored in bins specifically labelled as landfill or general waste. These bins are filled with clear bags (City of Halifax, 2019), cannot weigh more than 25 kg. The bins are located in multiple areas throughout hospitals. Generally, they are located where foot traffic is most common (i.e. waiting areas, rooms and hallways).

Central Storage

Once general waste has been collected from the bins, they are moved towards each hospital's respective docking areas. In the docking areas, general was is sent to a compactor where it is crushed to reduce the volume. General waste is typically broken into two categories, large and small waste.

Large waste are items such as furniture, appliances construction and demolition waste. Normally, furniture and appliances are sent to an on-site handyman who will look at the items when they have a minute and attempt to fix them. If the repairs on the furniture and appliances is successful, then they are sent back to their respective departments or any new departments in need of new items. Non-repairable furnitures and appliances are sent to landfills. Due to the nature of construction and demolition, this form of waste was kept out of the study.

Small waste are garbage items that end up in the landfill with no further use. These items sit in a compactor in the hospitals receiving bay waiting to be picked up daily. In Halifax, receiving bays are not large enough to accommodate for multiple compactors. The compactors in the QE II have two compartments. One of the compartments is dedicated to general waste while the other is for cardboard. The reason for this type of compactor is due to the space restrictions.

External Transport and Disposal

REgroup is one of the main waste collectors who are contracted by the NSHA. They operate daily to collect general waste from the NSHA in the HRM. Additional waste streams which are collected by them are the cardboard, recyclables, large garbage bags and electronic waste (Moayed, 2015).

Charges

The charges by REgroup come from pick up, transportation, and the weight of waste. Furthermore, REgroup charges a rental fee for the compactor containers and a tipping fee per kilogram of waste.

2.2.2. Recyclables

Definition

Recyclable waste is non-medical waste which is capable of being reused. Common waste materials which have the potential to be reused can be recycled as raw materials, can reduce energy consumption, reduce pollution, reduce further pollution of water and landfills; reducing the need for waste disposal (International Journal of Waste Resources, 2019). In hospitals, recyclable waste is what consumers would discard into blue bags. This stream does not include cardboard. The disposal of blue bag recyclables follows each hospital's respective municipal waste procedure.

Source Segregation

In the hospitals, this stream of waste goes into a blue bin or goes into the recyclable compartment of the four sectioned bins in filled with clear blue bags. These bins are located throughout the hospitals, normally to be found next to the general waste stream bins.

Central Storage

Once the clear blue bags are gathered from the hospitals, they sit in a container in the loading bay of each of the respective hospitals.

External Transport and Disposal

The container in which blue bag recyclables are stored in is picked up by REgroup multiple times per week throughout the Halifax locations. The truck then delivers the blue bag recyclables to a recycling depot where the contents are dumped and separated. The requirement for multiple pickups throughout the week is due to the lack of space across all hospitals.

Charges

In the city of Halifax, the container in which the blue blag recyclables are stored in is rented out from REgroup. Cost further includes pickup and hauling of the waste. In its current state, there are no tipping fees associated with this waste.

2.2.3. Cardboard

Definition

Cardboard is usually heavy-duty or thick sheets of paper known for their durability and hardness (Conserve Energy Future, 2019). In the health care sector, recycling carboard is a challenge due to the space it takes up and the potential contamination it may come across. Cardboard is easily reused and recycled. Cardboard is also bulky and large. It has its own stream which goes through a different recycling process than blue bag recycling. Cardboard is normally used to package material which enters and exists the hospitals.

Source Segregation

Cardboard is one of the most common forms of waste and is placed aside for the sanitation staff to come by and pick it up.

Central Storage

Once picked up, the corrugated cardboard is taken to a compactor which is rented out by REgroup and compacted to reduce the volume. This container has a steel wall separating the cardboard and general waste compartments.

External Transport and Disposal

Since general waste and cardboard are both stored in the same container, they are both picked up by REgroup multiple times per week, however, cardboard does not get sent to the landfill.

Charges

Charges for recycling cardboard include renting the container in which the cardboard is stored. There are also pick up and transportation fees.

2.2.4. Organics

Definition

The organic waste stream is the stream in which compostable material are sent to. The organic material includes, but is not limited to, food, leaves and yard waste (grass clippings, etc.), and non-recyclable paper waste (Nova Scotia Environment, 2009). For this report, organic material will refer to waste which falls under the food waste. The main source of generation of this waste can be found at the hospitals' kitchens, cafeterias and patient rooms. This form of waste is no longer accepted into the general waste stream and therefore cannot be sent to the landfill under the Nova Scotia Waste-Resource Management Strategy (Nova Scotia Environment, 2009).

Source Segregation

Mainly found in the cafeterias and hallways, the waste bins which hold organic waste are normally green or are part of the multiple compartment waste bins with a compartment specifically dedicated to organic waste.

Central Storage

Once organic waste has been collected from the source, the bins are taken to a designated area where the green bins are stored. This area is located closer towards the outside of the buildings for health and sanitation purposes.

External Transport and Disposal

In HRM, REgroup handles the pickup and the transportation of this waste. The bins are picked up multiple times a week regularly and can be picked up more frequently depending on the volume of patients in the hospitals. For HRM, REgroup then takes this waste to Ragged Lake compost facility while other counties send their compost waste to facilities located closer.

Charges

REgroup charges a fee for pickup and handling, and transportation of waste. There are no tipping fees included in organic waste.

2.2.5. Biomedical Waste

Definition

Biomedical waste is anatomic and non-anatomic waste which poses risk to human health if dealt with improperly. Biomedical waste poses a threat by being potentially contaminated and therefore infectious. According to the CSA Group, biomedical waste shall be properly handled, treated, and disposed of in order to prevent environmental contamination and disease (CSA Group, 2015). Table 2.3 breaks down what form of waste is categorised as biomedical waste.

Table 2.3 Type of biomedical waste (CSA Group, 2015)

Category	Type of waste
Human anatomic waste	• Human tissues • Organs • Body parts
Animal waste	• All animal anatomic waste • Bedding contaminated with infectious organisms • Fluid, blood and blood products • Items saturated with blood • Body fluids removed for diagnosis or removed during surgery, treatment or autopsy
Non-anatomic waste	• Laboratory cultures • Stocks or specimen of micro-organisms • Human diagnostic material • Vaccines for human use • Disposable laboratory material that has come into contact with human blood or body fluid waste
Contaminated sharps	• Needles • Lancets • Laboratory glass that is broken or easily broken • Scalpel blades

Source Segregation

Biomedical waste is stored in yellow bins which carries yellow bags indicating hazardous waste which are provided in all clinical areas generating such waste. These storage sites are to be fully enclosed and used exclusively for biomedical waste. The biomedical waste bins and areas are labeled clearly to avoid mixing waste and increasing cost by disposing of general waste as biomedical waste (Capital Health, 2015). These bins are not allowed to be stored in hallways.

Central Storage

Once collected they sit in an area where the containers remain out of sight and the exteriors get cleaned to eliminate vectors and unsightly appearances. The yellow bags are stored in grey bins provided by Stericycle, a local company responsible for picking up the waste.

External Transport and Disposal

Stericycle collects this form of waste from the designated storage areas multiple times per week. Stericycle then takes the waste from the HRM hospitals to a biomedical waste treatment facility in Burnside Industrial Park.

Charges

Stericycle charges for pickup and handling of waste. There are no rental fees for the grey bins nor are there any tipping fees.

2.2.6. Sharps

Definition

Sharps are items which can puncture, penetrate or cut the skin and come in contact with body fluid and micro-organisms (CSA Group, 2015). This form of waste can also be classified as biomedical waste. As previously mentioned, this stream of waste contains needles, lancets, laboratory glass and scalpel blades.

Source Segregation

Sharps are stored in yellow containers throughout the hospital. Normally, hung up near a wall, sharps containers are found in washrooms and clinical areas. As a safety measure, sharps are not required to be considered infectious to be disposed of in this bin. However, sharps which are contaminated with cytotoxic material are stored in different containers due to their requirement for different disposal treatment.

Central Storage

The yellow containers are stored alongside the grey biomedical bins. The storage area is locked away from unauthorised personnel to avoid infection and the spread of disease.

External Transport and Disposal

Stericycle handles and disposes of the sharps waste stream. This stream is picked up alongside the biomedical waste stream. Stericycle replaces old containers with new ones and cleans the old ones.

Charges

Sharps containers are not rented. Therefore, the only charges for this stream of waste are the pick up and handling, and transportation fees.

2.2.7. Cytotoxic Waste

Definition

Cytotoxic waste are all materials used for the preparation and administration of cytotoxic drugs and the patient's excreta post administration of the cytotoxic drugs (Capital Health, 2014). A cytotoxic drug is an agent which possess the ability to destroy cells. These agents could be genotoxic, oncogenic, mutagenic, teratogenic or other hazardous mechanisms mainly used to treat cancer using chemotherapy. Cytotoxic waste poses extreme health concerns and must be handled in an extremely cautious manner.

Source Segregation

Cytotoxic waste is stored in containers with yellow bags in them or a sharps container both of which have a biohazardous symbol on them.

Central Storage

Once collected, cytotoxic waste is separated from other waste and locked. Only authorised personnel with the proper personal protective equipment can access this area. The locked off area must be properly labeled to avoid other waste from being stored in the same area.

External Transport and Disposal

Cytotoxic waste is handled by Stericycle. Stericycle will collect the waste and take it to be incinerated. The handling and transportation of cytotoxic waste is done in accordance to the Transportation of Dangerous Goods Act and Regulations regulated by the Canadian Council of Ministers of the Environment (CCME).

Charges

Stericycle charges the hospitals for transportation and handling of waste. There are no tipping fees included.

2.2.8. Pharmaceutical Waste

Definition

Pharmaceutical waste include both prescribed and nonprescribed drugs. As of the recent policies, pharmaceutical waste fall under the same definition as biomedical waste and are handled in the same manner with the same precautionary measures.

Source Segregation

Pharmaceutical waste is stored in white receptacles in areas where this stream of waste is generated.

Central Storage

Once collected, the receptacles are stored in a biohazardous room separate from the biohazardous waste. The room must be properly labeled and sealed to avoid mixture of waste.

External Transport and Disposal

Stericycle also handles this type of waste. Once the receptacles are picked up, they are replaced by Stericycle. Stericycle then takes the waste to be incinerated.

Charges

Stericycle charges for pick up and transportation of pharmaceutical waste alongside its other pickups. There are no tipping fees included for this type of waste.

2.2.9. Confidential Papers

Definition

Confidential papers are any documentation which contains a patient name, medical condition or treatment. This stream of waste includes, but is not limited to, medical reports, addressograph cards and labels, and any items which may have addressograph information, such as IV bags and pill bottles. Furthermore, this stream of waste includes items that the hospital administration identifies as having confidential information. This includes staff performance evaluations, payroll and benefits (Capital Health, 2014).

Source Segregation

Confidential papers are stored separately from other waste sources. If the waste is of paper, the waste is placed in receptacles capable of shredding the documentation to avoid information leaks. If the waste source is made of medical waste, then it is placed in yellow bags inside receptacles indicating biohazardous waste.

Central Storage

Paper waste is collected and stored in locked bins inside of a locked area where only authorised personnel are allowed access.

External Transport and Disposal

Shred-it, the external vendor hired to handle confidential paper waste, comes by and picks up the waste from the locked areas in the hospitals and destroys the papers accordingly.

Charges

Shred-it charges the hospitals based on their standard pick up fees and on the type of receptacles the waste is stored in. The charges are mainly based on the number of receptacles picked up and their size.

2.2.10. Electronic Waste

Definition

Electronic waste is defined as various forms of electric and electronic equipment which no longer serve a purpose to their original owner (Gill, 2016). This form of waste includes computers, televisions, refrigerators and the like. In the HRM, many recycling depots do have the capabilities to recycle waste, however, there is no contract currently in place. In its current state, electronic waste ends up in a landfill.

Source Segregation

Electronic waste is located throughout the hospital and when it is no longer useful, the items normally remain in their location until replaced. If the user of the equipment is receiving an upgrade, the electronic technology is rehomed within the hospital. If not, the waste is taken to a dump site within the hospitals.

Central Storage

Electronic waste is separated from the general waste stream and is placed in a bin of its own near the loading bay where general waste is kept. The receptacle is similar to the receptacle which carries general waste.

External Transport and Disposal

REgroup collects electronic waste and takes it to Otter Lake for e-waste collected in HRM and other landfills for the remaining counties.

Charges

REgroup charges for collection, handling and disposal of waste. Since the waste goes to the landfill, there is a tipping fee included.

2.2.11. Chemical Waste

Chemical waste is defined as the waste generated in laboratories which include expired solid, liquid or gaseous waste which contain hazardous material. It is a minor stream in the list of NSHA waste streams. Chemicals are handled on a per compound basis. Some of the waste may be recycled while others may be stabilized and end up in the landfill.

2.2.12. Batteries

Batteries are another minor stream in the list of NSHA waste streams. Batteries contain toxic chemicals and cannot be landfilled. Therefore, batteries are recycled by being sent to battery recycling facilities. Currently, batteries are recycled through call2recycle by Grand & Toy which will ship a battery recycling box containing a pre-paid Purolator shipping label. Once the box is full and sent back to call2recycle, a new box can be ordered for new batteries. The program is free of charge. If the batteries' weight exceeds 227 kg, a bulk program is ordered instead.

2.2.13. Paints

Paints are a minor waste stream from the NSHA. If repainting is to be done, the old paint can be recycled and turned into new paint to avoid being sent to the landfills.

2.2.14. Pressurized Containers

While pressurized containers may pose risk of explosion, this waste stream is sent to the landfill. The pressurized containers are inspected to ensure they are empty to avoid any incidents from happening.

2.3. Problem Identification

This purpose of this report is to review and identify any outlying issues in the NSHA's current waste streams and to present possible solutions to the problems identified. Currently, the NSHA operates under standard operating procedures. Some of these procedures are out of date. After meeting with the Central Zone- Facility Support Manager, it was determined that introducing a new policy was out of scope for this study.

To divert waste from the landfill, an analysis on the current systems must be done. Furthermore, a new policy must be put in place. With the amalgamation of the NSHA occurring recently, a general policy will help standardise procedures across the province rather than operating on individual hospital standard operating procedures.

In this report a review of the standard operating procedures will be performed. A general policy with new waste terms to minimise ambiguity and misuse of bags will be introduced. Finally, a case study on whether it is worth diverting EPS from the landfill will be performed. The case study will cover the environmental impacts of landfilled EPS, the benefits of diverting this waste, and the cost of diverting EPS.

Chapter 3: Literature Review

Nova Scotia is one of the leading provinces in the diversion of waste from landfills and incinerators. According to Statistics Canada, in 2014, 148.8 kgs per person of waste was diverted falling behind to only Prince Edward Island, British Columbia and Ontario at 215.8, 153.1, and 149.9 kgs of waste diverted per person, respectively. The amount of waste diverted in Nova Scotia puts the province above the national average of waste diverted at 135.1 kgs per person (Statistics Canada, 2019). In 2016, 375,258 tonnes of waste were disposed of. 205,472 tonnes of that came from non-residential sources which includes hospitals, government facilities, seniors' homes, and other sources (Stats Canada, 2019).

Inappropriate medical waste disposal and the fear of acquired immunodeficiency syndrome have drawn attention to medical waste management practices (Rutala, Odette & Samsa, 1989). In 1987, the Centre for Disease Control's announcement attempting to reduce the transmission of human immunodeficiency diseases increased the general population's sensitivity to the general population's medical refuse (Tieszen, James & Gurenberg, 1992). In 1976, The US Congress charged the Environmental Protection Agency with the regulation and management of infectious waste (Rutala, Odette & Samsa, 1989).

In countries such as the United States, 75 – 100% of solid medical waste is incinerated (Moayed, 2015) (Chaerul, Tanaka & Shekdar, 2007). The environmental impact of burning such a large amount of waste is extremely harmful on the environment and is cost inefficient. Of the total solid medical waste generated in hospitals, approximately 10 – 15% of waste generated is infectious and only 1-2% of that waste requires incinerating (Moayed 2015). In Ontario, approximately 150,000 tonnes of solid waste were produced annually. Ten percent (10%) of waste produced was classified as biomedical despite only 6.1% of waste being biomedical waste.

A common strategy used to tackle waste across all sectors has been reduce, reuse and recycle, also known as the "3Rs". Due to the rising concerns with bloodborne diseases, a shift from reusable equipment to single use equipment was done in the 1980s. This shift caused an increase in waste produced in hospitals. In 2008, Canadian hospitals were the second most energy intensive activity in the commercial and institutional sectors (Kagoma, Stall, Rubinstein & Naudie, 2012). As a result of the study, it was found that the sector generated about 1.46% of Canada's total greenhouse gasses. Furthermore, in 2001, Canada was the source of 1% of total solid waste (Kagoma, Stall, Rubinstein & Naudie, 2012). In 2007, US healthcare facilities contributed 8% of total greenhouse gas emissions, disposing of more than 4 billion pounds of waste and were the second largest contributors to landfills (Kagona, Stall, Rubinstein & Naudie, 2012). In a different study performed by Tieszen, James & Gruenberg, it was found that drapes, wraps and gowns in use at US hospitals were of the disposable type. The removal of this waste plus paper and recyclable plastic lead to a 93% reduction in waste in the general waste stream (Tieszen, James & Gruenberg, 1992).

In an effort to improve the health of patients, Canadian hospitals have detrimentally affected the health of the environment. In 2009, the World Health Organization released a statement emphasizing the responsibilities the healthcare sector has towards better environmental sustainability (Kagoma, Stall, Rubinstein & Naudie, 2012). Although operating rooms occupy a small section of hospitals, they generate anywhere between 20 – 33% of the waste produced in the healthcare sector. Furthermore, waste generated in operating rooms are considered to be infectious and therefore go through high-energy and high cost waste disposal methods (Kagoma, Stall, Rubinstein & Naudie, 2012). Targeting operating rooms when attempting to reduce waste footprint would result in a high-yield change. Operating rooms require a lot of energy and a huge part of the budget to maintain. In 2009, operating rooms required 5.9% of the hospital budgets and it is estimated that 47 – 56% of the allocated budget is dedicated towards new material (Kagoma, Stall, Rubinstein & Naudie, 2012). The main challenge when it comes to greening the operating room is the need for absolute sterility. A potential solution to the need for sterility could be the introduction of two new Rs to the 3R concept: rethink and research (Kagoma, Stall, Rubinstein & Naudie, 2012).

Reduce, reuse, recycle, rethink and research, a strategy covered by Kagoma et al. in an attempt to tackle operating room waste. In reducing waste, proper waste segregation is imperative. Waste in an operating room can be broken down into two main waste streams, normal solid waste and regulated medical waste. Normal solid waste is sent to the landfill while regulated medical waste would require high-energy processing. As previously mentioned, as much as 85% of solid waste is nonhazardous waste. Up to 85% of the solid waste is safe enough to be disposed of in the landfill. Unfortunately, it is not and instead the solid waste is disposed of as biohazardous waste. Inappropriate segregation of waste increases the amount of waste being sent through the costly, energy intensive waste disposal method such as autoclaving and incineration (Kagoma, Stall, Rubinstein & Naudie, 2012). To better promote waste segregation, hospitals can introduce proper waste receptacles in operating rooms and properly educate staff on waste disposal policies.

Other areas of reducing waste come from fluid waste management, reusable sharps containers, the energy expenditure, medical equipment packaging and reducing overage. Fluid disposal in the operating rooms occurs by pouring fluids into wastewater streams, collecting fluids in surgical suction canisters and disposing of them as biohazardous waste or mixing the fluid with solidifiers and disposing of them in the regular waste stream (Kagoma, Stall, Rubinstein & Naudie, 2012). Manual disposal of fluids into wastewater is an occupational hazard as workers are exposed to infectious fluids. Closed collection systems, which collect fluids at their creation and then directly discharge them into a sanitary sewer have been shown to reduce workplace exposure while facilitating fluid disposal (Kagoma, Stall, Rubinstein & Naudie, 2012). The closed collection systems require an upfront capital investment; however, they can dramatically reduce the amount of infectious waste requiring high-energy processing.

Sharps are extremely common in the operating room. Sharps have transitioned to single use as a protective measure. The implementation of a reusable sharps' container produces less waste and decreases the cost of waste disposal over their lifetime (Kagoma, Stall, Rubinstein & Naudie, 2012). Due to the transition from reusable to single use equipment in the operating rooms, medical equipment waste generation has increased as a result. One of the main contributors to this form of waste is plastic with which some equipment are double wrapped (Kagoma, Stall, Rubinstein & Naudie, 2012). The other main contributor to this form of waste is blue sterile wrap. Blue sterile wrap contributes to approximately 19% of all waste generated from the operating rooms (Kagoma, Stall, Rubinstein & Naudie, 2012). Blue sterile wrap is not reusable and an alternative such as reusable hard metal cases to facilitate organization of equipment would greatly reduce waste generated (Kagoma, Stall, Rubinstein & Naudie, 2012).

The issue with transitioning to single use equipment is the overage produced from using the equipment. Manufacturers produce packages which are "surgery ready". These packages contain equipment which may or may not be used during the surgery. However, since the seal on the equipment has been broken, the unused items must be discarded alongside the used items (Kagoma, Stall, Rubinstein & Naudie, 2012). A study performed by the United States in 1993 found overage from 14,719,000 surgeries resulted in a loss of $125,000,000 (Kagoma, Stall, Rubinstein & Naudie, 2012).

The process of reusing in the operating rooms involves making single use devices suitable for reuse. In Canada, in a survey of 398 hospitals, it was found that only 28% of the hospitals reported the reprocessing of single use devices (Kagoma, Stall, Rubinstein, & Naudie, 2012). Reprocessing single use devices assists in diverting waste from landfills and would help reduce in cost. A potential incentive for reusable material in the operating room would be allowing hospitals to buy back reusable material at 50% of the original cost (Kagoma, Stall, Rubinstein, & Naudie, 2012). Another avenue in which reusing could help reduce both waste and cost are the surgical linens used in the operating rooms. Surgical linens, a term used for gowns, drapes, and table covers, contribute to 2% of hospital waste (Kagoma, Stall, Rubinstein & Naudie, 2012). In earlier life cycle analyses run on single use vs. reusable surgical linens, the environmental and cost reductions results were conflicting. However, in a more recent study performed by Conrardy et al. (2010), reusable surgical linens were far superior to single use linens.

During surgery, a high volume or plastic waste is generated. Collection containers designated for plastics would help reduce the waste generated by allowing for the plastic to be easily collected. Recycling waste generated from the operating room can be implemented on more than just the plastic generated. Paper, cardboard and metal are also materials generated in the operating rooms which are suitable to being recycled (Kagoma, Stall, Rubinstein & Naudie, 2012). Hospitals have achieved as high as 40% of total waste being recycled instead of being landfilled and have resulted in substantial savings (Kagoma, Stall, Rubinstein & Naudie, 2012).

Rethinking the way of disposing of single use items means finding alternatives to current solutions. While incineration is an efficient method of waste disposal, it extremely costly and harmful to the environment. By-products of incineration include nitrous oxide as well as known carcinogens like polychlorinated biphenyls, furans and dioxins (Kagoma, Stall, Rubinstein & Naudie, 2012). Exposure to the by-products have been linked to decrease in fetal weights, hormonal alterations, infertility, and the acidification of soil and aquatic environments (Kagoma, Stall, Rubinstein & Naudie, 2012) (Melamed A., 2003) (Singh & Agrawal, 2008) (Badr & Probert, 1993). In Kagoma et al., 2012, possible alternatives to incineration to treat medical waste are any thermal, chemical irradiative or biological approaches.

Anesthetic gas is a common method of making a patient unconscious, however, only 5 – 20% of the gas delivered to the patient is metabolized (Kagoman, Stall, Rubinstein & Naudie, 2012). The unused gas is then released into the atmosphere. The effects of releasing unused anesthetic gas is approximately 2000 times worse than the effects of released carbon dioxide (Kagoma, Stall, Rubinstein & Naudie, 2012) (Blue-Zone Technologies, 2005) (Doyle, Byrick, Filipovic et al., 2002). Reprocessing of anesthetic gas to has been proven to reduce cost, waste and the environmental impact. This has been proven in the Sunnybrook Health Sciences Centre in Toronto over a five-year analyses period (Kagoma, Stall, Rubinstein & Naudie, 2012).

Researching for greener methods of disposal of waste and better operation of hospitals is necessary. Bringing rigorous and evidence based approached to new technology is imperative for the legitimacy of new methods and technology. A way of verifying new research is by performing life-cycle analyses of materials, cost comparisons and development of devices which minimise environmental effects (Kagoma, Stall, Rubinstein & Naudie, 2012). Table 3.1 breaks down the strategy into its elements in an operating room.

Table 3.1 Operating room elements and the recommended method to reduce waste

Element	**Methodology in reducing waste**
Reduce	• Proper waste segregation • Reusable sharps container • Fluid waste management • Energy Expenditure • LED surgical lamps • Greener equipment packaging • Reusable hard case • Just-in-time model to reduce overage
Reuse	• Reprocessing of single-use devices • Reusable surgical lines
Recycle	• Recycle clean plastic and paper
Rethink	• Anesthetic gas reclamation

Element	Methodology in reducing waste
Research	• Life cycle analyses of materials, cost comparison, of technologies and development of “green” devices

It is reported by the World Health Organization (WHO) that the generation of waste is directly proportional to the hospital’s income level and the hospital’s medical solid waste generation (Chaerul, Tanaka & Shekdare, 2007). It is common to find a three-container system employed in hospitals, a yellow container for infectious waste, black bag for general waste, and a container for sharps. As previously mentioned, incineration may not be the best method of disposing waste with regards to the environment. Incineration is also a costly method of disposing waste. However, it yields good results in ridding waste of infectious elements. Currently, incineration is used to treat any infectious, anatomical, sharps, pharmaceutical, cytotoxic, chemical and low-level radiative wastes. When non-infectious waste is improperly disposed of and is incinerated, it increases the cost of waste disposal.

Waste is normally improperly disposed of when there is a lack of compliance. Lack of compliance stems from multiple different reasons such as staff’s unwillingness to participate, lack of motivation, lack of proper training and education. Furthermore, waste treatment is not a profitable business (Mato & Kassenga, 1997) (Askarian, Vakili, & Kabir, 2004) (Chaerul, Tanaka & Shekdar, 2007). Recently, there has been more pressure added onto hospital management to develop a sustainable plan for waste. However, the process of planning a waste management system is a complex one. Dealing with the health and environmental impacts of waste further add to the complexity (Chaerul, Tanaka & Shekdar, 2007).

Lack of proper separation of waste comes from how much ambiguity is allowed within the definition of the types of waste generated in the hospital. A comparison in Europe done by Muhlich, Scherrer and Daschner found of the countries studied, only one did not have ordinances regulating the classification and disposal of hospital waste (Muhlic et al., 2003). Across these countries, three countries stored infectious waste in a rigid container used for both internal and external transport. In countries where there was not a lot of waste generated, waste was collected in plastic bags. The common method of waste disposal the hospitals used once the waste left the facilities is incineration. For the hospitals which did not have access to an incinerator, infectious waste would be sterilized at another hospital using an autoclave. A tendency was found across the hospitals to label all waste as infectious waste (Muhlic et al., 2003). Due to lack of proper separation from improper labelling of waste, disposal of hospital waste is much more expensive than the disposal of domestic waste. For perspective, it costs the city of Barcelona approximately 2000 Euros per tonne to dispose of hospital waste in comparison to the 50 Euros per tonne for domestic type waste (Muhlic et al., 2003).

Improper segregation of waste stems back to the inappropriate definition of waste. The terms hospital waste, medical waste and infectious waste are incorrectly used as synonyms leading to inappropriate segregation. Rutala et al., 1989 suggested new definitions for hospital, medical and infectious waste. Hospital waste should refer to all solid waste – biological or nonbiological – which is discarded without any intention for further use. Medical waste should refer to material generated as a result of patient diagnosis, treatment or immunization. Finally, infectious waste should refer to waste which could transmit an infectious disease (Rutala, Odette & Samsa, 1989). In the United States, Rutala et al., 1989 concluded that infectious waste made up a median of 15% of total hospital waste generated. For waste not listed by the Centres for Disease Control and the Environmental Protection Agency as infectious, such as surgical, pediatric, obstetric, patient waste and examination room waste, non-respondents (poll takers who did not feel confident in their knowledge of the topic) classified the waste as infectious more than the respondents. Furthermore, US hospitals generally treated items containing secretions or excretions as infectious and would dispose of it using incineration or by steam sterilization (Rutala, Odette & Samsa, 1989).

In another article by Makajic-Nikolic et al. (2016), Komilis et al. (2012), Nwachukwu et al (2013). and the World Health Organization (2013), the definition of medical waste includes "needles and syringes to soiled dressings, body parts, diagnostic samples, blood, chemicals, pharmaceuticals, medical devices and radioactive materials". Where medical waste can "potentially expose healthcare workers, waste handlers, patients and the community at large to infection, toxic effects and injuries". Furthermore, they state the definition of infectious waste must comply with the State and Federal regulation and definitions. The World Health Organization defines infectious waste as "waste which contains potentially harmful micro-organisms which can infect hospital patients, health-care workers and the general public (Makajic-Nikolic, Petrovic, Belic, Rokvic, Radakovic, and Tubic, 2016).

Definitions lead to different waste categorization and the implications of broad definitions are significant. While the generation of onsite waste is increasing, the options for waste treatment are decreasing. This is owing in part to restrictions on incineration and landfills banning treated infectious waste. Furthermore, how infectious waste is defined greatly affects cost and how hospitals treat waste based on existing policies.

The Centres for Disease Control and the Environmental Protection Agency have guidelines on what waste should be designated as infectious. Table 3.2 covers the sources of medical waste and whether they should be considered infectious. Furthermore, Table 3.3 covers the recommended disposal method of infectious waste by the respective agencies.

Table 3.2 Waste source and whether the waste is defined as infectious

Source/Type of Medical Waste	**CDC**	**EPA**
Microbiological	Yes	Yes
Blood and blood products	Yes	Yes
Pathology	Yes	Yes
Sharps	Yes	Yes
Communicable disease isolation	No	Yes
Contaminated laboratory	No	Optional
Surgery	No	Optional
Autopsy	No	Optional
Dialysis	No	Optional
Contaminated equipment	No	Optional
Items contacting secretions or excretions	No	No
Intensive care	No	No

Source/Type of Medical Waste	CDC	EPA
Emergency department	No	No
Surgery patients	No	No
Obstetric patients	No	No
Pediatric patients	No	No
Treatment/examination room	No	No
All patient related	No	No

Table 3.3 Recommended methods of waste disposal as outlined by the CDC and the EPA

	CDC		EPA	
Source/Type of medical waste	Infectious Waste	Disposal/Treatment Methods	Infectious Waste	Disposal/treatment Methods
Microbiological	Yes	Steam sterilization and incineration	Yes	Steam sterilization, incineration, thermal inactivation, and chemical disinfection
Blood and blood products	Yes	Steam sterilization, and sanitary sewer	Yes	Steam sterilization, incineration, sanitary sewer, and chemical disinfection
Pathological	Yes	Incineration	Yes	Incineration, steam sterilization with incineration or grinding, and cremation or burial by mortician
Sharps	Yes	Steam sterilization and incineration	Yes	Steam sterilization and incineration
Communicable disease isolation	No	-	Yes	Steam sterilization and incineration
Contaminated animal carcasses, body parts and bedding	Yes	Steam sterilization and incineration (carcasses)	Yes	Incineration and steam sterilization with incineration or grinding (not bedding)

	CDC		EPA	
Contaminated laboratory waste	No	-	Optional	If considered infectious waste, steam sterilization or incineration
Surgery and autopsy wastes	No	-	Optional	If considered infectious waste, steam sterilization or incineration
Dialysis unit	No	-	Optional	If considered infectious waste, steam sterilization or incineration
Contaminated equipment	No	-	Optional	If considered infectious waste, steam sterilization or incineration

Of the hospitals studied in this article, only 2% reported disposal of infectious waste in a sanitary landfill without rendering the waste non-infectious (Rutala, Odette & Samsa, 1989). In the Resource Conservation and Recovery Act of 1976, hazardous waste is defined as "solid waste, or a combination of solid wastes, which because of its quantity, concentration, or physical, chemical or infectious characteristics may a) cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or b) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise" (Rutala & Sarubbi, 1983). Most hospitals in the United States, considered blood, isolation, laboratory, pathology, and autopsy waste as infectious. A recommended method for disposal of waste by the EPA and the CDC is covered in Table 3.4. None of the hospitals in the United States employed a water-pulping transport system (Rutala & Sarubbi, 1983).

Hospitals tend to label infectious waste differently. In the study performed by Rutala and Sarubbi (1983), it was determined the average number of waste categories across hospitals was seven. The categories generally included: laboratory, isolation, pathological, blood, operating room, microbiological, and items containing secretions. The seven waste categories are generally disposed of using the common methods of waste disposal. Incineration, sanitary landfills and grinders are among the major methods of waste disposal across United States hospitals. Across the three types of waste disposal methods, there are different advantages and disadvantages to using each of the methods.

Needle choppers are not recommended environmentally. Mainly, needle choppers potentially aerosolize microorganisms during the chopping process. Furthermore, it is less expensive to not chop or clip sharps. Finally, needle choppers may become contaminated with hepatitis B infection. Compactors were only used by one third of all the US hospitals. Compactors reduce the volume of waste generated and subsequently reduce the cost of transportation (Rutala and Sarubbi, 1989).

Infectious waste has negative impacts on human health. With the abundance of infectious waste in hospitals improper disposal leads to potential diseases. Makajic-Nikolic et al. (2016) have listed some of the potential diseases in which may appear from coming in contact with infectious waste. The list of potential waste is highlighted in Table 3.6.

Table 3.4 Recommended disposal method and treatments

Source	**Container**	**Needle recapped before disposal**	**Disposal/Treatment method**	**Comments**
		EPA		
Hospital and other generators	Rigid, puncture proof	No	Steam Sterilization	• After treatment, these items should be rendered non-usable by baking, compaction or grinding • Contaminated needles should not be broken or clipped unless the clipping device contains the aerosols
Source	**Container**	**Needle recapped before disposal**	**Disposal/Treatment method**	**Comments**
		CDC		
Hospitals	Rigid	No	General hospital solid waste	-
Hepatitis case	Labeled, impervious, puncture-resistant	No	Incineration, steam sterilization	• Needles should not be purposely bent or broken by hand

Immuno-chemistry lab	Labeled, impervious, puncture-resistant	No	Incineration, steam sterilization	• Needle nippers should not be used • Needles should not be purposely bent or broken by hand
JCAH				
Hospitals	Puncture-resistant	Not indicated	Not indicated	-

Table 3.5 Advantages and disadvantages to disposing of waste using incineration, a sanitary landfill or grinders

	Incineration	Sanitary Landfill	Grinders
Advantages	• Destroys most potential disease-causing organisms. • Usable energy may be generated. • 80% weight reduction. If on-site: • Reduces transportation cost. • Reduces volume of waste that needs to be stored before transfer to landfill.	• Inexpensive. • Class A landfill (covered with earth daily) should not be a public health hazard.	• Immediate removal of waste from the. environment • No need for storage or transport. • Labor savings due to decreased solid waste handling. • Reduction in odors.

	Incineration	Sanitary Landfill	Grinders
Disadvantages	• Expensive initial investment and maintenance cost. • Must meet federal and local air pollution standards. • Residue or ash requires disposal	• Many landfills are refusing to accept hospital solid waste due to the perceived risk associated with hospital waste. • Potential for fire and water (ground and surface) contamination if improperly located and operated. • Potential storage problem before disposal. • Some infectious waste may require sterilization before landfill disposal.	• Sometimes prohibited because of increased organic load on sewerage system. • Major use is for kitchens in health care facilities. • Noise, vibration, jamming of grinder and blocking of the drain line. • Possible microbial aerosol generated during use. • Limited applicability for certain combustible and non-combustible waste.

Table 3.6 List of waste which may be considered infectious

Waste	Way of infection	Diseases
Feces	Fecal-oral-intestinal, food, water, insects, polluted hands	Salmonellosis, shigellosis-dysentery, hepatitis A, enterocolitis (viral and bacterial), parasitic diseases
Dust	Respiratory – drip, inhalation	TBC, pneumonia (viral and bacterial)

Waste	Way of infection	Diseases
Blood, body liquids	Systems for infusion, transfusion, injuries of the skin and mucous freshly contaminated waste	AIDS, hepatitis B and C
Pus	Contact food	Skin infections, toxiinfectie alimentara
Genital secretions	Contact with fresh contaminated waste	Herpes genitalis, candidiasis, chlamydia
Liquor	Syringe, needle vessels	Meningitis (viral and bacterial)
Urine	Contaminated objects, water, food	Urinary infections
Blades	Injury	Hepatitis B and C, AIDS, pyodermas
Unsaturated and mixed medical waste	Flies, cockroaches, mice, rats, birds, stray dogs and cats	Urinary tract infections, injury

Hospitals routinely dispose of up to 70% of their waste into the biohazardous stream despite most of the waste being similar to office waste – mostly paper, cardboard and food waste (H2E, 2019). Improper disposal of waste drastically increases the cost of waste disposal, the cost of disposal sometimes increases 10-fold. Hospitals for a Healthy Environment, a group founded by the American Hospital Association, American Nurses Association, Health Care Without Harm, and the U.S. Environmental Protection Agency, joined together to help healthcare facilities reduce environmental impact while saving money and reducing liabilities (H2E, 2019). Hospitals for a Healthy Environment came up with a 10-step strategy to reduce regulated medical waste highlighting the most opportune areas to reduce weight come from eliminating coffee cups, packaging, paper towels, clean blue wrap and pizza boxes which get tossed in biohazardous waste streams.

The 10-step methodology created by Hospitals for a Healthy Environment for reduction in regulated medical waste is as follows (H2E, 2019):

1. Understand regulated medical waste definitions.
    a. The proper removal of liquids may cut infectious waste stream in half.

   b. OSHA's definition on regulated waste: "Regulated Waste means liquid or semi-liquid blood or other potentially infectious materials; contaminated items that would release blood or other potentially infectious materials in a liquid or semi-liquid state if compressed; items that are caked with dried blood or other potentially infectious materials and are capable of releasing these materials during handling; contaminated sharps; and pathological and microbiological wastes containing blood or other potentially infectious materials.

2. Define the problem and develop a cost/benefit analysis.
   a. How much regulated medical waste is generated?
   b. Total disposal costs?
   c. Potential savings?
3. Create a team to develop goals and an action plan.
   a. Create a team from housekeeping, infection control, nursing, safety, facilities, education, purchasing, laboratory and clinicians.
   b. Make goals measurable.
4. Planning for waste segregation.
   a. Work with department heads and nurses to determine the volume generated in the different sections of the hospitals.
   b. Survey the facilities to determine proper waste needs.
   c. Purchase required containers and signage based on departmental needs.
5. Container placement and signage.
   a. Red (yellow) bag containers should be covered to reduce casual solid waste disposal.
   b. Develop proper signage clearly indicating what waste can be disposed of in each receptacle.
   c. Remove red (yellow) bags from non-critical care patient areas where people are like to dispose of their solid waste in regulated medical waste containers.
   d. Locate regular waste containers next to infectious waste containers.
6. Worker training and education plans and policies.
   a. Train new employees on proper waste disposal methods.
   b. Retrain staff on agreed upon definition of regulated medical waste.

c. Work with administration to hold department heads accountable for cost associated with regulated medical waste disposal. Make these numbers part of annual review.

7. Sharps management.
   a. Consider using a reusable sharps container.
8. Problem identification and resolution plan.
9. Waste treatment and hauling.
   a. Understand how waste is being treated and consider the treatment technologies.
   b. Consider minimization of technologies such as incineration or reduce the amount of waste incinerated.
10. Track your progress, report success and reward staff.

Furthermore, 11 recommendations for improving medical waste management provided by the Technical Working Group of the Basel Convention help provide specific planning and action programs within the municipal government followed by the individual health care facilities to improve waste segregation (Basel Action Network, 1999).

1. Clearly define the problem.
   a. Waste streams in the United States from medical facilities is broken into three major categories:
      i. Hospital waste: all waste generated from a facility.
      ii. Medical waste: waste generated as a result of patient diagnosis, treatment, or immunization of human beings or animals.
      iii. Potentially infectious waste: the portion of medical waste that has the potential to transmit an infectious disease.
2. Focus on segregation first.
   a. Follow segregation protocols and infrastructure to reduce risk to the workers directly in contact with the waste and the risk to general public:
      i. Accidental exposure from contact with wastes at municipal disposal bins.
      ii. Exposure to chemical or biological contaminants in water.
      iii. Exposure to chemical pollutants from incineration of the wastes.
   b. Hospitals are burning waste or dumping waste in municipal bins which are transported to unsecure dumps.

    c. Imposing segregation practices will result in a clean solid waste stream which can be easily, safely and cost-effectively managed through recycling, composting and landfilling the residues.
    d. Proper segregation is achieved through training, clear standards, and tough enforcement, resources and be turned to the management of the small portion of the waste stream needing special treatment.
3. Institute a sharps management system.
    a. Segregation of sharps in rigid, puncture proof containers which are then monitored for safe treatment and disposal.
    b. Proper sharps management reduces the risk of disease transmission from medical waste.
4. Keep focused on reduction.
    a. Hospitals in the third world produce much less waste than hospitals in the United States.
    b. Phasing out mercury-based products and technologies would benefit waste management.
5. Ensure worker safety through education, training and proper personal protective equipment.
    a. Properly educating all staff from doctors to labourers to ensure an understanding of the risk the waste poses, how to protect themselves and how to manage the waste.
6. Provide secure collection and transportation.
    a. Taking into account the containers are equipment post waste disposal.
7. Require plans and policies.
    a. To ensure continuity and clarity, proper waste policies should be developed for the proper management and disposal of wastes. This should be integrated into employees' everyday routine.
8. Invest in training and equipment for reprocessing of supplies.
    a. Disposables are costly, increase waste generation and do not necessarily provide for decreases in infection rates in hospitals.
9. Invest in environmentally sound and cost-effective medical waste treatment and disposal technologies.

a. The rush to incinerate material worldwide as a solution to a problem not properly defined is an injustice to the community, the public health of its people and the environment.
b. Ash generated from incineration of medical waste is tainted with heavy metals and toxic residues.
c. Other treatment technologies such as autoclaving, hydroclaving, microwaving and chemical disinfection pose less of a risk to the general public and contaminate water sources rather than air if improperly operated.

10. Develop an infrastructure for the safe disposal and recycling for hazardous materials.
11. Develop an infrastructure for safe disposal for municipal solid waste.

Table 3.7 Methods of disposal and recycling for hazardous waste

Hazardous Material	**Point of generation**	**Point of use and disposal**	**Common disposal**
Chemotherapy and antineoplastic chemicals	Prepared in central clinic or pharmacy	• Patient care areas • Pharmacy • Special clinics	• Incineration as regulated medical waste • Disposal as hospital waste
Formaldehyde	• Pathology • Autopsy • Dialysis • Nursing units	• Pathology • Autopsy • Dialysis • Nursing units	Diluted and flushed down sanitary sewer
Photographic Chemicals	• Radiology • Satellite clinics offering radiology services	• Radiology • Clinics offering radiology services	• Developer and fixer are often flushed down sanitary sewer • X-ray film is disposed of as solid waste
Solvents	• Pathology • Histology • Engineering • Laboratories	• Pathology • Histology • Engineering • Laboratories	• Evaporation • Discharged to sanitary sewer
Mercury	• Throughout all clinical areas in thermometers, blood pressure	• Clinical areas • Labs	• Broken thermometers are often disposed in sharps containers • If no spill kits are available, mercury is often

	cuffs, cantor tubes, etc. • Labs		disposed of as regulated medical waste or solid waste • Often incinerated
Hazardous Material	**Point of generation**	**Point of use and disposal**	**Common disposal**
Ethylene oxide	• Central sterile reprocessing • Respiratory therapy	• Central sterile reprocessing • Respiratory therapy	• Vent exhaust gas to the outside
Radio muclides	Radiation oncology	Radiation oncology	Vent exhaust gas to the outside
Disinfecting cleaning solutions	Hospital-wide environmental services, facilities management, operating theater	• Diagnostic areas • Operating theater • Facilities management	• Dilution, disposal in sewer
Maintenance: • Waste oil • Cleaning solvents • Leftover paints • Spent florescent lamps • Degreasers • Paint thinner • Gasoline	Maintenance	Maintenance	• Solid waste • Sewer

Incinerating waste is an effective method of disposing of infectious waste, however, incineration does have impacts on the health of the handlers and the communities surrounding the incineration sites. Once waste is incinerated, the ashes continue to remain infectious. In the past, performance of incineration sites has been quite poor (Giusti, 2009). The main pathway for exposure to the infectious elements of the incinerated ash is through inhalation, consumption through water, the food chain and land spreading of sewage and manure (Giusti, 2009). Furthermore, alongside the harmful emissions, greenhouse gasses such as carbon dioxide, methane and nitrous oxide are released during incineration. The environmental impacts of solid waste management are highlighted in Table 3.8.

Table 3.8 Environmental impacts of solid waste management

	Water	Air	Soil	Landscape	Climate
Activity					
Landfilling	Leachate (heavy metals, synthetic organic compounds)	CO_2, CH_4, odour, noise, VOCs	Heavy metals, synthetic organic compounds	Visual effect, vermin	Worst option for greenhouse gases emission
Incineration	Fall-out of atmospheric pollutants	SO_2,NO_x, N_2O, HCl, HF, CO, CO_2, dioxins, furans, PAHs, VOCs, odour, noise	Fly ash, slags	Visual effect	Greenhouse gases
Composting	Leachate	CO_2, CH_4, VOCs, dust, odour, bioaerosols	Minor impact	Some visual effect	Small emissions of greenhouse gases
Land spreading	Bacteria, viruses, heavy metals	Bioaerosols, dust, odour	Bacteria, viruses, heavy metals, PAHs, PCBs	Vermin, insects	Small emissions of greenhouse ases,
Recycling	Wastewater	Dust, noise	Landfilling of residues	-	Minor emissions
Waste transportation	Spills	CO_2, SO_2, NO_x, dust, odour, noise, spills	Spills	-	Significant contribution of CO_2

CO_2 = Carbon dioxide; CH_4 = methane; VOCs = volatile organic compounds; SO_2 = sulphur dioxide; NO_x = nitrogen oxide; N_2O = nitrous oxide; HCl = hydrochloric acid; HF = hydrofluoric acid; CO = carbon monoxide; and PAHs = polycyclic aromatic hydrocarbons.

The effects to human health due to exposure to the elements released from waste can result in two different cases, they can be acute in case of a serious accident resulting in short term exposure or chronic if exposure is long term (Giusti, 2009).

Though incineration has been known to emit pollutants, the main concern to the process are the dioxins which are released (Pembina, 2018). Dioxins such as dibenzo-p-dioxins, polychlorinated dibenzofurans, and polychlorinated biphenyls are produced by the combustion process. Exposure to the dioxins have been linked to people forming non-Hodgkin's lymphoma and soft tissue sarcomas. This becomes a concern for compost workers who are constantly exposed to waste as they are more likely to develop respiratory and dermal diseases (Giusti, 2009) (Pembina, 2018).

Pollution from incineration sites differ based on how much capital is invested on monitoring dioxins released from the process (Pembina, 2018). Municipalities in Ontario regularly monitor NO_x, SO_x, CO, HCl, O_2, opacity, temperature and ammonia content of incinerated waste. Other pollutants are regularly monitored at an annual rate through stack tests (Pembina, 2018). Tests must be regularly scheduled so that they may be performed under optimal operating conditions.

Studies performed on incinerators found a correlation between the toxins released from incinerators and nearby communities exposed to the emissions. In a study published by Staessen et al. performed on adolescent children which were exposed to the emissions of two nearby incinerators, there were elevated levels of PCBs, dioxins and VOCs found in the bloodstream. Furthermore, the study showed a delay in the adolescents' sexual maturation, delayed breast development in girls directly correlated to an increase in blood dioxin level, and delayed genital development in boys directly correlated to increased levels of PCBs in the blood stream. Moreover, there was a reduction in the testicular volume found in boys (Pembina, 2018). Finally, a series of studies found increased death rates in children from causes such as cancer of the larynx, liver, stomach, rectum, and lungs (Pembina, 2018).

With the side effects of incineration, the efficiency of the process is put into question. Material found in our waste stream such as plastics, paper, tires, and wood waste contain carbon which could be used to create energy (Pembina, 2018). The amount of energy released from incinerating waste varies based on the status of the waste, i.e. how much non-combustible material is in the waste and what the moisture content of the waste looks like. Recycling waste streams rather than combusting is a much more efficient method of disposing of waste simply due to skipping all the energy intensive processes incorporated in incinerating waste (Pembina, 2018). Table 3.9 displays the energy saved from recycling in comparison to incinerating waste.

Table 3.9 Energy expenditure from recycling vs. incinerating waste

Material	Energy savings from recycling (GJ/tonne)	Energy output from incineration (GJ/tonne)	Energy savings from recycling versus incineration
Newsprint	6.33	2.62	2.4
Fine paper	15.87	2.23	7.1
Carboard	8.56	2.31	3.7
Other paper	9.49	2.25	4.2
HDPE	64.27	6.30	10.2
PET	85.16	3.22	26.4
Other plastic	52.09	4.76	10.9

In Ontario, incineration as an energy producing technology comparatively created the most amount of greenhouse gasses. If compared exclusively to coal fired technology, incineration contributes to 33% more gasification and up to 90% more greenhouse gas emissions per kWh of electricity generated (Pembina, 2018).

Given the range of incineration technologies available, the cost of operation will vary across methods used. Cost can be broken down into how much sorting will need be done prior to incineration, emissions testing and monitoring, operator training, and ash management (Pembina, 2018). New projects costs range from \$102 to \$168 per tonne depending on the variables and training after incorporating energy revenue. With the increased diversion of waste, the net calorific value of incineration may not be enough to constantly operate the incinerators and an import of energy would normally be required, normally done through natural gasses. Furthermore, there is an instability of energy buyers from incineration and no guarantees can be made to always find a buyer interested in the energy generated (Pembina, 2018).

For incinerators to run optimally and reduce pollution, the facilities must combust waste around the clock. Unlike landfills, incinerators require a steady stream of waste in order to continually run. Furthermore, the waste stream must contain a sufficient percentage of high calorific burnable waste like paper and plastic to maintain operations over the entire lifespan of the facility (Pembina, 2018). However, there are many case studies done around the world which have shown it is not possible to meet the requirements to consistently run incineration facilities. As a result of insufficient waste generation and calorific content in the waste, surpassing allowable emissions limit, and unplanned mechanical failures, the projects have run into significant debt requiring additional cost investments from communities (Greenaction for Health and Environmental Justice, 2006).

It is recommended for municipalities to look at other avenues other than incineration. As technology is developed, other means of diverting waste have been proven to be better alternatives. A focus on reducing, reusing, and recycling and composting are much more efficient waste management methods with lower risks, lower environmental impacts, and allows for the variability in quantities of waste (Pembina, 2018).

Chapter 4: Hospital Visits

4.1. Methodology

To collect representative samples, hospitals were chosen based on location and size. In the HRM, the hospitals chosen for the visits were the QE II VG and Camp Hill sites, the IWK, the Dartmouth General, and the Cobequid Regional Hospital. Outside of the HRM, the hospitals chosen for a visit were the St. Martha's Hospital, Colchester Regional Hospital, and the Lillian Fraser Hospital. Furthermore, while doing hospital visits, we collected statements from the hospital waste collection staff, nurses, physicians and, in the case of St. Martha's Hospital, from members of the board.

Waste data numbers collected were sourced from the Central Zone Facility Manager and David Bligh from Efficiency NS.

Source	Waste Data
Central Zone Facility Manager	• CH 20-016 Recycled and General Waste Management. • Regroup invoices. • Shred-it invoices. • Stericycle invoices.
David Bligh	• St. Martha's Hospital compactor rental costs. • Stericycle 2016 waste report. • Colchester East Hants Health Centre and Lillian Fraser 2016 and 2017 waste data.

4.2. Hospital current practices

Across the province of Nova Scotia, hospitals use different waste disposal methods. The differences in practices currently stem from the previous practices in place. The standardization of practices has experienced many delays, especially in the implementation of a new waste policy. One can argue that a proper waste policy is essential to a successful waste disposal system followed by the ability to implement the waste policy. Educating hospital staff and visitors is a helpful step in the right direction. Successful disposal of waste occurs at the source through proper separation.

Treating general hospital waste similar to household waste will reduce a lot of cost from improper disposal as hazardous waste. In the household, a band-aid stained with blood is tossed in the garbage. In a hospital setting, there are more factors at play. However, if gauze contaminated with blood is disposed of in the hazardous waste stream then it is sent to the incinerator. If the blood is left to dry and disposed of in the general waste stream, then it reduces the cost of disposal. Disposing of dried blood in the general waste stream does pose its own risk. Blood contaminated with blood-borne diseases remain to have the ability to contaminate for up to a few days after the blood has dried (CDC, 2019). There are ways to reduce the risk of cross-contamination from dried blood. The reduction of risk comes from disinfecting surfaces which came in contact with blood, changing out gloves after coming in contact with patients, and refraining from touching personal items when wearing potentially contaminated gloves (CDC, 2019).

According to the Curbside Collection of Household Medical Waste Council Report, households who opt in to receive in-home medical treatments are required to use clear bags for waste disposal but are however allowed one black bag for privacy purposes (Halifax Regional Council, 2018). Hospitals of the NSHA follow a similar guideline. Waste generated in the hospitals are disposed of in waste bags specifically designated for the different categories of waste. In Curbside Collection Report and the NSHA website, bags are outlined as follows (Halifax Regional Council, 2018) (NSHA, 2019).

Table 4.1 Receptacle colour from Curbside Collection Report vs. NSHA website

Waste Category	**Curbside Collection Report receptacle colour**	**NSHA Website receptacle colour**	**Disposal method**
Anatomical waste	Red	Red	incineration
Microbiological Waste	Yellow	Yellow	Incineration
Fluid Waste	Yellow	Yellow	• Sanitary sewer if permitted by municipal bylaws • Incineration
Sharps	Yellow or Red if incinerated	Yellow	Incineration
General Waste	Green, black or clear	-	Landfill

On the NSHA website and policy number CH 20-016 of the old Capital Health system, there are no mentions of what bags the general waste should be disposed in. Current practices across the hospitals are the use of black plastic bags for general waste. General waste receptacles are placed in multiple areas throughout the hospitals – mainly in hallways, offices, operating rooms and the cafeteria. There is a lack of consistency as to what receptacles are used to dispose of general waste, even within a single hospital. In recent visits, receptacles have varied from buckets with black bags in them to waste receptacles similar to the Ice Green Glutton bin found on the Divert NS website (Divert NS, 2019). Furthermore, there have been instances where multiple empty receptacles are found in a single area.

4.3. Hospital visits

4.3.1. QE II Victoria General

Black bags are meant to be used for general waste due to patient and hospital privacy policies. General waste receptacles were found in many areas throughout the QE II – these were the most common bins found. There was a definite lack of consistency in types of receptacles used. A general waste bin ranged from anything from an official waste bin to a bucket with a black plastic bag placed in it. In the tour of the hospital, compost bins were found in the cafeteria area as part of waste receptacles which were split into sections for general, organic, paper and recyclable waste sections. The current practice is to place receptacles where corresponding waste items are found. Which in turn means there were no compost bins in public waiting areas or hallways. Compost bins were clearly marked green indicating the receptacles intended use. Prior to Tim Horton's leaving the hospitals, coffee cups were a major contributor to cafeteria waste. In the kitchen area, there were buckets filled with coffee grounds from the sheer amount of coffee made in a day. Coffee cups continue to be a large contributor to the waste based of visual analysis even after the departure of Tim Horton's. Coffee cups are not recyclable due to the plastic lining which makes them waterproof and are therefore immediately tossed out into the general waste bin (Recyclecoach, 2019). The plastic lids and the corrugated cardboard which are found on the cups are recyclable if local recycling facilities allow for it. In Nova Scotia, those items currently just go into the general waste stream (Divert NS, 2019).

The waste signage found atop the bins were inconsistent. The labels highlighted general items in which are disposed of in the respective receptacles. Common items sold or found in the hospitals were not displayed on the labelling. Furthermore, some bins even lacked a label to begin with. This was more common when items such as buckets were used to put together a makeshift waste receptacle. Another issue found with the general waste bins was the improper use of coloured or clear bags. In the general waste bins, it was not uncommon to find a yellow bag in the waste receptacle. Yellow waste bags indicate the waste is hazardous and should be sent to the incinerator, increasing the emissions and the cost of disposal, as displayed in Appendix A.

In staff-only restricted areas, receptacles were split into separate bins for each waste stream. This was done to prevent cross-contamination. In an operating room, once the operation was completed, anatomical waste is collected and placed in a separate room and is locked until it is picked up by hospital staff to be relocated prior to collection. Currently, items covered in blood are sent to the incinerator. This increases the costs of waste disposal significantly. Items such as gloves used to handle containers of blood and body fluids, paper towels or bench paper stained with blood or any other material used to handle blood which did not come in direct contact with blood should not be classified as biohazardous waste and can therefore be placed in the general waste bin (Extranet, 2019).

Doctors have their medical supplies provided from different sources. Some doctors receive their medical equipment in single packaging while others have full kits prepackaged. There are advantages to both methods of packaging. Both forms of packing keep the medical equipment sterile which is the packaging's main purpose (Neil, 2018). However, depending on the apparatus, there may need to be extra layers of packaging added to ensure safety. If the apparatus is classified as sharps, additional packaging such a protective sleeves or lids may be required for safety measures (Neil, 2018). Typically, medical equipment is packaged in plastic. The packaging is made of two different plastics: clear and opaque. The difference in plastics mean it is not easily recyclable. The two plastics must be separated and treated differently. Single use disposable equipment has been around since the 1960s (Glauser, Petch, & Pendharkar, 2016). The transition to reusable equipment has been a struggle due to the inability to clean medical apparatus adequately.

Upkeep of the hospital happens sporadically throughout the year. It is not uncommon to see different parts of the hospital undergoing repair. Waste from repairs are collected and are separated from the different waste streams in the hospital. The roofing, wood and other forms of waste are collected and placed in plastic totes before being wheeled off and placed in large green bins before being collected by REgroup and are transported to the waste site.

Private hospital documents waste stream was not reviewed in great depth. It was assumed that this waste stream was strictly paper and was not mixed in with other forms of waste. The reasoning behind this was to avoid any privacy breaches.

4.3.2. QE II Camp Hill Site

The Camp Hill visit was done in tandem with the Central Zone Facility Support Manager. In this meeting, a couple of important things were brought to light. The first point being people know how to separate waste and they know how important it is to properly separate waste streams. However, there are a few challenges which arise when it comes to storage of waste. The main problem with proper separation of waste is the lack of space. Compliance officers operate at Otter Lake to ensure proper separation of waste from the hospitals. Otter Lake is where all the black bag and clear waste goes. It is rare that the hospitals in the Central Zone receive any citations for improper separation of waste. There is a lack of communication on waste policies and procedures across hospitals, staff and sanitation employees. There has been a policy in the works for the past few years and was set to be released before the end of 2018. The new policy is yet to be released.

The Central Zone Facility Support Manager confirmed that due to lack of storage, mixed recycling is picked up five times a week from hospitals. He also confirmed that a biomedical reduction presentation would have occurred to come up with mitigation strategies for the biomedical waste stream. The meeting would have congregated members from the Halifax Regional Municipality and waste employees to mandate them to get information on biomedical waste disposal alongside a provincial roll up. A follow up on this meeting could not be found.

Improper separation and the inability to update waste disposal procedure comes from insufficient funds directed towards waste disposal and recycling. Insufficient funds are the main reason why the hospitals need to properly separate their waste. The cost of waste disposal breaks down into a flat rate of $1.20/kg plus a flat tipping fee $0.25/kg. The inability to recycle some of the items that end up in the landfill only contribute to the cost. Furthermore, there is a hidden cost associated with waste disposal which is the environmental impact of placing waste in a landfill. The frequent transportation of waste to and from the hospitals to the landfills contribute to the global emissions.

While touring the hospitals and checking out the waste bins, there was waste improperly disposed of in different waste bins. For instance, in the infirmary, there was a mixture of waste in the paper waste bin. Food waste is generated mainly in the kitchen area. The transition from precooked meals to pre-ordered food has greatly reduced the waste generated in the kitchen areas. This was achieved by getting inpatients to order their meals at the beginning of the day and then having the ability to change their order throughout the day before the meal is made. This does not completely eradicate the organic food waste generated but it greatly reduced it. Previously, patients used to just receive a premade meal in which they would only eat what they liked, and the rest went to waste.

4.3.3. Dartmouth General

The Central Zone has its food made in the QE II. Dartmouth General Hospital has its food shipped over the bridge from Halifax. Thus, there is very minimal food waste generated from inpatient care. The food waste stream comes from the waste generated mainly in the cafeteria. The items used to transport food are then sent back to the QE II for cleaning and disposal. In the cafeteria, there was one waste bin which had two garbage receptacles, one recyclables section and an unlabeled section. There were no signs of separation in this receptacle. Cafeteria users did not know where to put their food waste. In the kitchen located in the cafeteria, there were many buckets used for coffee grounds and coffee filters laying around the worker stations.

Other areas of the hospital had general waste bins and there was an abundance of them. In one of the hallways in front of the dialysis unit, a bucket containing a black bag had a milk carton in it. There were no recyclables or organic receptacles once you left the cafeteria. In one specific hallway, there were three general waste receptacles next to each other. These receptacles were next to a Social Bean coffee machine with disposable paper cups. The waste in these three bins were mainly from the coffee machine. In a grey cart which was left in the hallway, there was a yellow bag with individualised plastic packaging. Due to being in yellow garbage bags, the plastic packaging would be sent to incineration instead of being put in the landfill.

A common issue found in hospitals was the blue bag recyclables waste stream. At the time of the visits, there were no vendors willing to take any of the blue recycling bags. The waste stream just took up space. Blue bag recyclables were just collected by people whenever it started piling up. Throughout the year there were talks of vendors who were starting negotiations with the hospitals to pick up blue bag recycling but due to the early stages of the negotiations, information could not be collected.

The operating rooms in the Dartmouth General were one of the only wings in the hospital which properly separated its waste. In the operating room, there were multiple bins for the different waste streams. Biological waste was stored in a separate, enclosed room waiting to be picked up by employees with proper equipment. The entry way was proper labeled with signage indicating the contents stored in the room.

A sanitation employee working at the Dartmouth General was asked with regards to the issues with waste disposal. According to the employee, there is a lack of knowledge on where to dispose waste due to a lack of signage. Though waste would be properly separated at the source, the sanitation employee has witnessed waste collectors just dispose of all the bags into one truck. In the Dartmouth General, the employee did not witness any organic recycling being done. The electronic waste was being disposed of in the general waste stream and not being recycled either.

Across the street at the Mount Hope Hospital, not much waste is generated. When the site was visited, there was not much activity. However, in the docking area, Mount Hope had a separate compactor for waste and cardboard. This was made possible due to the excess amount of space available. Furthermore, there was a green compost bin sitting outside waiting to be picked up. Mount hope takes care of the linen recycling. There is a large facility where linen is packaged and received. There is a large amount of plastic waste generated due to the packaging of the linens. Numbers on the exact amount of plastic used were not available.

4.3.4. St. Martha’s Hospital

The trip to St. Martha’s Hospital was done in tandem with attendance to a hospital board and staff meeting. Based on previous employee behaviour demonstrated at St. Martha’s Hospital, it was concluded people are willing to do what the policy requires of them to do. Employees want to have easier access to waste receptacles by increasing the number of receptacles available to them.

Instead of having to walk down an entire wing to get to a receptacle, have more available in the area. However, with more receptacles, the question of space comes up. Space is extremely limited and there is a huge demand for more space from multiple departments in the hospitals.

The main problem to overcome is the lack of policy. Without a proper policy in place, staff members do not have a clear procedure to dispose of waste. When a new waste policy is put in place, it is imperative to properly educate hospital staff, from surgeons to sanitation employees, on the new waste policies and procedures.

One third of the waste generated in St. Martha's Hospital comes from the operating room. In the cardiac catheterization lab, St. Martha's Hospital managed to reduce 80-90% of their waste. An audit was done previously by a local student on the hospital waste generation numbers. However, the hospital did not receive a report to date and has since lost contact with the student.

According to the meeting attendees, implementing a new waste policy and getting it approved is a process which takes about two to three years. The new policy implemented must be a working document due to the nature of waste disposal. Waste disposal number are a moving target and the policy must be able to explain what is to be done in the different scenarios.

St. Martha's Hospital was exploring options on dealing with plastics generated in the facility. They were working on trying to find a deal with C&D Recycling. C&D recycling is a local company which takes in plastic and makes it into animal bedding, shingle sand aggregate, shingle flake/plastic mix alternative fuel, sceptic sand as we as other products (C&D Recycling, 2019).

In the operating room, there are also multiple receptacles for the different streams of waste. The biohazardous waste is placed in a separate room and is properly labeled and kept away from staff who have unauthorised access. Any waste with a medical label on it cannot be placed into a receptacle other than general waste. Once syringes are opened and prepared for the operation, they cannot go into the recycling stream and must go into the general waste stream, even if they were not used for the operation to avoid contamination. Plastic tubes go through a similar process. There was only one yellow bin available for waste and it fills up so frequently it required daily disposals. An area of concern in the operating rooms is the improper disposal of recyclable waste in the wrong receptacles. Doctors normally bring in their own utensils to the operation and therefore have their own individual packaging to be disposed of post-surgery.

An area of concern for St. Martha's alongside many other hospitals is blue wrap disposal. Blue drapes are an area of major concern across all hospitals. In St. Martha's hospital, there was so much blue drapes waste being generated they were stacking them in multiple rooms and areas across the hospitals. There is currently no one who can take care of the blue drapes in order to recycle them.

St. Martha's hospital has one of the best numbers for separating waste in the province. This is due to the Green Team which was created many years ago. An issue with the Green Team is the team does not have sanitation staff on the team nor do sanitation staff attend of their meetings.

4.4. Hospital numbers and charts

When a meeting was conducted with the Central Zone Facility Support Manager, the hospital waste numbers were requested of him to determine the state of waste separation in the province. The waste numbers provided were broken into five categories – regulated medical waste, reusable sharps, pathology/chemotherapy, pharmacy and other. The hospitals waste separation data collected in 2016 was as follows.

4.4.1. Colchester Regional Hospital

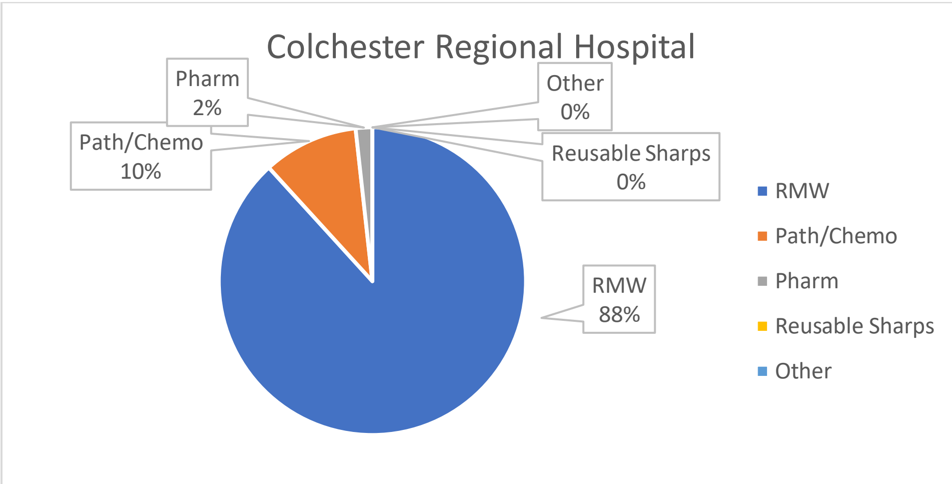

Figure 4.1 Percentage of container waste from the Colchester Regional Hospital

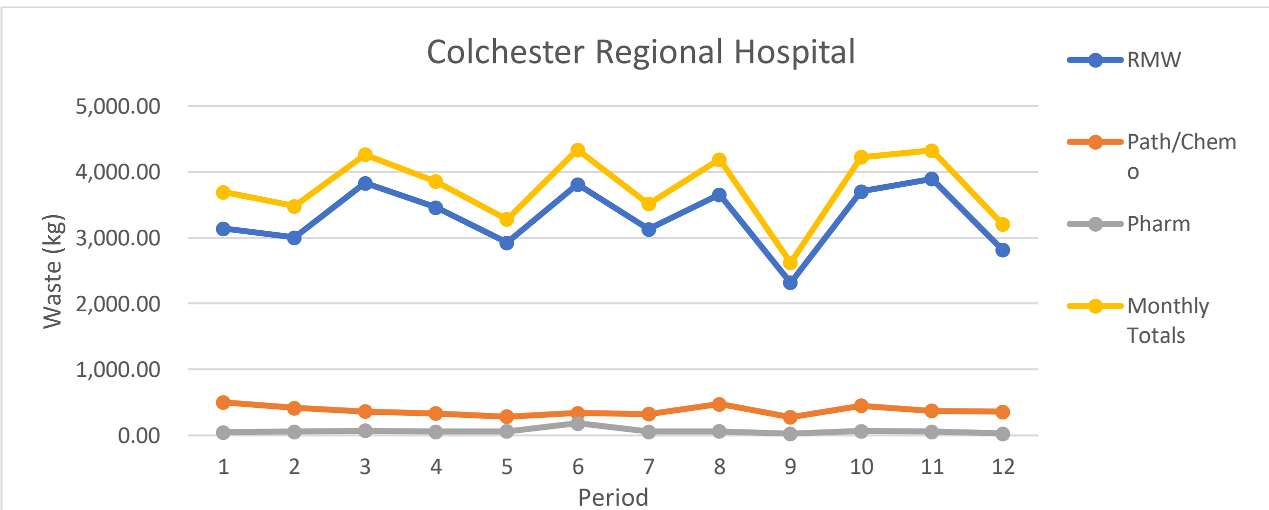

Figure 4.2 Waste generated per period in kg from the Colchester Regional Hospital

Table 4.1 Numeric values from the Colchester Regional Hospital

Monthly Totals	
Max (kg)	4,337.76
Min (kg)	2,619.96
Mean (kg)	3,748.78
Std Dev (kg)	524.01
Median (kg)	3,773.04
N (samples)	12

4.4.2. Dartmouth General Hospital

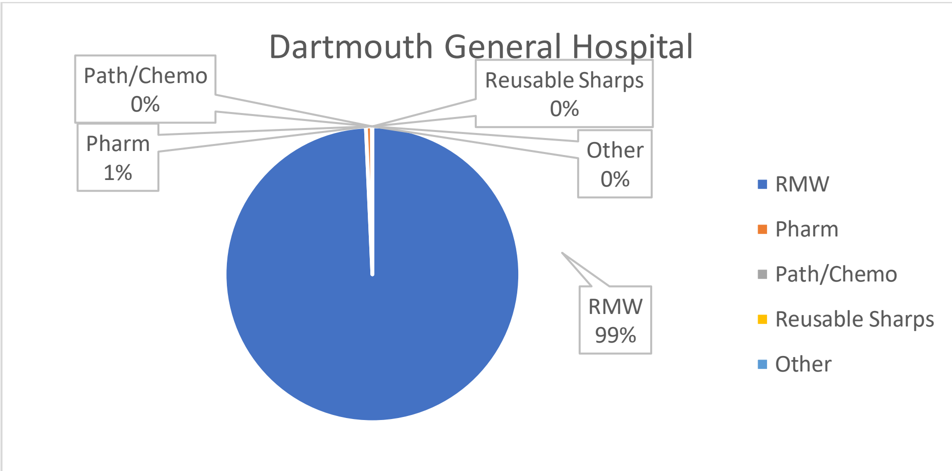

Figure 4.3 Percentage of container waste from the Dartmouth General Hospital

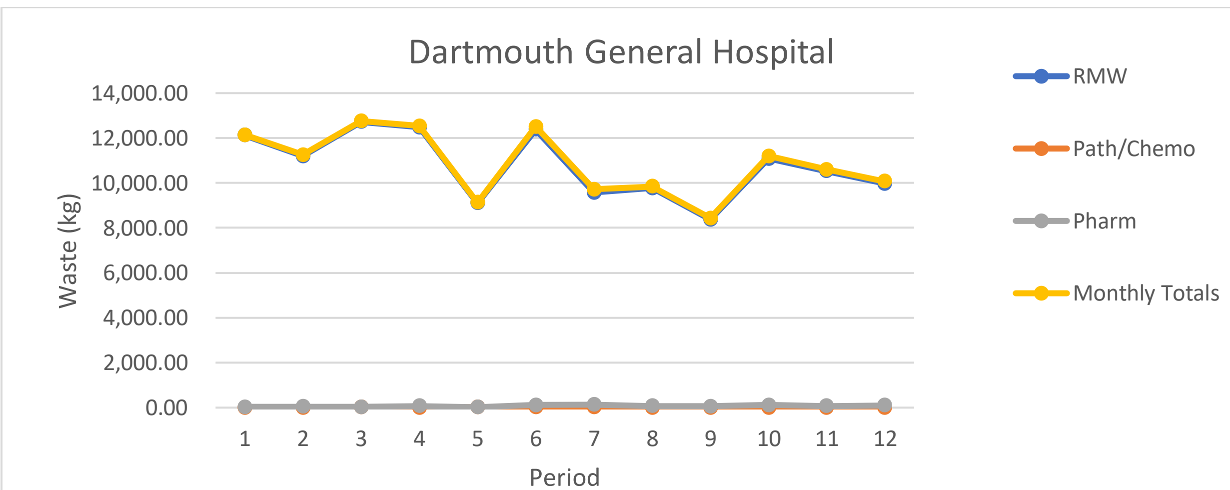

Figure 4.4 Waste generated per period in kg from the Dartmouth General Hospital

Table 4.2 Numeric values from the Dartmouth General Hospital

Monthly Totals	
Max (kg)	12,755.80
Min (kg)	8,439.69
Mean (kg)	10,849.98
Std Dev (kg)	1381.15
Median (kg)	10,896.06
N	12

4.4.3. QE II Victoria General

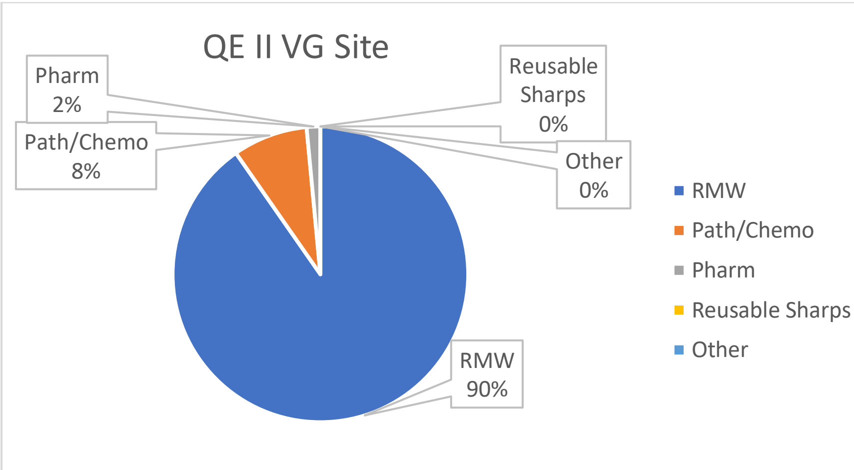

Figure 4.5 Percentage of container waste from the QE II VG Site

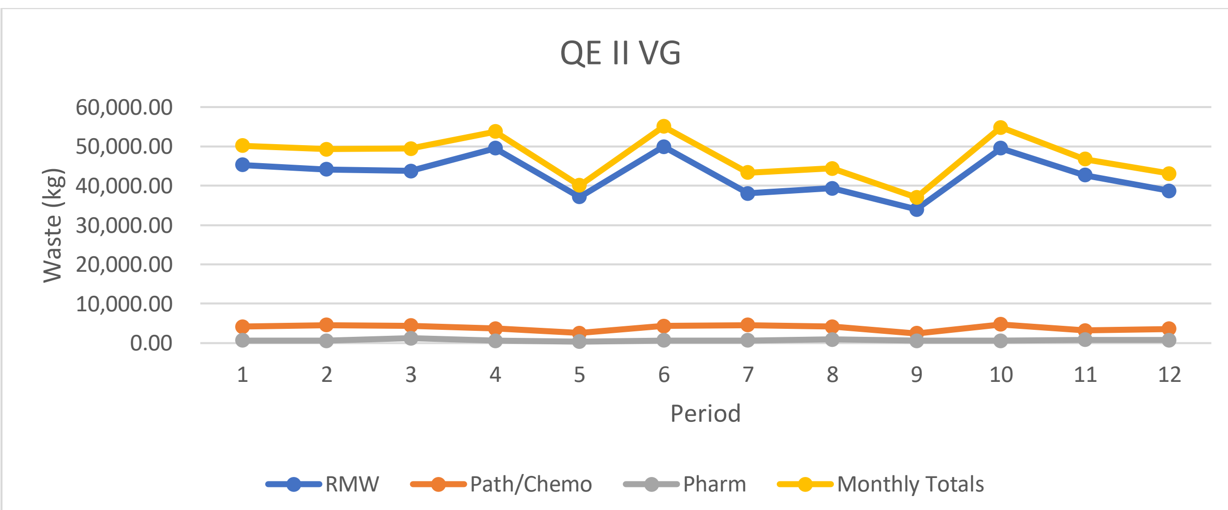

Figure 4.6 Waste generated per period in kg from the QE II VG Site

Table 4.3 Numeric values from the QE II VG Site

Monthly Totals	
Max (kg)	55,029.45
Min (kg)	37,037.70
Mean (kg)	47,261.40
Std Dev (kg)	5594.97
Median (kg)	48,014.50
N	12

4.4.4. QE II Camp Hill Site

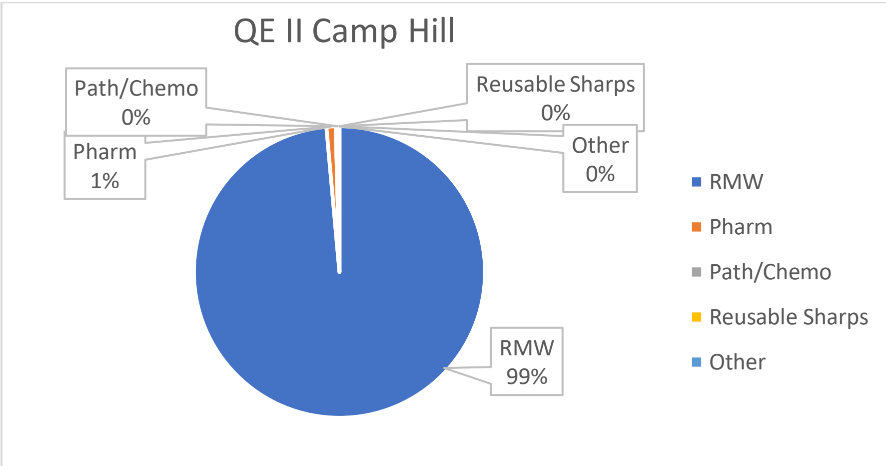

Figure 4.7 Percentage of container waste from the QE II Camp Hill Site

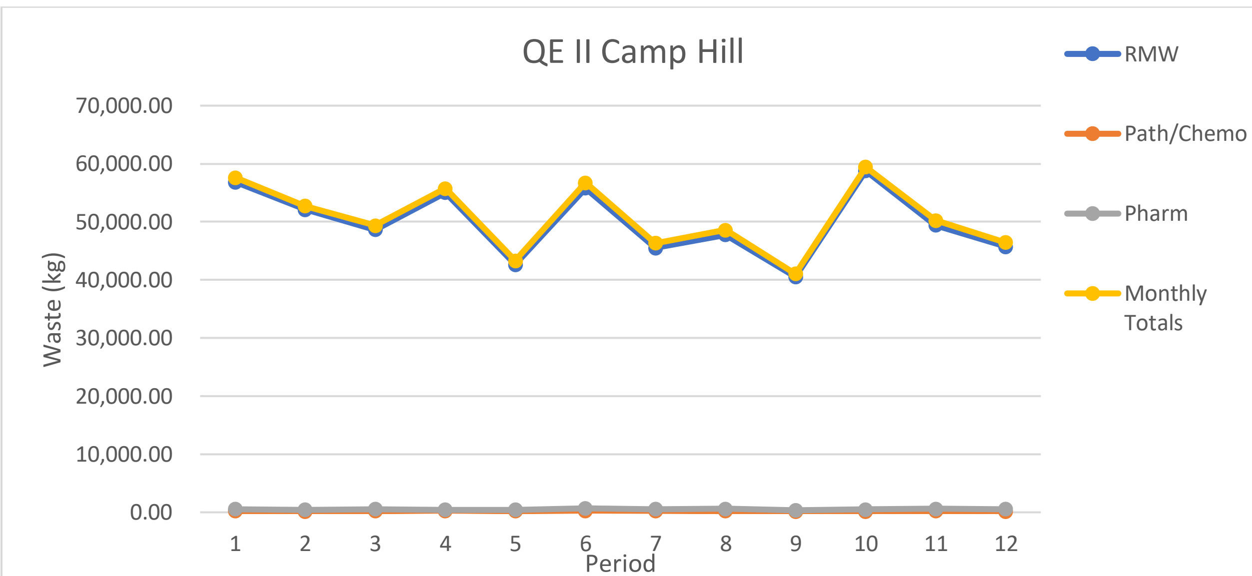

Figure 4.8 Waste generated per period in kg from the QE II Camp Hill Site

Table 4.4 Numeric values from the QE II Camp Hill Site

Monthly Totals	
Max (kg)	59,428.74
Min (kg)	41,036.31
Mean (kg)	50,633.08
Std Dev (kg)	5637.29
Median (kg)	49,811.14
N	12

4.4.5. Cape Breton Regional Hospital

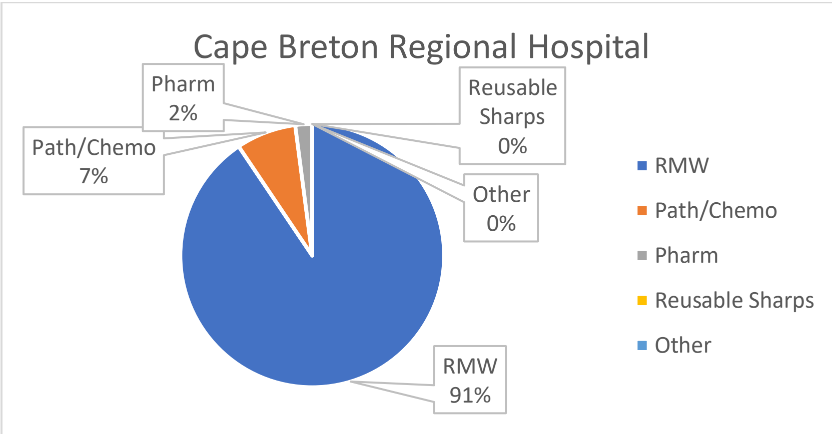

Figure 4.9 Percentage of container waste from the Cape Breton Regional Hospital

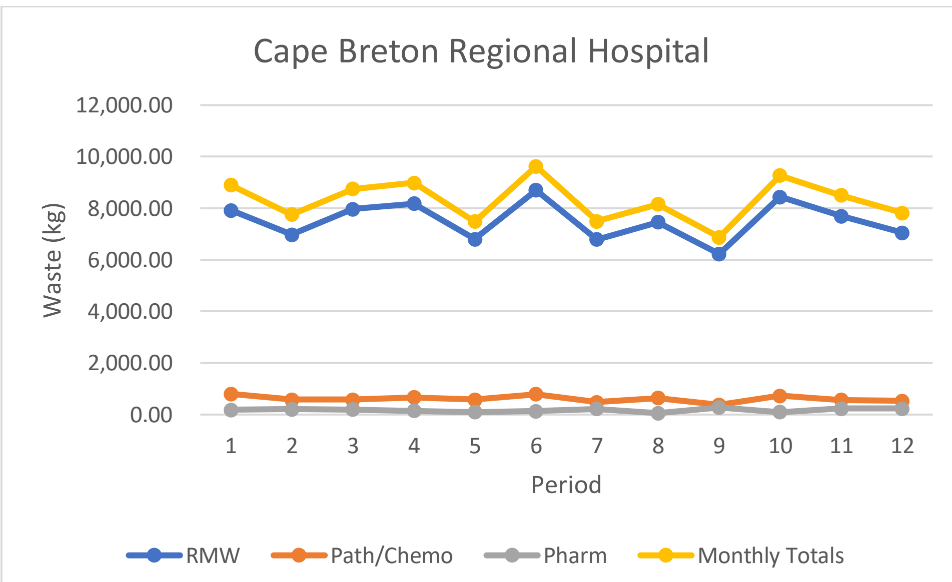

Figure 4.10 Waste generated per period in kg from the Cape Breton Regional Hospital

Table 4.5 Numeric values from the Cape Breton Regional Hospital

Monthly Totals	
Max (kg)	9,626.61
Min (kg)	6,880.86
Mean (kg)	8,301.04
Std Dev (kg)	798.01
Median (kg)	8,327.66
N	12

4.4.6. IWK Health Centre

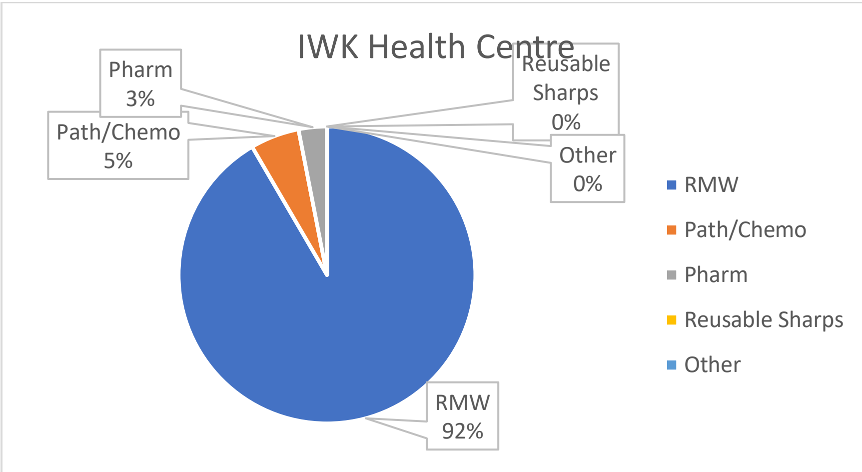

Figure 4.11 Percentage of container waste from the IWK/Grace

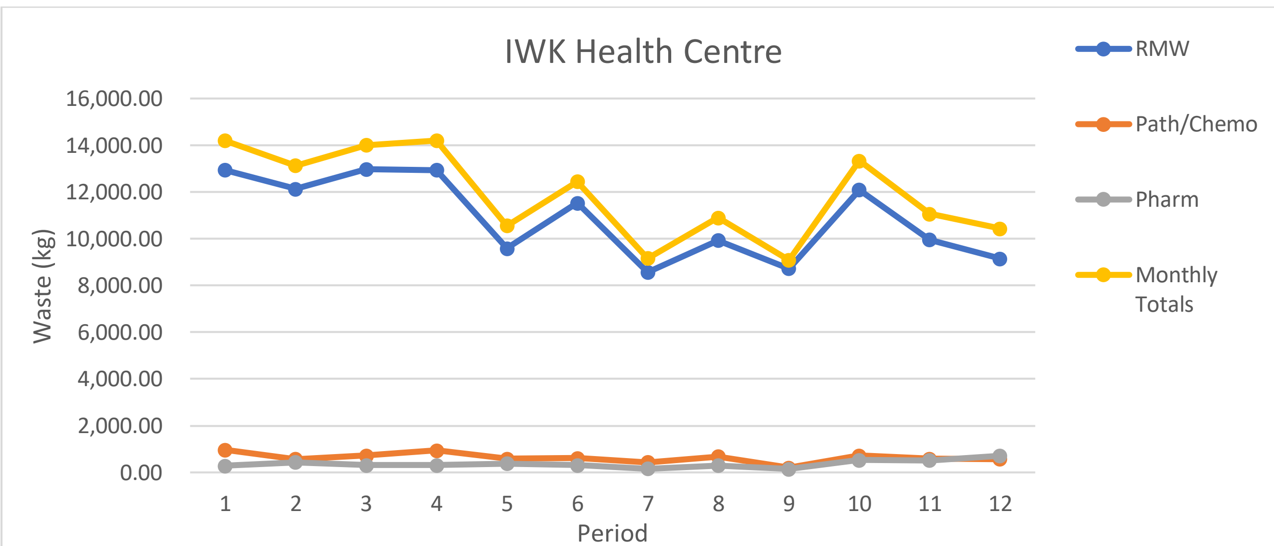

Figure 4.12 Waste generated per period in kg from the IWK – Grace

Table 4.6 Numeric values for the IWK - Grace

Monthly Totals	
Max (kg)	14,200.42
Min (kg)	9,085.23
Mean (kg)	11,876.52
Std Dev (kg)	1824.85
Median (kg)	11,756.43
N	12

4.4.7. Discussion

The data provided by the Central Zone Facility Support Manager indicate the medical facilities' main waste stream is regulated medical waste. For some of the medical facilities, there was insufficient information collected in different periods making it unable to form a line graph. There seems to be no indication on which specific months correspond to which period which means if a hospital started collecting mid-year, that would be period 1. Another observation which can be determined from the graphs is the correlation between amount of waste generated and the hospital's income. The more income a hospital has, the more waste it produces. This observation can be confirmed by looking at the amount of waste generated in the QE II, IWK, Dartmouth General and Cape Breton Regional Hospitals. There are months where more waste is generated than other months. A reason for this cannot be determined from the data given. The large percentage of waste which is classified as regulated medical waste is incinerated. This largely contributes to the cost of waste disposal and carbon emissions.

4.5. Waste Collected in Lillian Fraser Memorial & Colchester Health Care Centres

4.5.1. Colchester East Hants Health Centre 2016

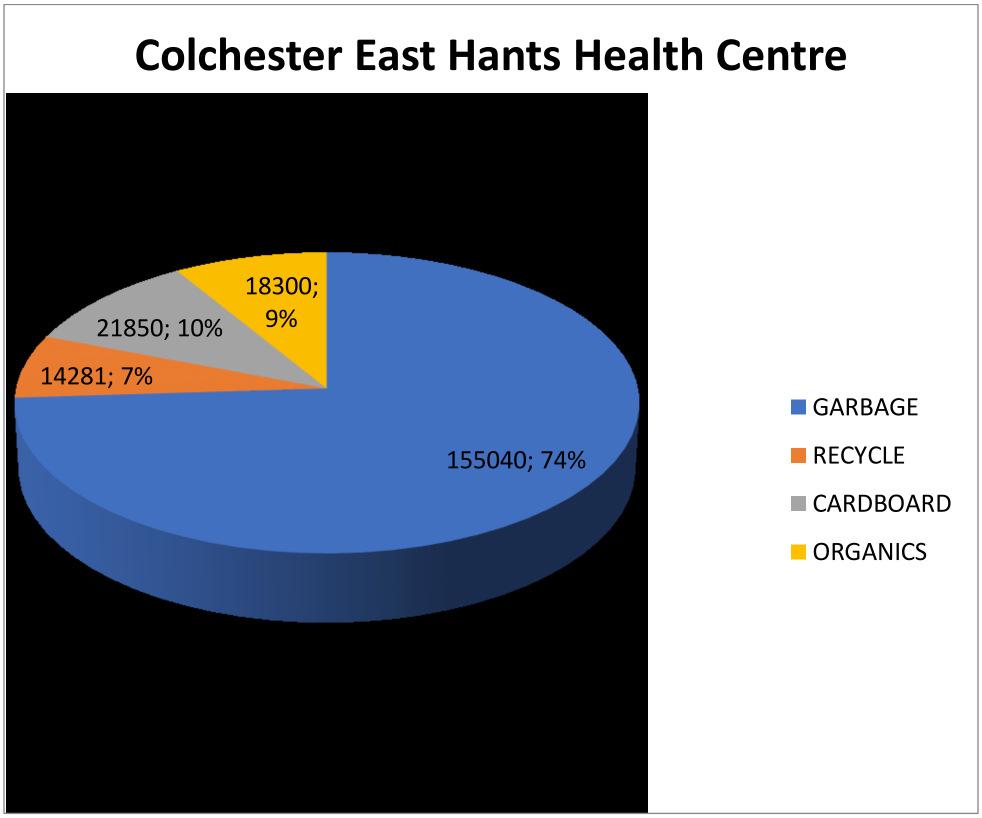

Figure 4.13 Waste in kg and percentage of waste collected from Colchester East Hants Health Centre in 2016

Table 4.7 Weight of waste collected from Colchester East Hants Health Centre in 2016

Stream	Kilograms
Garbage	155,040
Recycle	14,281
Cardboard	21,850
Organics	18,300
Total	209,471

4.5.2. Colchester East Hants Health Centre 2017

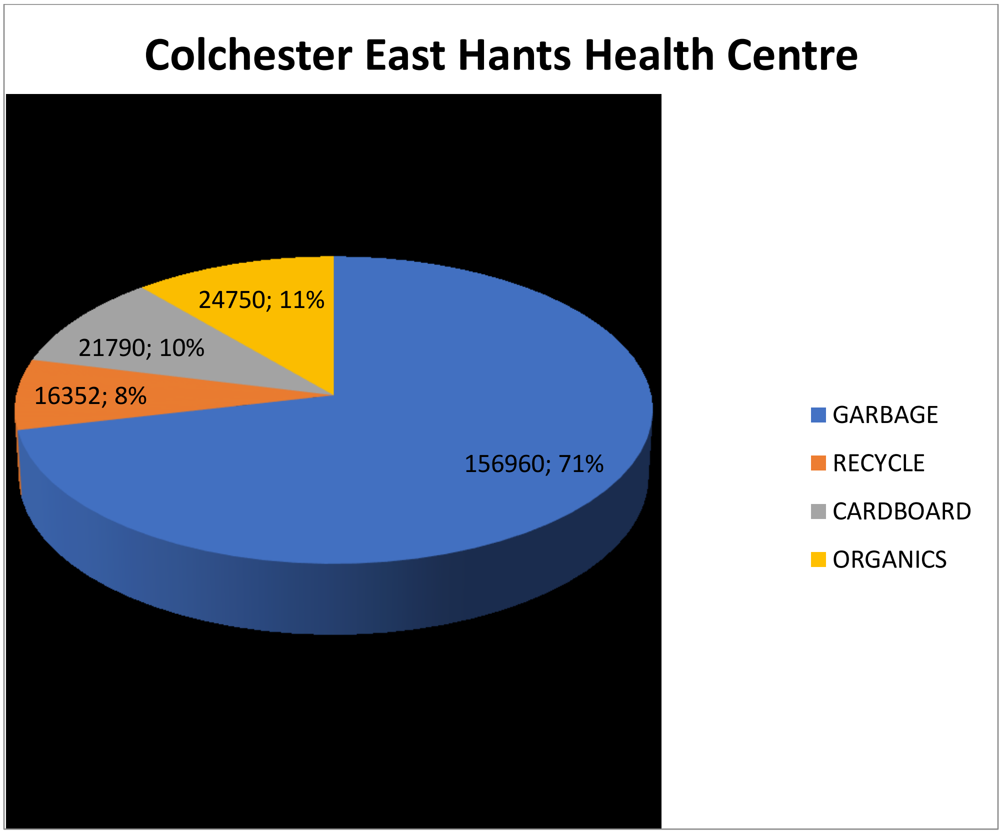

Figure 4.14 Waste in kg and percentage of waste collected from Colchester East Hants Health Centre in 2017

Table 4.8 Weight of waste collected from Colchester East Hants Health Centre in 2017

Stream	Kilograms
Garbage	156,960
Recycle	16,352
Cardboard	21,790
Organics	24,750
Total	219,852

4.5.3. Lillian Fraser 2016

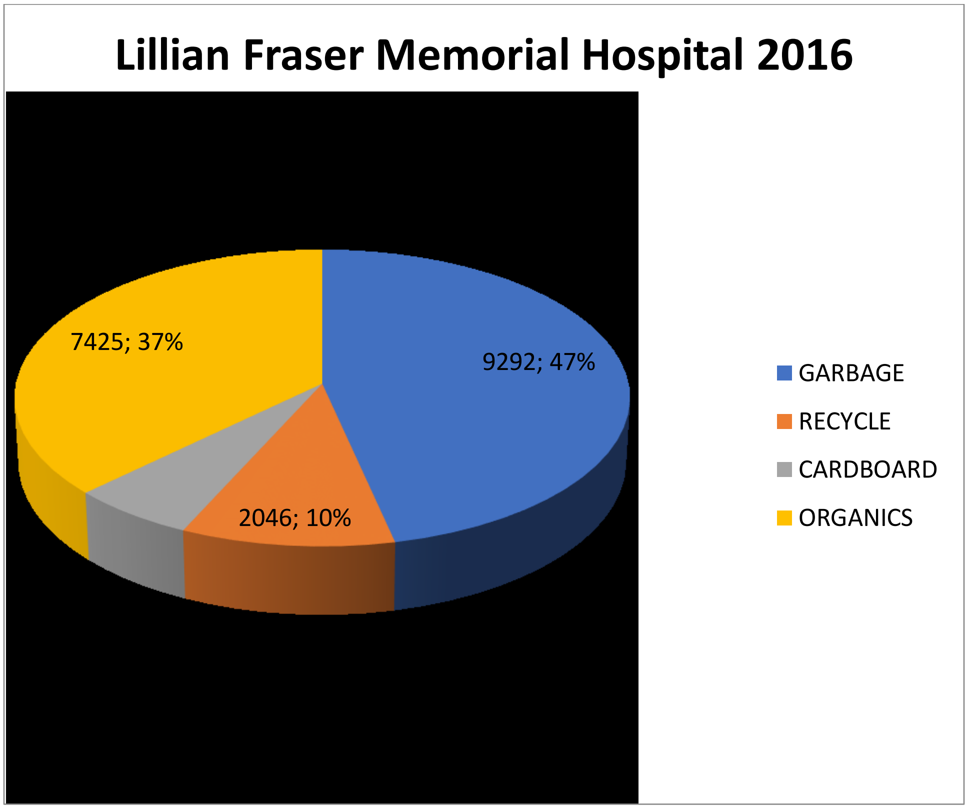

Figure 4.15 Waste in kg and percentage of waste collected from Lillian Fraser Memorial Hospital in 2016

Table 4.9 Weight of waste collected from Lillian Fraser Memorial Hospital in 2016

Stream	Kilograms
Garbage	9,292
Recycle	2,046
Cardboard	1,201
Organics	7,425
Total	19,964

4.5.4. Lillian Fraser 2017

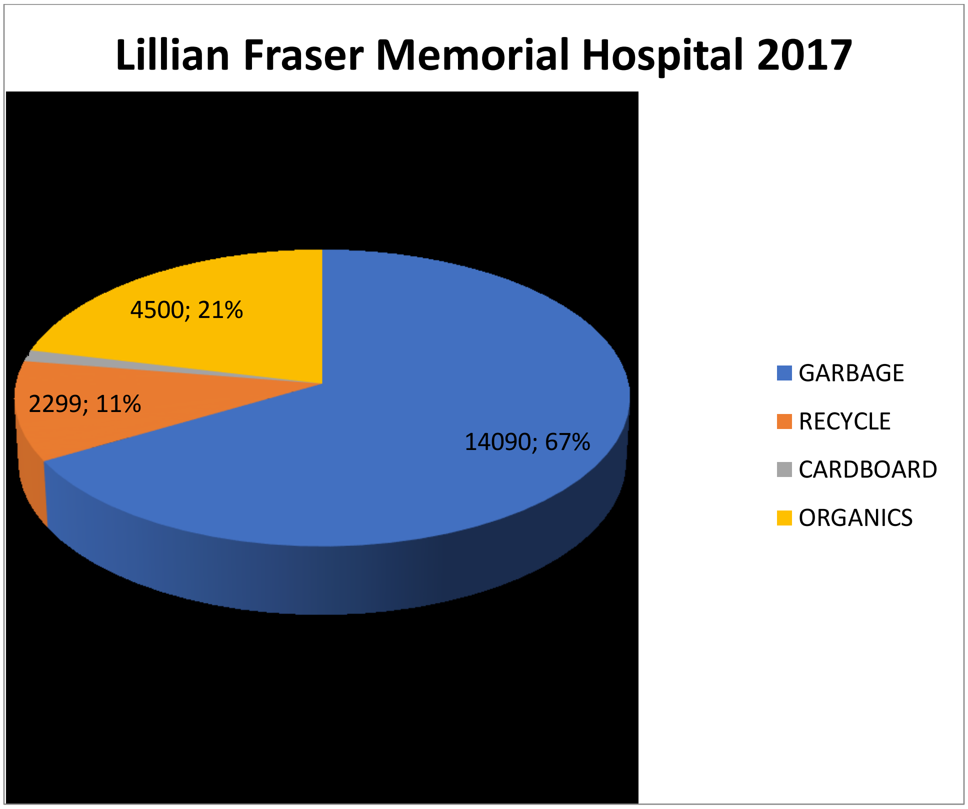

Figure 4.16 Waste in kg and percentage of waste collected from Lillian Fraser Memorial Hospital in 2017

Table 4.10 Weight of waste collected from Lillian Fraser Memorial Hospital in 2017

Stream	**Kilograms**
Garbage	14090
Recycle	2299
Cardboard	260
Organics	4500
Total	21149

4.6. Waste in the HRM

The following data was collected from July 1, 2016 to June 30, 2017. Terms used in the legend are extracted from the collected data. It is the weight of black bag, cardboard, C&D and metal waste. Legend is as follows:

Acronym	Meaning
FEL	Front End Load
RL	Rear Load
RO	Roll Off
C&D	Construction & Debris

4.6.1. Central Stores

Table 4.11 The weight of waste from the Central Stores

Type	Total Weight (kg)
FEL Regular Black Bag Waste	3,852
RO Cardboard	648
RO Regular Black Bag Waste	16,128

4.6.2. Victoria General

Table 4.12 The weight of waste from the Victoria General

Type	Total Weight (kg)
RO Cardboard	97,922
RO Regular Black Bag Waste	317,696

4.6.3. Nova Scotia Hospital

Table 4.13 The weight of waste from the Nova Scotia Hospital

Type	Total Weight (kg)
FEL Regular Black Bag Waste	6,436
RO Cardboard	4,048
RO Regular Black Bag Waste	57,104

4.6.4. Dartmouth General Hospital

Table 4.14 The weight of waste from the Dartmouth General Hospital

Type	Total Weight (kg)
RO Cardboard	22,168
RO Regular Black Bag Waste	109,072
RO Regular Black Bag Waste	520
RO Regular Black Bag Waste	864

4.6.5. Camp Hill Medical Centre

Table 4.15 The weight of waste from the Camp Hill Medical Centre

Type	Total Weight (kg)
FEL C&D	13,728
RO C&D	16,207
RO Metal	2,656
RO Regular Black Bag Waste	638,228
RO Cardboard	31,672

4.6.6. Burnside Corrections Facility

Table 4.16 The weight of waste from the Burnside Correction Facility

Type	Total Weight (kg)
RO Cardboard	15,056
RO Regular Black Bag Waste	83,320

4.6.7. Cobequid Community Health Centre

Table 4.17 The weight of waste from the Cobequid Community Health Centre

Type	Total Weight (kg)
RO Regular Black Bag Waste	40,008
RO Cardboard	5,030

4.6.8. Connections Clubhouse

Table 4.18 The weight of waste from the Connections Clubhouse

Type	Total Weight (kg)
RO Regular Black Bag Waste	9,271

4.6.9. Integrated Chronic Care

Table 4.19 The weight of waste from the Integrated Chronic Care

Type	Total Weight (kg)
RO Regular Black Bag Waste	870

4.7. Other HRM waste streams

The following data is pulled from a single invoice from Stericycle. The invoice is as of June 30, 2018. It is the only invoice which was provided. A total due for these streams of waste was $135,030.34 due by July 30, 2018. The coding legend is as follows:

Code	Meaning
1	96 Gal Grey Tote
2	Pharmaceutical Waste
3	Non-anatomical Waste
4	Anatomical Waste
5	Container Cytotoxic

4.7.1. Dartmouth General

Table 4.20 Hazardous waste collected from the Dartmouth General

Waste type	Total Weight (kg)	Total Cost ($)
1	11,989.8	12,589.29
2	116.8	122.64
3	43.2	45.36
4	9.8	10.29
5	12.6	13.23

4.7.2. Eastern Shore

Table 4.21 Hazardous waste collected from the Eastern Shore

Waste type	Total Weight (kg)	Total Cost ($)
1	69	72.45

4.7.3. Hants Community Hospital

Table 4.22 Hazardous waste collected from the Hants Community Hospital

Waste type	Total Weight (kg)	Total Cost ($)
1	1,085.6	1,139.88
4	5	5.25
5	0.6	0.63

4.7.4. Musquodoboit Valley Memorial

Table 4.23 Hazardous waste collected from the Musquodoboit Valley Memorial

Waste type	Total Weight (kg)	Total Cost ($)
1	82.4	86.52

4.7.5. Nova Scotia Psych Hospital

Table 4.24 Hazardous waste collected from the Nova Scotia Psych Hospital

Waste type	Total Weight (kg)	Total Cost ($)
1	91.2	95.76

4.7.6. Twin Oaks Memorial

Table 4.25 Hazardous waste collected from the Twin Oaks Memorial

Waste type	Total Weight (kg)	Total Cost ($)
1	168.6	177.03

4.7.7. QE II Victoria General

Table 4.26 Hazardous waste collected from the QE II Victoria General

Waste type	Total Weight (kg)	Total Cost ($)
1	36,541.80	38,368.89
2	2,115.40	2,221.17
3	191.60	201.18
4	1,588.40	1,667.82
5	2343.00	2,460.15

4.7.8. QE II Camp Hill

Table 4.27 Hazardous waste collected from the QE II Camp Hill Site

Waste type	Total Weight (kg)	Total Cost ($)
1	51,522.60	54,098.73
2	504.40	529.62
3	3,083.60	3,237.78
4	31.60	33.18
5	188.60	198.03

4.7.9. Cobequid Community Health Centre

Table 4.28 Hazardous waste collected from the Cobequid Community Health Centre

Waste type	Total Weight (kg)	Total Cost ($)
1	1,390.60	1,460.13
4	13.00	13.65

4.7.10. Community Mental Health Bayers Road

Table 4.29 Hazardous waste collected from the Community Mental Health Bayers Road

Waste type	Total Weight (kg)	Total Cost ($)
1	13.40	14.07

4.7.11. CDHA Blood Collection Centre

Table 4.30 Hazardous waste collected from the CDHA Blood Collection Centre

Waste type	Total Weight (kg)	Total Cost ($)
1	74.60	78.33

4.7.12. St. Margaret's Bay Road Health Centre

Table 4.31 Hazardous waste collected from the St. Margaret's Bay Road Health Centre

Waste type	Total Weight (kg)	Total Cost ($)
3	16.40	17.22

4.7.13. Dartmouth Community Mental Health Centre

Table 4.32 Hazardous waste collected from the Dartmouth Community Mental Health Centre

Waste type	Total Weight (kg)	Total Cost ($)
3	0.80	0.84

4.7.14. Woodlawn Blood Collection Centre

Table 4.33 Hazardous waste collected from the Woodlawn Blood Collection Centre

Waste type	Total Weight (kg)	Total Cost ($)
3	32.60	34.23

4.7.15. Ocean View

Table 4.34 Hazardous waste collected from the Ocean View

Waste type	Weight (kg)	Cost ($)
1	14.00	14.70

4.7.16. Spryfield Blood Collection Centre

Table 4.35 Hazardous waste collected from the Spryfield Blood Collection Centre

Waste type	Weight (kg)	Cost ($)
1	6.20	6.51

4.8. St. Martha's Hospital Compactor Waste breakdown

4.8.1. Weight of picked up waste

Table 4.36 Weights of waste picked up in 2016 and 2017

Pick up date (2016)	Weight (kg)	Pick up date (2017)	Weight (kg)
January 6	3,080	January 4	3,620
January 20	4,980	January 18	5,070
February 3	4,740	February 1	4,720
February 17	4,890	February 15	5,010
March 2	4,850	March 1	4,200
March 16	5,170	March 15	4,900
March 30	4,360	March 29	4,860
April 13	5,050	April 12	4,970
April 27	4,600	April 26	4,660
May 11	4,490	May 10	4,970
May 25	4,660	May 24	5,300
June 8	5,530	June 7	5,140
June 22	4,810	June 21	4,870
July 6	4,470	July 5	4,670
July 20	4,720	July 19	4,930
August 3	4,280	August 2	5,050
August 17	4,210	August 16	4,580
August 31	4,280	August 30	4,960
September 14	4,680	September 13	4,540
September 28	4,500	September 27	5,190
October 12	4,810	October 11	4,790
October 26	5,310	October 25	5,140
November 9	5,010	November 8	5,150
November 23	2,980	November 22	4,860
December 7	5,030	December 6	5,280
December 21	4,680	December 20	5,280
Total weight	**122,170**	**Total weight**	**126,710**

4.8.2. Cost breakdown

Table 4.37 Cost breakdown of waste pick up in 2016 and 2017

2016		2017	
Source	**Cost ($)**	**Source**	**Cost ($)**
Tipping fee	9,385.09	Tipping fee	9,859.30
Compactor rental	6,600.00	Compactor rental	6,600.00
Compactor pickup	3,770.00	Compactor pickup	3,770.00
Plastic recyclables	7,800.00	Plastic recyclables	7,800.00
Carboard recyclables	7,678.32	Carboard recyclables	7,678.32

2016		2017	
Total Cost	**35,233**	**Total Cost**	**35,708**

4.9. Discussion & Recommendations

Compactor rental was $550 per month. Pick up of compactor waste happened every second Wednesday and cost St. Martha's hospital $145 per pick up. Plastic recyclables were picked up every Monday and Thursday at $75 per pickup. Cardboard recyclables were picked up every Monday Wednesday and Friday at $24.61 per pickup. These costs did not increase for the year of 2017. The tipping fee was based on the district of Guysborough Waste Management Facility and started off at $0.07682 per kilogram then increased to $0.07781 per kilogram and finally to $0.07886 per kilogram in 2016, 2017 and 2018, respectively.

From the waste data collected, it can be concluded there were errors the disposal of waste or the collection of waste. For example, the Dartmouth General waste disposal charts in Figure 4.4.2, displays there were 0% sharps disposed of over the 12 periods. This data could not be accurate. The Dartmouth General administers medication using the injection method and there were many yellow containers used for sharps disposal sighted during the hospital visits.

A list of problems identified from the data collected is shown below:

- Waste currently being disposed of based on regional standard operating procedures rather than a provincial standard for disposal waste.
- Improper waste separation or collection from Stericycle data.
- General waste improperly disposed of in yellow bags leading to unnecessary incineration.
- Non-infectious waste is being incinerated.
- Increased cost of waste disposal from improper waste separation.
- Increased emissions from unnecessary incineration.
- Behaviour of patients, visitors and hospital staff leads to improper waste separation.
- If standard operating procedures are used, and there is a lack of commonly used definitions, proper waste separation is lost due to the high turnover in a hospital environment.

List of best practices include:

- St. Martha's Hospital implemented a system which helps reduce and properly separate waste.
- St. Martha's Hospital once had a team called the Green Team which dealt with the education of proper waste separation and had a champion from each department as part of the team.

List of recommendations:

- Implementing a ban on single use plastics.
- Implementing a system where receptacles are clearly identified with the type of waste which is to be discarded in the respective receptacle.
- Behaviour is hard to change, therefore, introducing less waste into the hospitals will result in less mixture of waste streams.

4.10. Confidential Waste disposal

Confidential waste stream is taken care of by Shred-it. An invoice from July 31, 2018 was provided. The cost of a large tote filled with confidential information is $27 per tote. However, there is a minimum order value of $30. An order is considered a pickup and disposal of confidential waste. A standard container will vary from $35 to $45 for pickup and disposal.

Table 4.38 Shred-it cost breakdown per location

Location	Cost ($)
Halifax Peninsula Community	69.00
QE II VG Centennial Building	1,376.58
QE II VG Bethune Building	1,020.04
QE II VG Victoria Building	1,070.64
QE II VG Dickson Building	1,009.42
QE II VG MacKenzie Building	577.36
QE II Halifax Infirmary	3,698.68
QE II Clinical Research Centre	717.60
QE II Redevelopment Team	172.50
Capital Health Dartmouth	34.50
Nova Scotia Rehab Centre	437.00
Spryfield Wellness Clinic	69.00
New Beginnings Club House	34.50
Connections Clubhouse	69.00

Location	Cost ($)
Community Health & Wellness East Preston	34.50
Hantsport Collaborative Centre	69.00
NS Health Dartmouth	338.68
Eastern Shore Memorial Hospital	40.25
Continuing Care Joseph Howe	196.30
Integrated Chronic Care Services	103.50
Dartmouth General Hospital	1,299.52
Community Mental Health Centre Dartmouth	69.00
East Dartmouth Community Health	34.50
Mental Health Case Management	34.50
Community Health North Preston	69.00
QE II Foundation	34.50
Mumford Professional Centre (6960)	100.05
Public Health Mellor Ave	121.90
Community Transition Program	34.50
East Coast Forensic	155.25
Mumford Professional Centre (7001)	172.99
Hants Community Hospital	402.50
Veterans Memorial Building	621.01
Bayers Road Community Mental Health Centre	80.50
Correction Facility	442.76
Twin Oaks Memorial	75.90
Addiction Services	69.00
Operational Stress Injury Clinic	14.88
NS Health Lovett Lake	69.00
Musquodoboit Valley Memorial	34.50
DG Expansion & Renovation	34.50
Total of current invoices	**$16,213**

Chapter 5: Hospital Waste Policies

A new hospital waste policy was expected from the NSHA in 2018. However, the policy was never completed. There are many stages in which a waste policy must go through before receiving approval and being published for the NSHA to use. Currently, hospitals are just going through standard operating procedures. Every hospital is currently going through with their regular contracts. Across the NSHA, in the different zones there are different companies which collect general waste from the different zones. Some counties have different items which are not banned from the landfill creating the need for different waste separation practices. In order to standardize waste practices throughout the province, recycling practices would have to be standardized across the province as well.

Since the amalgamation of the NSHA there have been no new policies implemented. On the NSHA webpage, the definition of the different streams of waste are available. However, the procedures and policies which are in place were all created during the capital health days. The list of waste streams included on the website are of biohazardous waste, recycled waste, confidential waste and recycling of used batteries. Biohazardous waste is further broken down into subcategories including human anatomical waste, animal waste, microbiology lab waste, blood and body fluids, sharps waste, and cytotoxic waste.

The current available waste disposal policies are as follows: CH 20-015 Confidential Waste Management, CH 20-016 Recycled and General Waste Management, CH 20-017 Biomedical Waste Management, CH 20-060 Sharps Disposal, CH 05-055 Safe Handling of Cytotoxic Drugs/Waste, and CH 05-066 Disposition of Surplus-Obsolete Capital Health IT Hardware and Software – Application Assets.

The new hospital waste policy should be broken down into new categories with reduction in mind rather than proper separation. While proper separation is important, the reduction of the carbon footprint is an important goal. Aluline Group, a company based in the EU which committed to the new legislation introduced by the EU Landfill Directive, changed the way they dispose of waste (Aluline Group, 2019). They have broken down the new Waste Management Policy into a hierarchy. The hierarchy lists reduction as the most important goal followed by reuse then recovery and final disposal of waste (Aluline Group, 2019). The new waste management policy further outlines the responsibilities of the property and facilities, and the members of staff. The hierarchy will be used as a reference when reviewing the NSHA's waste policies. The full policies can be found in Appendix B.

5.1. CH 20-015 Confidential Waste Management

The Confidential Waste Management Policy was created in November of 2011. The policy is will be eight years old in November. A policy should be reviewed or updated every one to three years (PowerDMS, 2019). This policy is extremely outdated for two reasons: a) the policy was created before the amalgamation of the NSHA and b) the policy has not been updated since it was first released.

Policy CH 20-015 is broken down into three sections, policy, definitions, and procedure. The policy section addresses the privacy and what form of waste should not be disposed of under the policy terms. The second section, definitions, defines what waste is covered. The last section of the policy is a procedure highlighting how to dispose of waste. The policy is general enough for the procedure to remain relevant.

To improve on the policy, the policy should focus on the reduction of waste rather than the disposal. Furthermore, the policy should be more specific as to which vendors dispose of confidential waste. The definitions only define waste yet interchangeably use the terms employees and housekeeping services. The location of where waste is stored should be defined to indicate the proper storage areas and procedure of storing waste in order for information to not get leaked.

This stream of waste could be completely eliminated or significantly reduced by making a switch to a digital filing system.

5.2. CH 20-016 Recycled and General Waste Management

The Recycled and General Waste Management Policy was created in December 2014. There is no evidence for any reviews done on the policy, falling outside of the recommended review period. Policy CH 20-016 is broken down into four sections which are policy, definitions, procedures and references. General waste is heavily regulated by the Provincial Government and therefore the procedure adheres to those regulations. The policy focuses on the disposal of waste rather than the reduction. The policy defines recyclables as corrugated cardboard, mixed office paper, plastic and glass bottles, bags, wrap and plastic containers, metal and aluminum tins and cans, and organic waste. furthermore, the policy defines general waste as solid waste which cannot be recycled, composted or reused (NSHA, 2019).

5.3. CH 20-017 Biomedical Waste Management

The Biomedical Waste Management Policy is vastly different than the other policies. Biomedical Waste Management requires proper disposal. The policy follows the Canadian Council of Ministers of the Environment Guidelines. The policy assigns the responsibility to the housekeeping staff for collection, handling, storage, transportation and disposal. Furthermore, the policy has an appendix clearly outlining handling procedures.

The policy's aim is the safety of the employees who handle this specific waste stream. The policy states a schedule in which housekeeping staff must collect the waste. The schedule in which the waste is picked up is not outlined. The procedure does not go into great depth explaining how to safely handle the waste. The policy has no mention of PPE.

5.4. CH 20-060 Sharps Disposal

The Sharps Disposal Waste Policy was designed in 2003. The policy was set to be reviewed in 2006. The policy states proper education of waste must be administered by Managers or Supervisors. The waste policy does not go into too much depth, the policy states the users must dispose of sharps in a safe manner. The module or guideline in which staff must be trained could not be found. On the NSHA website, updated eLearning training modules can be found, however, none pertain to waste.

5.5. CC 05-055 Safe Handling of Cytotoxic Drugs/Waste

The Handling of Cytotoxic Drugs/Waste Policy was published in January 2014, just before the amalgamation of the NSHA. Due to the nature of cytotoxic waste, this policy is by far the most detailed and longest policy in the NSHA. The policy clearly defines the apparatus used to administer cytotoxic waste to a patient and what cytotoxic drugs, material, protective practices, spills and waste are. Furthermore, the policy has a guiding principle describing what cytotoxic material how they are an occupational hazard. The policy also includes certain disclaimers on the lack of knowledge on the results from extended exposure to the waste and the ways a person could come in contact with the waste.

As it may be apparent in the name, the policy outlines how to handle cytotoxic material during and after operating procedures. The policy is the only policy which details which method of waste disposal to dispose the cytotoxic stream of waste due to how hazardous it is and what apparatus cannot be used to dispose of the waste. The policy also defines any human excreta which may have come in contact with cytotoxic material to be considered cytotoxic waste and defines a time window in which excreta should be considered cytotoxic waste. The policy also outlines how to handle accidental exposure to cytotoxic waste whether it be to a doctor or the patient or any family members. Since family members are not safe from accidental exposure, the policy dictates staff must educate family members on safe handling practices and why they are implemented.

5.6. Discussion

The policies that the NSHA authority currently have in place are out of date and are in need of review. The recommendation is to review the current policies in place and highlight current practices according to the new contracts put in place between the NSHA and waste disposal vendors. It is also recommended for the NSHA to implement teaching modules in which teach staff about policy updates on waste management whenever there is a change. The policies should be implemented across the province of Nova Scotia where applicable. The current system of the NSHA is the operation based on old practices. The reduction of waste would be an appropriate focus of the new policies before focusing on the disposal of waste. The proper disposal of waste would decrease the cost of disposal; however, the reduction of waste would achieve the same thing and free up some space in the hospitals.

The policies in place at the NSHA go in great depth with waste streams which could make the hospitals liable for any incidents. However, the amount of detail put into the biohazardous and cytotoxic waste policies should also be translated into the recyclable and general waste stream policies. The oversight of a few items such as textiles, wax paper products and construction and demolition waste costs the environment. The NSHA should approach the review of their new policies with the environmental impacts in mind.

A list of problems with the policies are:

- Waste policies have not been reviewed in years.
- Municipal by-laws impede on implementing province wide waste separation policies.

5.7. Policy Recommendations

The following policies abide by the HRM's waste disposal rules and regulations collected from the official Halifax website. In the new policies which are to be put in place, the following should be included:

- Definition of waste,
- Apparatus used to collect waste,
- PPE required to collect waste,
- Proper storage protocols,
- MSDS for hazardous materials.

Further recommendations for newly introduced policies are:

- Clearly stating objective of policy before creating policies.
- Implementing a board consisting of members from different hospitals, which includes member(s) from the maintenance staff, nurses, physicians and the board.
- Review policies every one to three years.
- Introducing a team which champions the education of defining waste to hospital staff across the province and implements proper signage to encourage proper waste disposal.
- Introducing the reduction of waste to different levels of government and imposing a ban on problematic waste to have province wide compliance.
- Clearly defining the difference between waste reduction and waste diversion.
- Waste reduction can be defined as waste not allowed to enter the hospitals.
- Waste diversion can be defined as proper source separation.

Furthermore, as of July 22, 2019, newly issued signage can be printed off the website for businesses to display on their waste receptacles. However, it would be more beneficial to display a list of what is available for hospitals visitors to buy in more specialised areas such as the cafeteria.

5.7.1. General Waste

General waste is waste directed to the landfill following the HRM's definition. General waste is non-medical and cannot be recycled. The material is to be collected in black or clear bags. In accordance to the HRM by-law S-600, the weight of the general waste bag cannot exceed 25kg, including the bag's contents. Bag specifications can be found under section 7 of the by-law "Regulation Plastic bags and Containers for Municipal Collection". Construction and demolition waste should be handled by Halifax C&D Recycling Ltd (Halifax, 2019). Standard PPE should be used for the collection of general waste.

5.7.2. Recycling

Recycling is to be separated into its elements and each element should be considered a separate waste stream. The waste streams are not to be mixed and are to be stored in clear blue bags. The first stream should be considered the recycling stream which contains plastic bags, glass bottles and jars, steel and aluminum cans, and the like. Styrofoam will not be included in the recyclables waste stream (Halifax, 2019). There is next to no hazard for this waste stream and can be disposed of using standard PPE.

5.7.3. Organic Waste

Organic waste should only contain food waste and napkins. The waste receptacle for food waste should only be green. Fat, oil, and grease must be collected by a rendering service (Halifax, 2019). Definitions of what can be considered food waste should be added to the waste policy.

5.7.4. Biomedical Waste

Biomedical waste should be contained within the appropriate waste containers. Ones which will not allow for any leaks. Animal waste, human anatomical waste, microbiology lab waste, blood and body fluids, sharps, and cytotoxic waste are all considered biomedical waste. This stream of waste is to be disposed of in yellow bags to be disposed of using the proper means such as incineration or autoclaving. A definition of each waste stream is to be included in the waste policies alongside proper storage and disposal of each waste stream. It is important to also include the material data safety sheets for the material to be handled or have a designated location defined where the data sheets are easily accessible for staff to refer to. Waste stream should be stored safely away from access to the general public or where hospital staff would not be affected by any potential spills.

5.7.5. Confidential Papers

Confidential waste should be stored in locked receptacles and locked away from staff and be stored until ready for pickup by staff hired to properly dispose of the waste.

Chapter 6: Case Study

6.1. Introduction

The case study performed was on polystyrene and polystyrene waste. Known widely as Styrofoam, polystyrene is not currently a banned substance from the landfill. The two most common forms of polystyrene are expanded polystyrene (EPS) and extruded polystyrene (XPS), both made of polystyrene resin. EPS is manufactured by expanding the resin and then molding it to form a closed-cell material which uses air as its insulation medium (similar to the material shown Appendix C). The manufacturing process of XPS includes the liquification of the polystyrene resin and is then extrusion through a die to form a closed-cell material which also uses trapped air as insulation medium (ACH Foam Technologies, 2019). Polystyrene has useful properties such as insulation, shock absorption, durability, nonbiodegradability, and its low manufacturing cost. The reason behind choosing the diversion of polystyrene waste from the landfill is due to its nonbiodegradability (ACH Foam Technologies, 2019). Furthermore, polystyrene takes up a lot of its volume with respect to its weight which requires more space in the landfill. The goal of this case study is to reduce the polystyrene waste which is introduced to the landfills.

The list of case studies was narrowed down to both blue sterile wrap recyclables and polystyrene. However, at a certain point throughout the year and with several meetings with the Central Zone Facility Support Manager and hospital management, a vendor was picked up to potentially take care of blue sterile wrap recycling from the hospitals.

6.2. Literature Review on Polystyrene

Polystyrene is used in many products we use today from packaging found in boxes, to cups to the meat holding plates found in grocery stores. Polystyrene plastic is naturally transparent and is available in both film and foam (Rogers, 2015). The two most well-known forms of foam polystyrene are EPS and XPS. The controversy of polystyrene is its inability to biodegrade quickly. Therefore, taking up space in the landfill. Polystyrene is extremely useful and is used in many ways throughout society. The issue is with the extensive use of the monomer, there are not many ways in which it can be recycled. With polystyrene being a plastic, it does not biodegrade quickly. In Nova Scotia, in 2017, approximately 1.52% of all waste was polystyrene (Rogers, 2015).

Polystyrene is a plastic, and like other plastics it is formed through the distillation of hydrocarbon fuels into lighter groups combined with catalysts to form the plastic (Rogers, 2015). Once the monomer is created, blowing agents expand the plastic into its foam like shape trapping air inside of it to use as a medium for insulation. Polystyrene is inert, it does not do well with acidic or basic solutions. If polystyrene comes in contact with a chlorinated or hydrocarbon substance, it dissolves almost immediately. Polystyrene is nontoxic and odourless. While some are led to believe it is completely harmless, there have been studies which have shown health impacts from ingesting food stored on polystyrene. Polystyrene is also a plastic, and like other plastics, is flammable. If polystyrene is melted, it emits carbon dioxide adding to global emissions (Rogers, 2015).

Polystyrene is a monomer; therefore, its products are normally made purely of polystyrene. The purity of polystyrene allows for recycling opportunities. The issue is there are not many avenues in which polystyrene recycling can occur.

The raw material used for EPS are fossil fuels (Tan and Khoo, 2004). In a life cycle analysis performed by Tan and Khoo (2004), the results indicated the production of EPS had the biggest climate change factor. In another study performed by Zabaniotou and Kassidi (2003), eggcups made by polystyrene required nearly twice the amount of fossil fuels needed to make the same product out of recycled paper and nearly 39 times the amount of natural gas required of raw material. Furthermore, the EPS eggcups produced more air and liquid waste in comparison to recycled paper eggcups.

The creation of EPS is an energy intensive one, however due to the properties of EPS, it can return up to 200 times the amount of energy required to produce it if used as insulation (EPS Industry Alliance, 2019). The main attribute of EPS which allows for such a high return is its long lifespan. To be able to reuse the energy used to make EPS, EPS would have to either be made into insulation or resold to an interested party who has the ability to densify and reuse EPS.

Polystyrene is a microplastic. Microplastics have contributed to the pollution of marine habitats (Xanthos & Owen, 2015). The ingestion of polystyrene by sea creatures has been linked to the colour of the disposed polymer (Wright & Thompson & Galloway, 2013). Plastic debris which has not been properly landfilled was eventually found in marine environments. Obard et al. (20014) suggested plastic microbeads have found their way to the polar sea, and when the ice beds melt, the plastic microbeads will find their way back into the environment (Xanthos & Owen, 2015).

6.3. Methodology

6.3.1. Truefoam

To determine how to properly divert polystyrene from the landfill, research was done on what methods of recycling were available locally. Truefoam is a company located in Burnside, Dartmouth and deals with the recycling of EPS. Contact was established with Truefoam in the past; however, polystyrene is yet to be diverted from the landfill. Truefoam is a company which deals with EPS recycling and turns it into insulation material. Truefoam has its own supplier of EPS, however, they are willing to take in foam waste in the spirit of the environment and recycling. Truefoam is willing to accept any amount of EPS waste but would however need to set up drop off times if the shipment of waste was large. Truefoam had no interested in taking any of the XPS generated in the hospitals.

Due to the volume to weight ratio of polystyrene, weight was not used as a measurement in how much waste was generated. Truefoam supplied polywoven bags which were 4' x 4' x 4' and could carry up to 800kg of beaded foam. The polywoven bags are supplied for free from Truefoam and are easily picked up at their recycling facility. Transportation of polystyrene was done using a rental truck which could carry the volume of polystyrene. The case study was performed in the HRM on the QE II Victoria General, QE II Camp Hill and Dartmouth General Sites. There were three different collection runs done from Monday to Friday to determine the amount of polystyrene created. Frequent collections had to be done from the hospitals due to a lack of space available in the hospitals. This is a common problem amongst all of the hospitals in NS. This led to the pickup of foam more frequently than the trucks would require getting filled up.

Polystyrene was collected from each site multiple times a week and dropped off at Truefoam. If a bag was partially filled, it was considered one full bag due to the nature of transportation and fitting the bag in a truck. For the sake of labour, the foam was accepted as is and not broken down into smaller piece. Nothing was stored beyond receiving the foam at the storage locations in the hospitals. If Truefoam could not receive the foam, the foam would just get thrown out in the waste bin.

Truefoam had specific criteria in which they would accept the waste from the hospitals. The list of criteria included:

- Truefoam only wanted to deal with EPS. No XPS.
- The EPS must be clean. There could be no contamination or other material on the foam (i.e. no tape or labelling).
- Truefoam would not pick up or deliver the waste since it was not part of their business model and this would incur extra costs on them.

Truefoam already has a contract with Miller Group to pick up and deliver foam waste to their facility. However, after speaking with the Central Zone Facility Support Manager about the potential to work with Miller Group, this option was discarded as not feasible. Truefoam has not done an analysis on what it would cost them to receive waste from external sources, however they believe it costs them money to recycle the extra material.

A quick chat with the Central Zone Facility Support Manager revealed negotiations with Truefoam had happened in the past, however plans fell through due to logistical reasons. The hospitals do not have much room in their budget to invest more money into the transportation of waste and Truefoam refuses to go out of their way to pick waste up, incurring any extra costs.

6.3.2. GreenMax Intco Recycling

Research on foam diversion in NS has led to discovering EPS and XPS recycling already happening in Colchester County. Colchester county had successfully managed to move their foam waste from the waste stream to recycling. In Colchester County, foam is picked up alongside the bluebag container recycling and is separated in their local facility. Colchester Materials Recovery Facility collects waste from Colchester, Stewiack, Truro, Pictou, Antigonish, St. Mary's, Guysborough, East Hants and the Town of Windsor. Not all of the aforementioned counties send their EPS and XPS waste to the material recovery facility. The material recovery facility had given the option to opt out of recycling EPS and XPS waste if it ended up being too costly.

The Colchester Materials Recovery Facility had purchased a densifier and densifies both EPS and XPS, making them into ingots of polystyrene before selling them to the market. On the market, white polystyrene ingots are sold at a price per pound higher than that of the coloured ingots. The densifier purchased for the material recovery facility was provided by GreenMax, a company operating out of China. Due to the manufacturing of the machine being done in China, there were adjustments which needed to be done on the machine in order to get approval for use in Canada.

Furthermore, changes had to be made to the materials recovering facility to accommodate for the introduction of the new recycling stream. Incurred cost to the material recovery facility came from purchasing the densifier, rearranging the material recovery facility and introducing an exhaust system for emissions, buying a new feed line, extending the container line and purchasing the proper PPE. The material recycling facility does sell their ingots to a client. They refused to share that information due to contractual agreements. GreenMax does purchase EPS and XPS ingots and have a quoted price based on weight.

GreenMax offers a variety of machinery to densify EPS and XPS. The breakdown of each machine and its costs are highlighted in Table 6.1 from a quote provided by GreenMax.

Table 6.1 GreenMax machine costs

Item	Unit	Unit Price (USD)	Quantity	Amount (USD)
GreenMax M-C100	Set	35,000	1	35,000
GreenMax M-C200	Set	42,000	1	42,000
GreenMax Z-C100	Set	32,000	1	32,000
GreenMax Z-C200	Set	40,000	1	40,000

The Colchester Material Recovery Facility purchased the C200 for their diversion operations.

6.4. Analysis and Results

6.4.1. Truefoam

The collection of foam from the three hospital locations was done three times. For the purpose of meeting Truefoam's requirements, only EPS was collected. The hospital management agreed to put aside polystyrene waste in designated locations for three different weeks. The generation of waste was extremely inconsistent. The amount of waste was measured in number of polywoven bags filled throughout the week. Table 6.2 displays the amount of waste generated in each week per location.

Table 6.2 Number of bags of polystyrene foam collected from the hospitals

Location	Bags in week 1	Bags in week 2	Bags in week 3	Average number of bags (rounded to the next bag)
Dartmouth General	0	1	1	1
QE II Victoria General	7	2	1	4
QE II Camp Hill	1	1	1	1

Picture of the bags filled with EPS is presented in Appendix C. On a day to day basis, there was not a constant generation of EPS waste. Therefore, the recording of the collection was done over the week rather than daily basis. Foam takes up a lot of space. In the QE II Victoria General, there was a space in the basement to store the waste, but that filled up quickly. In the QE II Camp Hill site, the foam was stored in clear bags outside. The bags were safe from the weather and wind. In the Dartmouth General, there was a small room located near the docks where the foam was generated. In this room, there barely was any foam stored. When asked, the staff did not know about separating the foam from the rest of the waste streams. Furthermore, there were piles of blue drapes stored in the room where the foam was supposed to be stored in and separated from the rest of the waste. The QE II Victoria General site failed to separate EPS and XPS. The other two sites only separated EPS from the general waste stream, as intended. A picture of the EPS waste and the XPS waste is presented in Appendix C.

The NSHA has an ongoing contract with REgroup to collect and transport waste in the HRM. A representative from REgroup gave us an estimated cost on what it would be to transport the waste. REGroup does not do any on-call pickups as of February. Therefore, a monthly pick-up and delivery service would cost $175 plus taxes per trip monthly from the hospitals to deliver the waste to Truefoam. The delivery truck would be able to handle 8 cubic yards of polystyrene per trip. Truefoam does not charge a fee to receive any extra foam from suppliers looking to recycle and therefore REgroup would not charge a tipping fee for delivery of foam. Thus, the yearly collection cost would be 175x12x1.15=$2,415.

Another incurred cost the hospitals would have to take is to properly educate staff on the differences between EPS and XPS and how to identify them. Furthermore, a policy on the procedures of separating the waste and a designated storage area would be required for a monthly pickup. During test runs, I was able to collect and sort the Styrofoam at a hospital within an hour. A labour cost equivalent to 1/8th of the annual wages of a janitorial employee is about $3,959.

The total yearly cost to take the styrofoam from one of the HRM hospitals to Truefoam would then be approximately $6,374 per year.

6.4.2. GreenMax Intco Recycling

The GreenMax densifier can densify both EPS and XPS. The same data from the three weeks of collection can be used to approximate whether purchasing a densifier is a feasible option. The initial investment of the densifier would immediately rule out the diversion being cost effective. Furthermore, the installation of a densifier would require space and restructuring of the hospitals. The hospitals have problems with space as is. A new building is being set up in the HRM to replace the current hospitals, including a densifier in those buildings could be a potential solution. In the interim, waste is still not diverted from general waste stream and both EPS and XPS still end up in the landfill. The new hospital building is still years away from being built and in turn, that is years of waste going to the landfill rather than being recycled. Colchester County recycles waste from households and ICI diverting waste from the landfill to a consumer willing to buy densified polystyrene ingots. To potentially divert polystyrene waste from the landfill, the diversion would have to be scaled up from the waste in the hospitals to waste in the HRM. If the project is to be implemented in the HRM, further scaling up can be done to divert waste from the rest of NS.

According to the 2016 Census performed by Statistics Canada, the average household has 2.8 people in the HRM (Statistics Canada, 2016). In 2017, the province wide waste audit performed by Divert NS indicated a total of 124,890 tonnes of waste generated over the year. Of the waste generated 1.52% was polystyrene totalling 1,898,328 kg per year or 158,194 kg per month on average from both the residential and ICI sectors. The following Table 6.3 will break down the initial cost of purchasing each form of densifier and how many total units are needed to satisfy the HRM's waste production.

Table 6.3 Initial cost from purchasing the densifier

Machine	Production Capacity (kg/hr)	Hours of operation per month (hr)	Days of operation if 1 machine on a 10-hour workday (days)	# of machines to operate 20 days in a month (machines)	Unit cost (USD)	Total cost (USD)
Z-C100	100	1581.94	158.19	8	32,000	256,000
Z-C200	200	790.97	79.10	4	40,000	160,000
M-C100	100	1581.94	158.19	8	35,000	280,000
M-C200	200	790.97	79.10	4	42,000	168,000

The M-C200 is the machine currently being used in the Colchester Material Recovery Facility. In addition to purchasing the densifier, there are extra costs. Using the Colchester Material Recovery Facility as a reference, the extra costs would be similar to what is highlighted in Table 6.4.

Table 6.4 Reoccurring costs from purchasing the densifier

Source	Cost ($)	Units
Extended container line	74,000.00	One time
Average wage of 1 new employee	18.31	Per hour
Tote bag	16.74	Per unit
Exhaust	5,580.00	One time
Pallet	13.50	Per unit
Shrink wrap	20.00	Per unit
Safety mask (P100 rating)	162.00	Per unit
Safety gloves (700F rating)	18.00	Per unit
Certification of machinery	7,000.00	One time
Preventive Maintenance	660.00 (500 USD)	Yearly

The densifier was purchased in China. The Canadian standards require a bit more work to get the required certification.

To meet the HRM's requirement for waste generated, a minimum of four machines would need to be purchased. Assuming, the M-C200 was the machine purchased, the approximate cost on the city would be as follows. The same capital recovery variable assumptions were made for this avenue of diverting waste. The Excel sheet, "Cost per year", is attached to the report to change the figures are receive a more accurate result based on actual cost.

Assumptions:

1. Machinery will be located in the HRM.
2. Costs of extending the container line is the same as what it cost in Colchester.
3. 1 new employee per machine.
4. 1 exhaust system per machine.
5. Purchase of a set of new safety masks per machine.
6. Purchase of a set of pairs of gloves per machine.
7. Only one-time costs and the average yearly salary per employee are included in the calculations.
8. Employees are full time workers. The employee has 35 paid hours per week and works 52 weeks a year. The average wage is similar to the wage from Colchester.
9. Assumed 5% of cost is maintenance cost yearly as well as estimated cost from GreenMax for oiling and cleaning of machinery which is about $500 USD.
10. 1 USD = 1.34 CAD as of August 30, 2019.

Details of the calculations presented can be found in the Excel file attached to this report.

Purchase of machinery: $236,376

Training of workers: $16,080

Installing two container lines: $148,000

Installing exhaust: $22,320

Certification of machinery: $28,000

Cost of PPE: $648

Gloves: $72

Cost of maintenance: $12,318

Cost of Electricity: $31,574

Employee wages: $133,297

The initial cost of purchasing the equipment is $486,000 with a reoccurring yearly cost of $128,000. Over the 5-year amortization period of the machinery, it would cost roughly $440,000 per year to operate the machinery and divert the waste. The calculations for these costs can be found in the Excel file attached.

HRM already collects Styrofoam with garbage, so there would be no additional collection cost incurred if that is the collection method to be used. However, this may induce additional sorting cost at the processing centres need to separate Styrofoam from the rest of garbage and also lead to contamination, which would reduce the quality and amount of densified Styrofoam sold to Intco. In the event that Styrofoam diversion is implemented, the HRM could ask residents to sort and put their Styrofoam waste into clear bags to be collected with their garbage. This would help lower the sorting cost but add additional cost. It is recommended to conduct a more detailed study and possibly a pilot program with one machine in one of the municipalities of HRM to ascertain the total cost of running such a diversion program.

6.4.3. Revenue Avenues

If the NSHA decides on following through and donating the foam waste to Truefoam, then there is no revenue to be made from the disposal of waste and the operation will cost the facilities money to recycle this stream of waste. This is not a favourable option for the NSHA due to lack of budgeting. The only form of capital recovery from following through with the simple diversion of polystyrene and sending it to Truefoam would be the money saved from not entering the landfill. Otter Lake's model of charging for waste based on weight and not on volume poses an added layer of complication to the waste being sent to the landfill. The weight to volume ratio of polystyrene is fairly small. Therefore, the landfill will be filled up by a large amount of polystyrene and the money saved from not entering the landfill does not accurately reflect the amount of waste entering the landfill.

Purchasing the densifier from GreenMax allows for the hospital to resell the densified polystyrene ingots. Colchester Material Recovery Facility did not give an exact number on how much money they make per ingot. The facility estimated their revenues to be between $400 to $600 CAD per metric tonne and $200 to $300 CAD per metric tonne of white ingots and coloured ingots, respectively. A quote from a representative from GreenMax states GreenMax pays $0.2 USD per pound for both EPS and XPS. Using GreenMax's calculations for purchasing ingots, the estimated revenue is outlined below.

Assumptions:

1. 80% foam collected is converted into ingots.
2. 1.52% of total waste generated in the HRM is polystyrene foam.
3. The purchase price per pound is the average for both white and coloured foam ingots.

First, we convert the revenue from pounds to kilogram.

$$\frac{\$0.2}{1\ lb} \times \frac{2.20\ lb}{kg} = \frac{\$0.44}{1\ kg}$$

Then we multiply the purchase price by the total amount of foam waste generated in 2017.

$$\frac{\$0.44}{1\ kg} \times 1{,}898{,}328\ kg \times 1.34 \times 0.80 = \$897{,}283$$

The total revenue generated in 2017 had the densifiers been purchased would have been \$897,283 assuming one colour. Furthermore, diverting the waste from the landfill would have had an additional saving of \$151,866 if 80% diversion was achieved. Based on the calculations done in the case study, the revenue made in 2017 would cover the one-time costs and the reoccurring yearly costs. To come up with a more accurate estimate, it would be beneficial to perform a pilot study but the approximate calculations carried out in this report show that there can be significant benefits to diverting Styrofoam from HRM garbage collection as long as the additional yearly collection and sorting cost are less than \$750,000 (897,283+151,866 – 291,300).

6.4.4. Recommendations

The recommendation before purchasing the equipment to divert polystyrene waste from the landfill would be to perform an actual study to include a more accurate cost estimate based on how many facilities will include a densifier. Costs indicated in this report are estimated with a pessimistic nature. Before densifying polystyrene, it would prove helpful to understand what the energy costs of operating the machinery would be, how many more trips REgroup would have to make to pick up all the added waste, and what the emissions of densifying polystyrene are like.

Furthermore, since the polystyrene waste is transferred from the general waste pile to the recycling pile, what the savings from reduced general waste pick-ups are.

To inquire about the densifiers, Mr. Daniel Wang from GreenMax may be contacted at danielwang@intco.com.

Chapter 7: Conclusion

The amalgamation of the NSHA occurred in 2014 and the hospitals have been disposing of waste using the same operating procedures prior to the amalgamation. The purpose of the amalgamation was the standardize operating procedures. Due to the lack of the change, the NSHA has a discrepancy in the way waste is disposed of from hospital to hospital. The creation of a new waste policy is low on the list of things to do according to the Central Zone Facility Support Manager. Problematic areas which need to be reassessed in the NSHA waste streams are C&D, textiles, paper products, organic material, hazardous and plastic wastes.

The most common waste stream in the NSHA is general waste. The misuse of coloured bags was a common issue found during hospital visits alongside the vast difference of waste receptacles used for the same waste stream. It was not uncommon to find multiple different waste receptacles in one area. Respective waste receptacles were generally placed where waste would generate. Hospital waste policies have not been reviewed or updated in many years, with some policies dating back to 2003.

A summary of the recommendations are as follows:

- Implementing a ban on single use plastics.
- Implementing a system where receptacles are clearly identified with the type of waste which is to be discarded in the respective receptacle.
- Behaviour is hard to change, therefore, introducing less waste into the hospitals will result in less mixture of waste streams.
- Clearly stating objective of policy before creating policies.
- Implementing a board consisting of members from different hospitals, which includes member(s) from the maintenance staff, nurses, physicians and the board.
- Review policies every one to three years.
- Introducing a team which champions the education of defining waste to hospital staff across the province and implements proper signage to encourage proper waste disposal.
- Introducing the reduction of waste to different levels of government and imposing a ban on problematic waste to have province wide compliance.
- Clearly defining the difference between waste reduction and waste diversion.

- Waste reduction can be defined as waste not allowed to enter the hospitals.
- Waste diversion can be defined as proper source separation.

In a case study run on the diversion of EPS and XPS waste, it was not recommended for the NSHA to divert waste as it would cost too much. However, the diversion of EPS and XPS is still a viable option if scaled up to the HRM. Scaling up the diversion of polystyrene to the HRM would result in the diversion of the waste stream becoming a financially viable option. The diversion of EPS and XPS from the landfill has already been implemented in Colchester County using a densifier. Colchester County sells the densified foam ingots for a profit for the foam to be used for a different purpose rather ending up in the landfill. This system can be implemented in the HRM and the waste can be diverted from both the residential and the industrial, commercial and institutional sectors.

The assessed levels of polystyrene produced in the hospitals were not enough to push with the diversion of waste. However, the HRM produces enough polystyrene waste to purchase densifiers and sell for a profit. Furthermore, this project can be scaled to densify polystyrene generated in the province of Nova Scotia. The ability to implement this project would require different levels of governments introducing new by-laws to bypass the different municipality laws.

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Appendix A: Results of Hospital Visits

Figure A. 1 General waste collection in the Dickson Building

Figure A. 2 Blue wrap storage St. Martha's Hospital

Figure A. 3 Another blue wrap storage area St. Martha's Hospital

Appendix B: Hospital Waste numbers

B.1. Medical Examiner Service

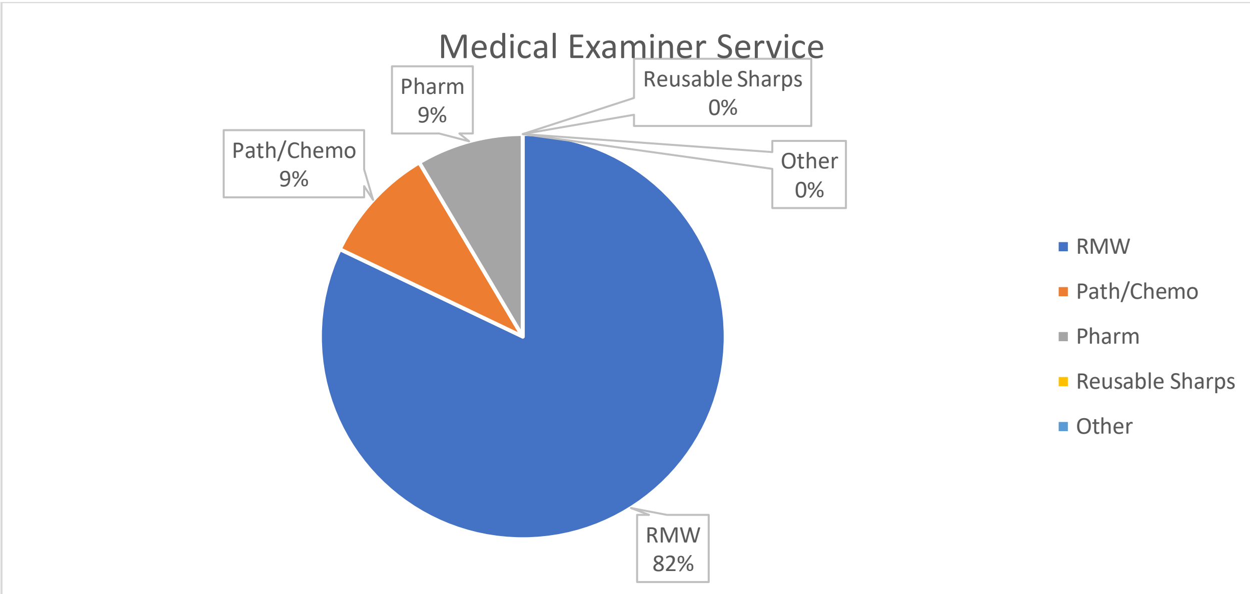

Figure B.1 Percentage of container waste type from the Medical Examiner Service

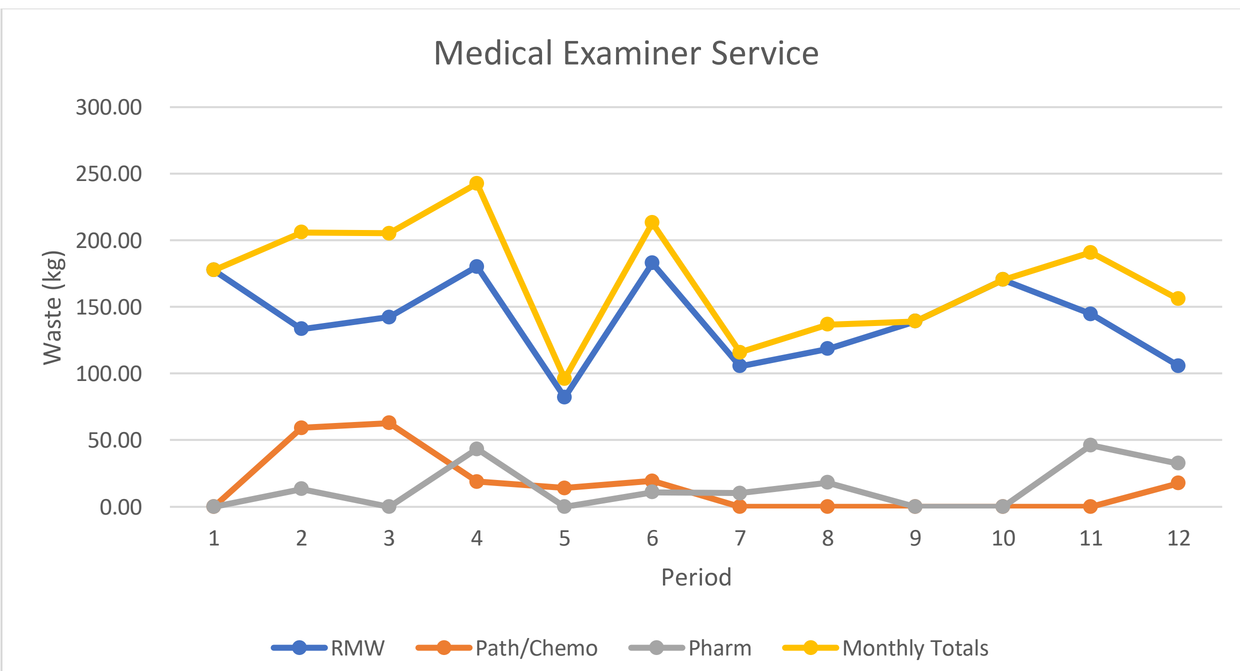

Figure B.2 Numeric values of waste generated per period in kg from the Medical Examiner Service

Table B.7.1 Numeric values from the Medical Examiner Service

Monthly Totals	
Max (kg)	242.65
Min (kg)	96.18
Mean (kg)	170.84
Std Dev (kg)	41.62
Median (kg)	174.04
N	12

B.2. Fisherman's Memorial Hospital

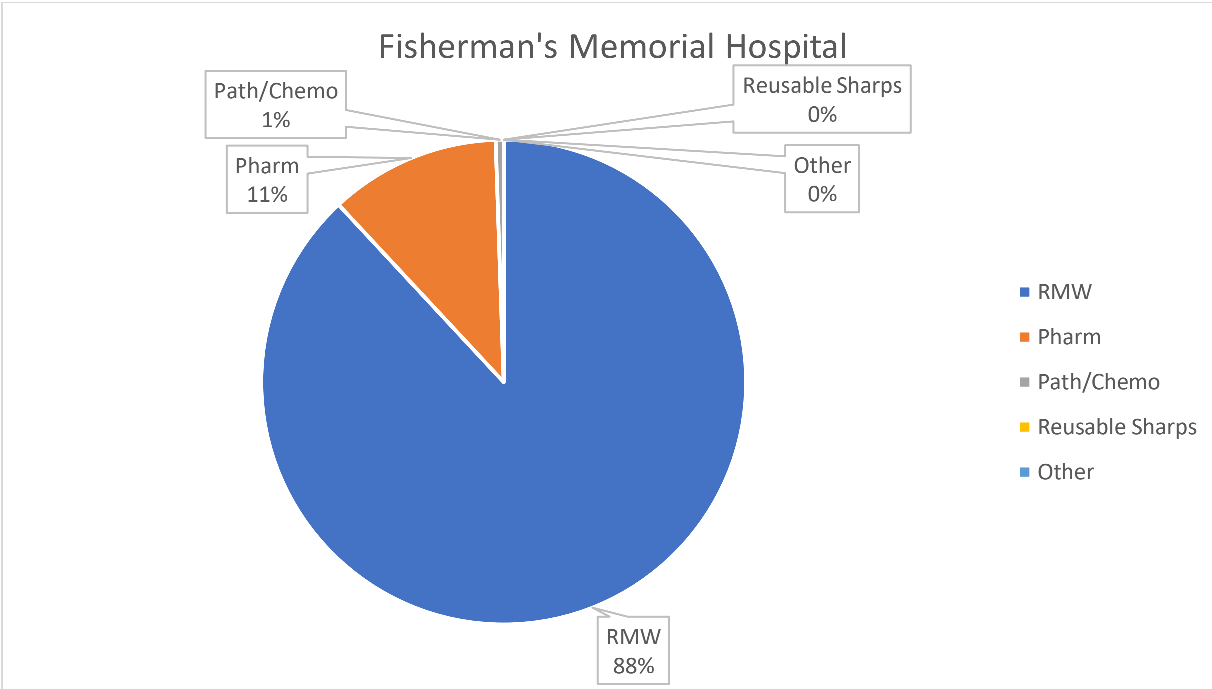

Figure B.3 Percentage of container waste type from the Fisherman's Memorial Hospital

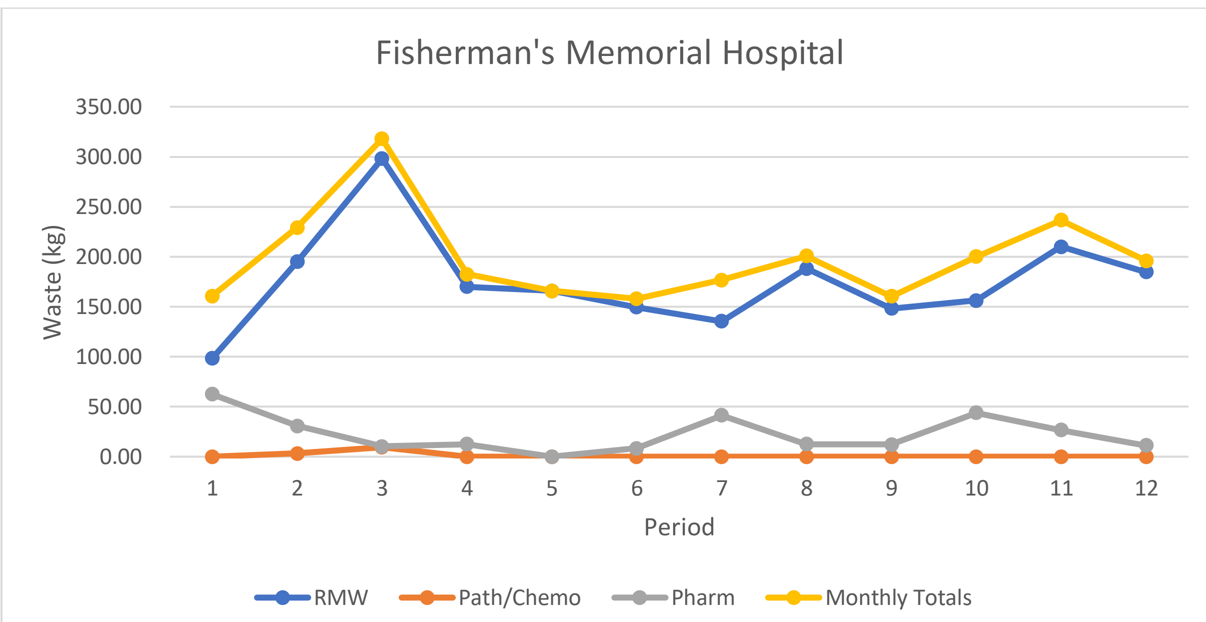

Figure B.4 Numeric values of waste generated per period in kg from the Fisherman's Memorial Hospital

Table B.7.2 Numeric values from Fisherman's Memorial Hospital

Monthly Totals	
Max (kg)	317.86
Min (kg)	157.92
Mean (kg)	198.67
Std Dev (kg)	43.75
Median (kg)	189.16
N	12

B.3. South Shore Regional Hospital

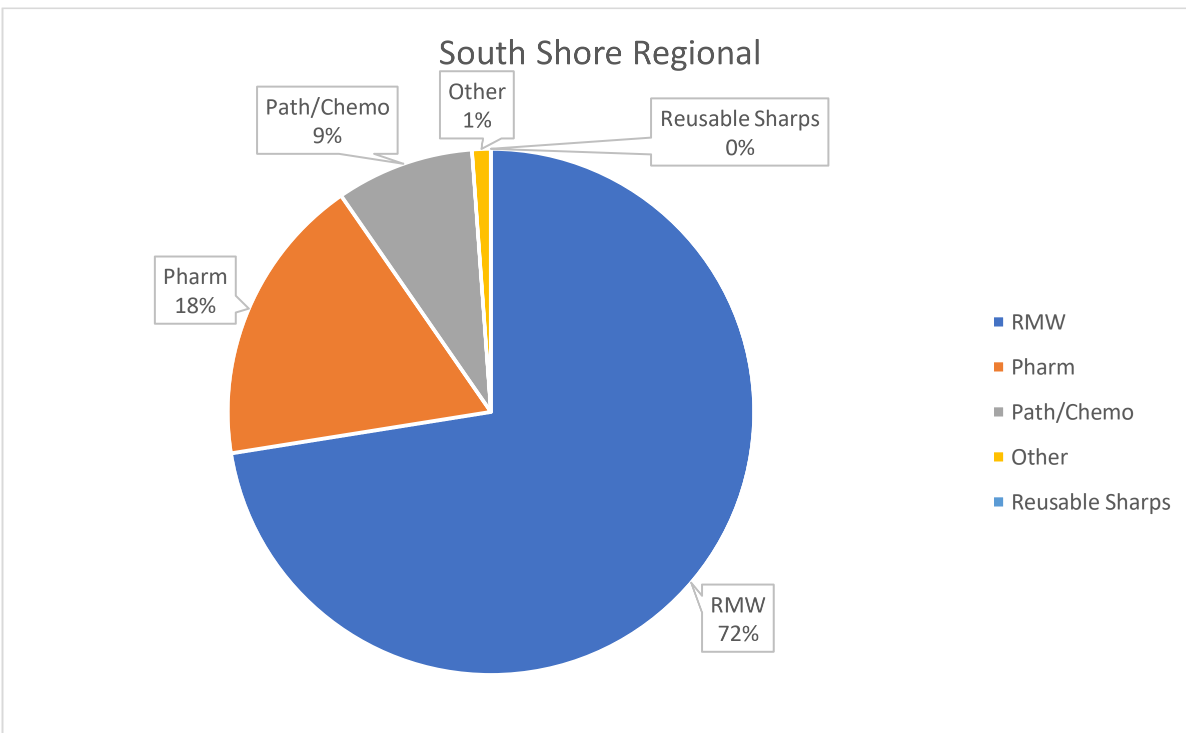

Figure B.5 Percentage of container waste from the South Shore Regional Hospital

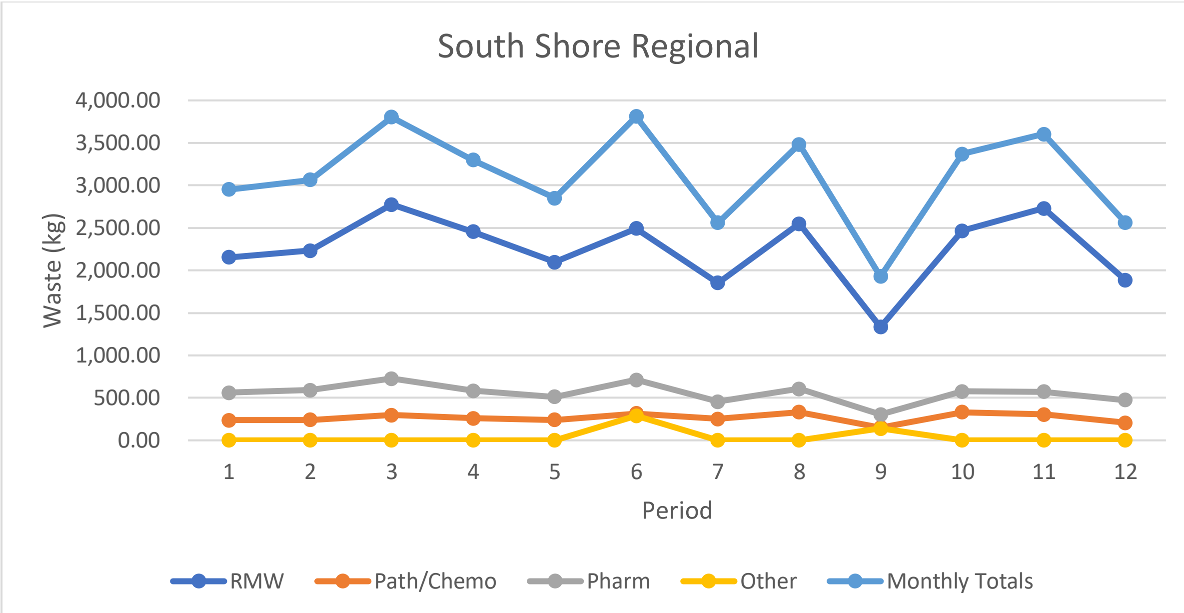

Figure B.6 Numeric values of waste generated per period in kg from the South Shore Regional Hospital

Table B.7.3 Numeric Values from the South Shore Regional Hospital

Monthly Totals	
Max (kg)	3,808.55
Min (kg)	1,927.35
Mean (kg)	3,106.86
Std Dev (kg)	544.10
Median (kg)	3,180.64
N	12.00

B.4. Queen's General Hospital

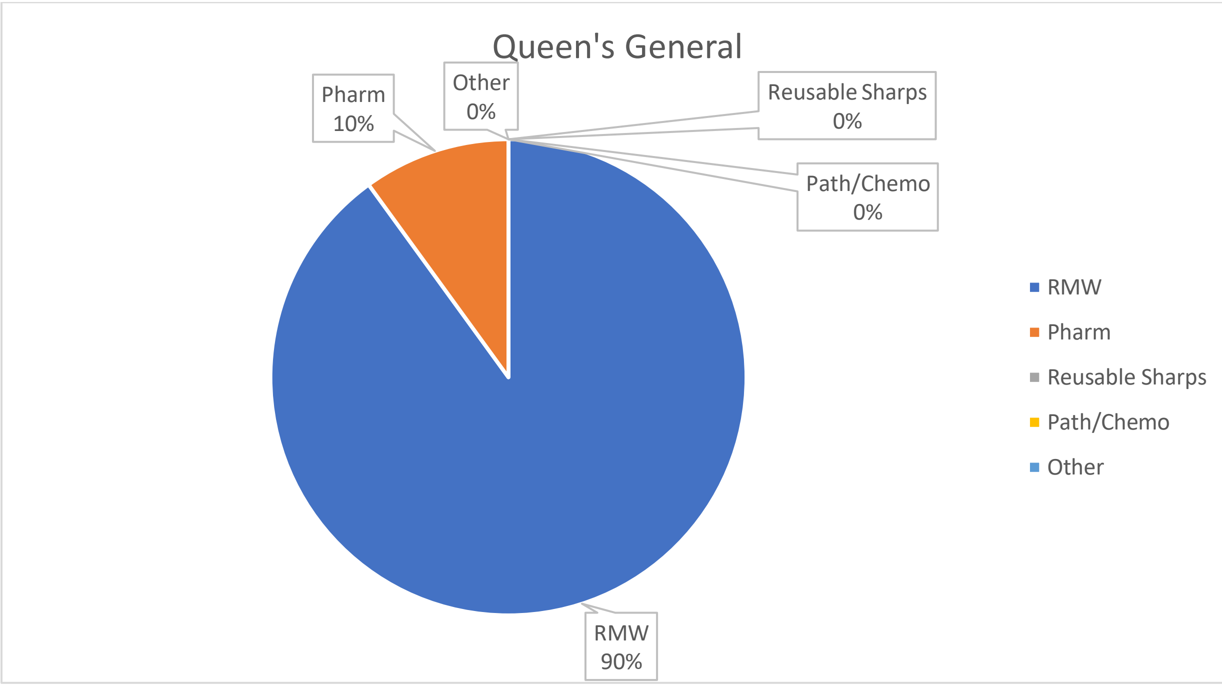

Figure B.7 Percentage of container waste from the Queen's General Hospital

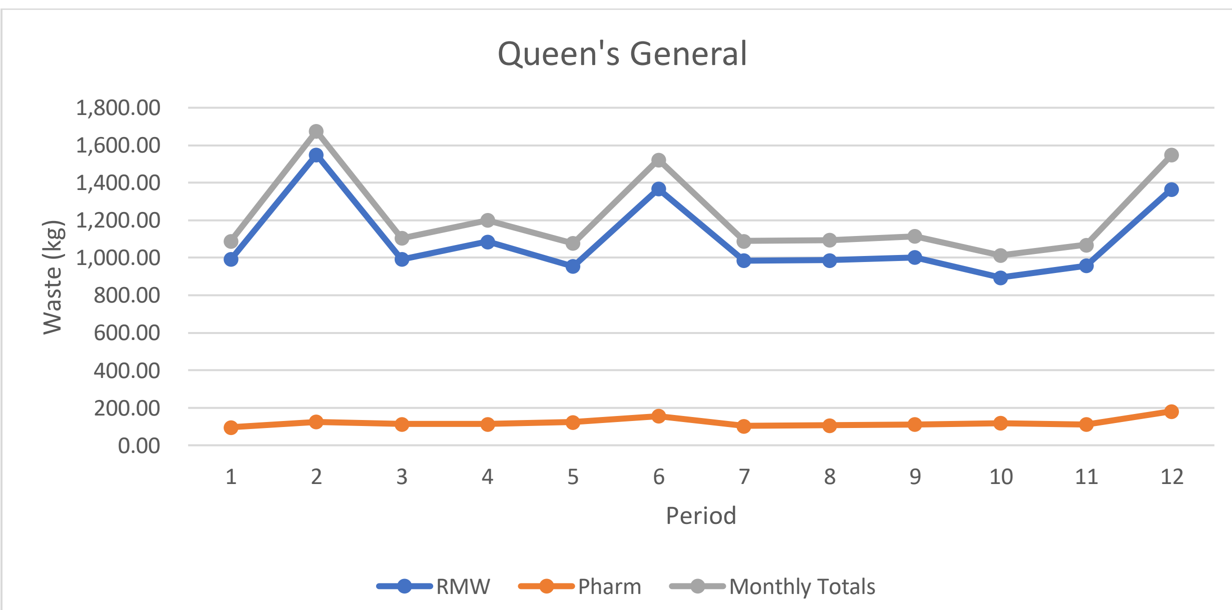

Figure B.8 Numeric values of waste generated per period in kg from the Queen's General Hospital

Table B.7.4 Numeric Values from the Queen's General Hospital

Monthly Totals	
Max (kg)	1,674.57
Min (kg)	1,012.81
Mean (kg)	1,216.15
Std Dev (kg)	217.33
Median (kg)	1,099.59
N	12.00

B.5. Roseway Hospital

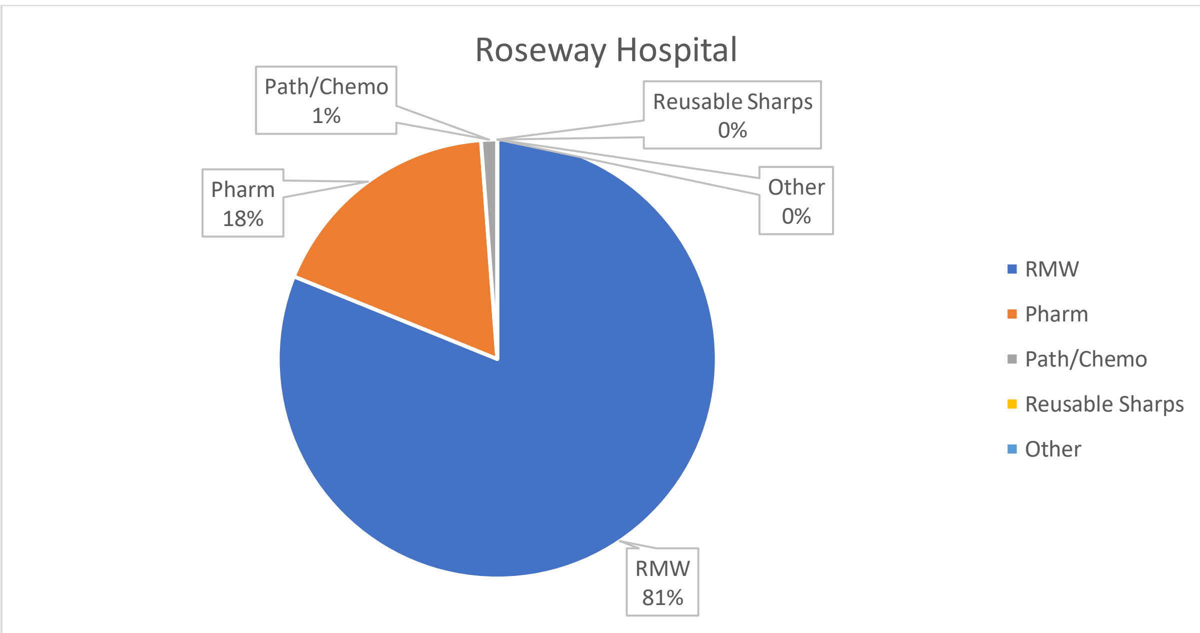

Figure B.9 Percentage of container waste from the Roseway Hospital

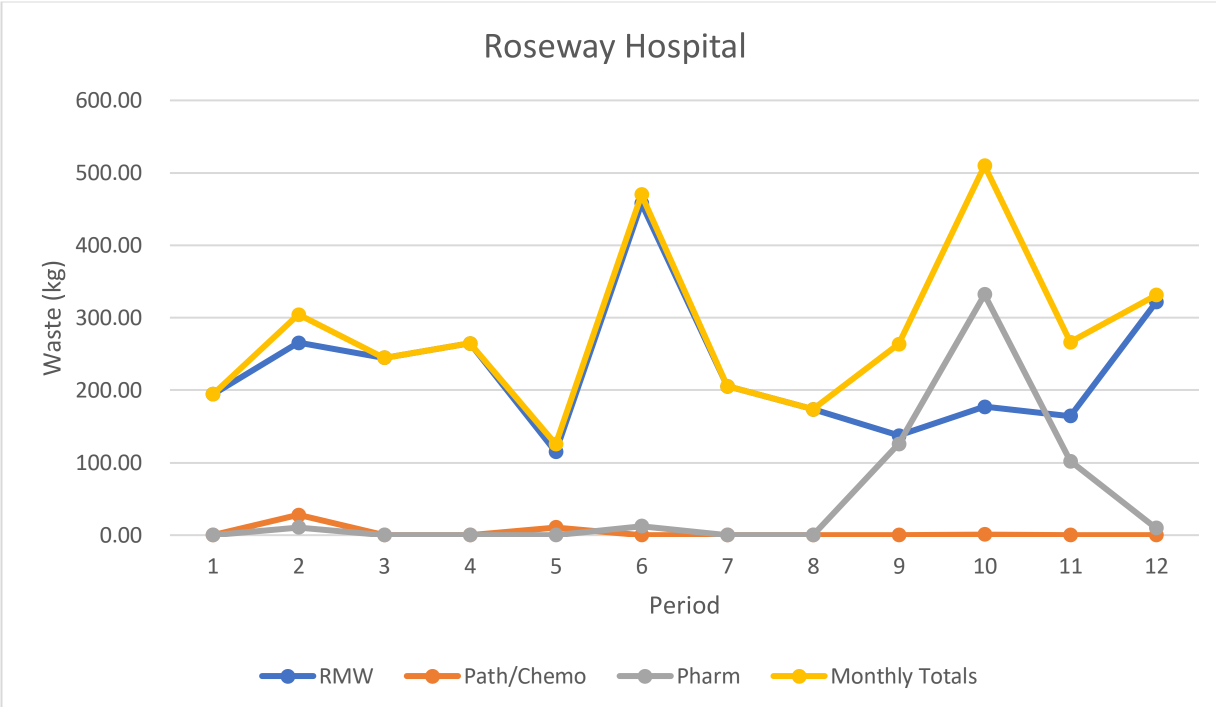

Figure B.10 Numeric values of waste generated per period in kg from the Roseway Hospital

Table B.7.5 Numeric values from the Roseway Hospital

Monthly Totals	
Max (kg)	509.88
Min (kg)	125.58
Mean (kg)	279.48
Std Dev (kg)	108.89
Median (kg)	264.14
N	12

B.6. Yarmouth General Hospital

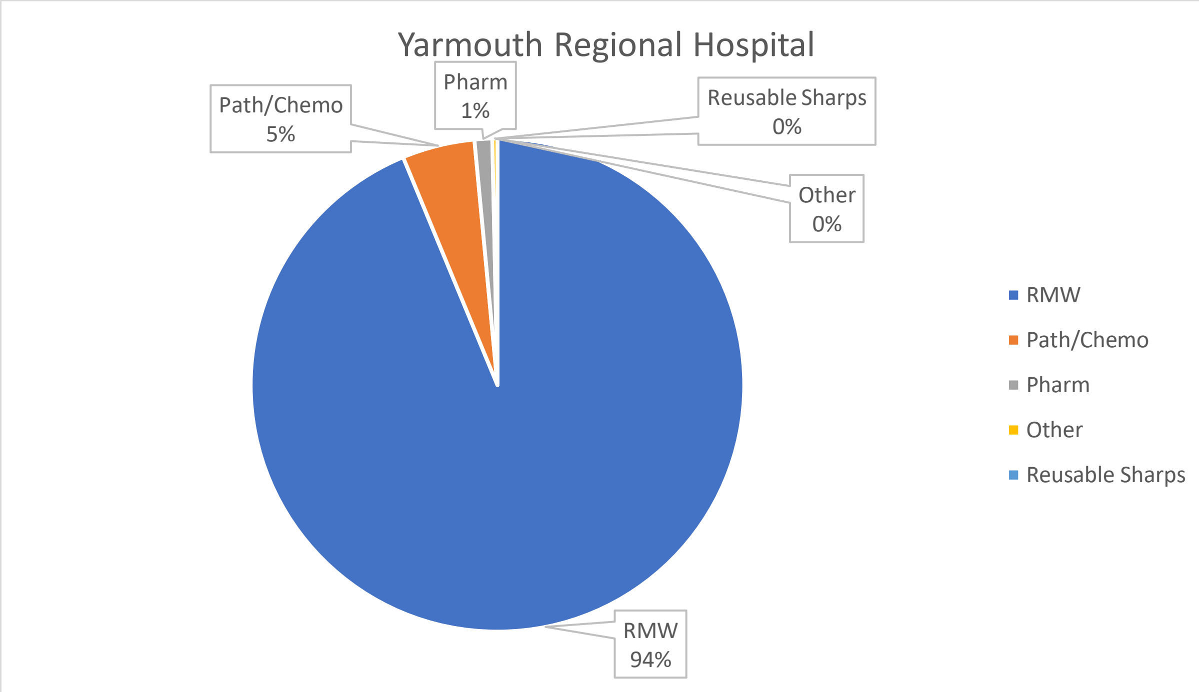

Figure B.11 Percentage of container waste from the Yarmouth Regional Hospital

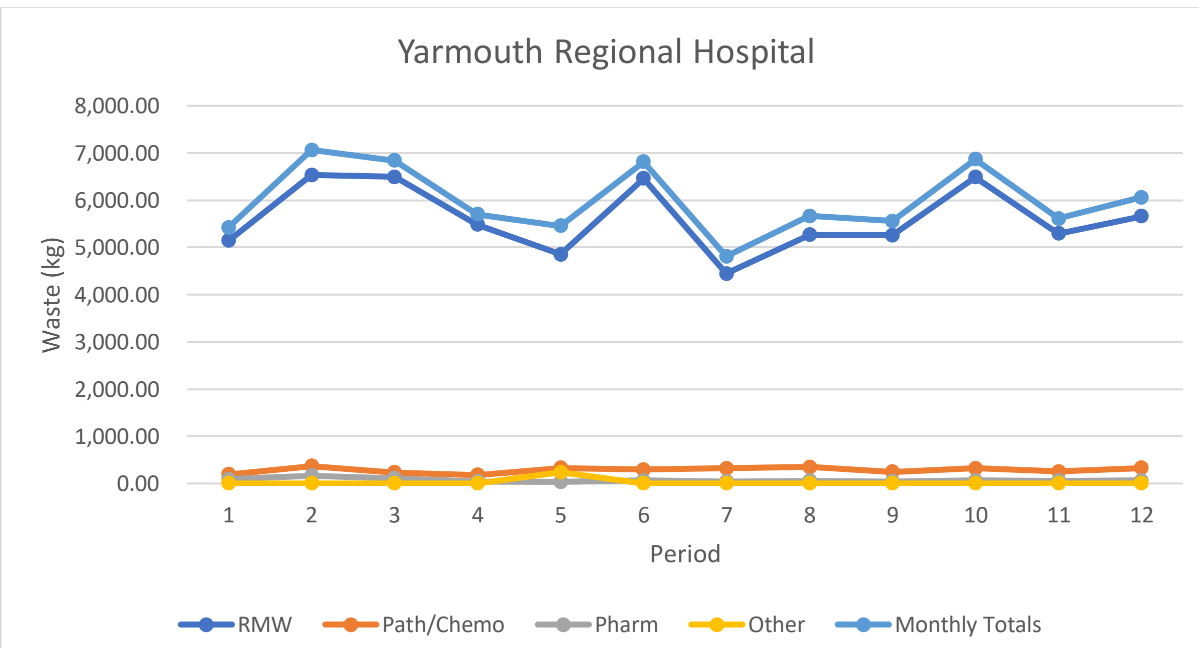

Figure B.12 Numeric values of waste generated per period in kg from the Yarmouth Regional Hospital

Table B.7.6 Numeric Values from the Yarmouth Regional Hospital

Monthly Totals	
Max (kg)	7,065.30
Min (kg)	4,812.54
Mean (kg)	5,989.04
Std Dev (kg)	697.55
Median (kg)	5,684.62
N	12.00

B.7. Digby General Hospital

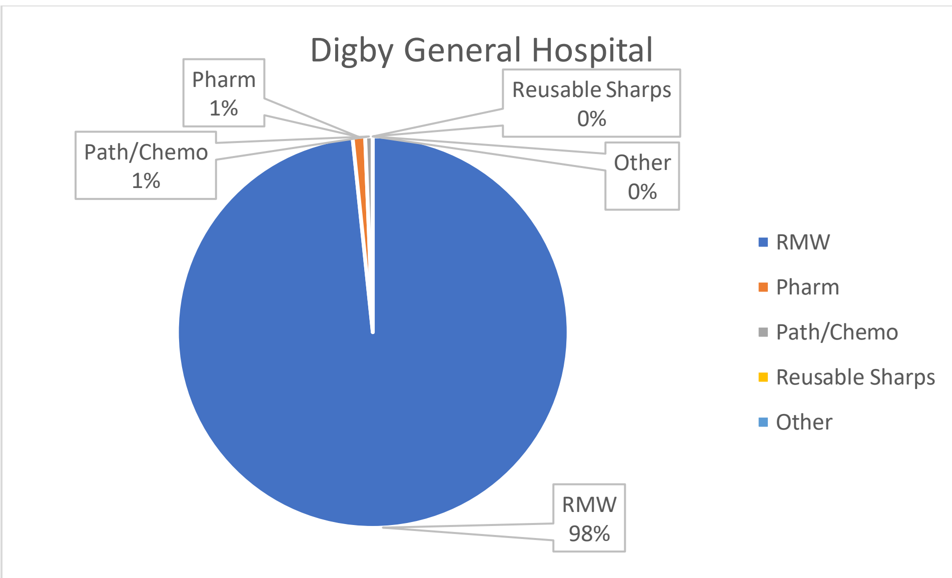

Figure B.13 Percentage of container waste from the Digby General Hospital

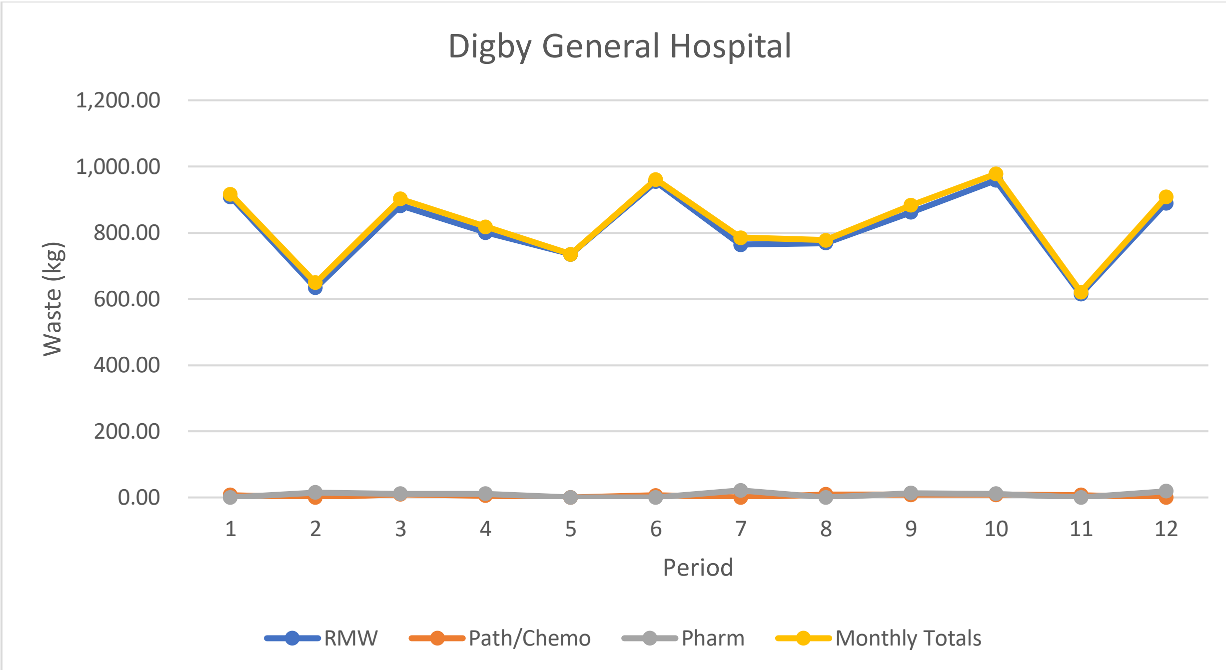

Figure B.14 Numeric values of waste generated per period in kg from the Digby General Hospital

Table B.7.7 Numeric values from the Digby General Hospital

Monthly Totals	
Max (kg)	977.34
Min (kg)	621.18
Mean (kg)	827.74
Std Dev (kg)	112.15
Median (kg)	850.14
N	12.00

B.8. Annapolis Community Health

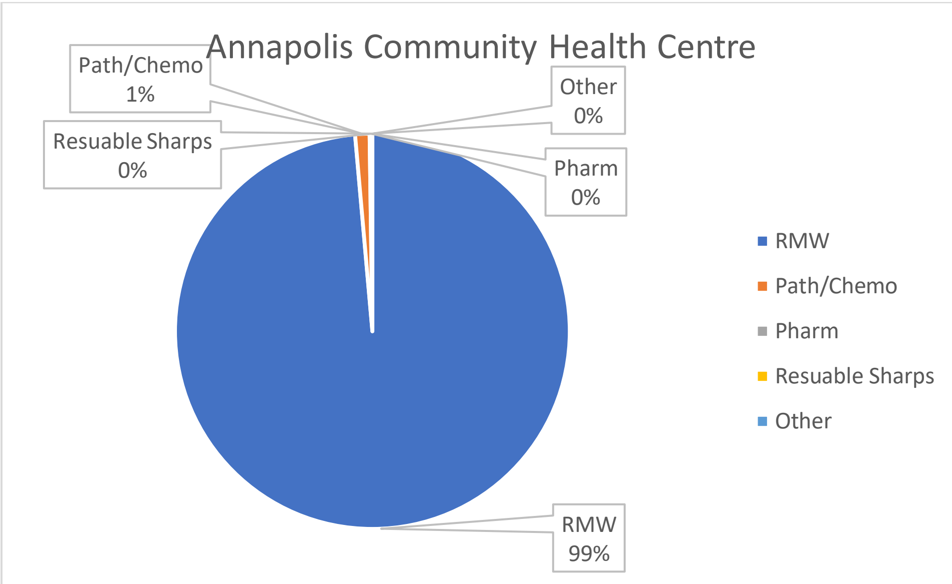

Figure B.15 Percentage of container waste from the Annapolis Community Health Centre

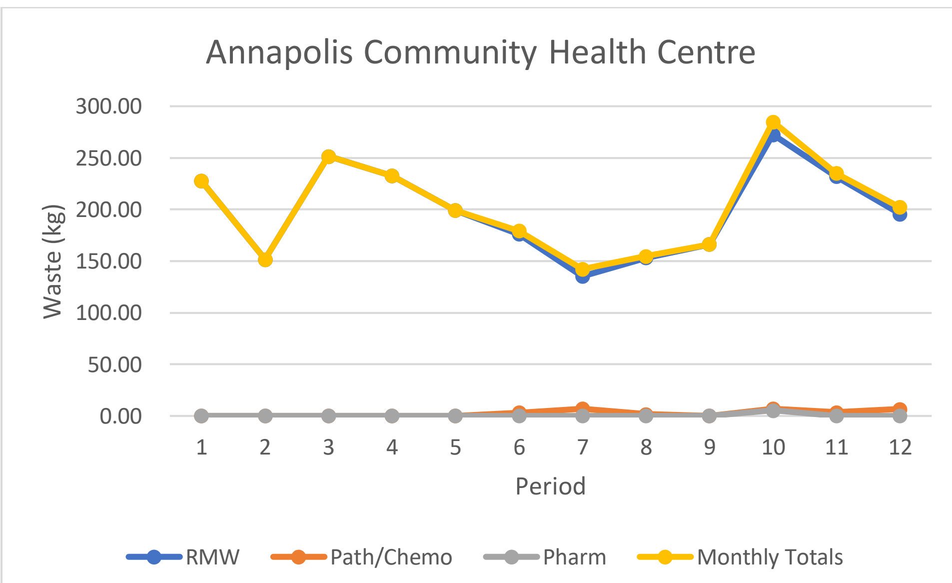

Figure B.16 Numeric values of waste generated per peiod in kg from the Annapolis Community Health Centre

Table B.7.8 Numeric Values from the Annapolis Community Health Centre

Monthly Totals	
Max (kg)	284.97
Min (kg)	142.17
Mean (kg)	202.27
Std Dev (kg)	43.02
Median (kg)	200.66
N	12

B.9. Western Kings Memorial

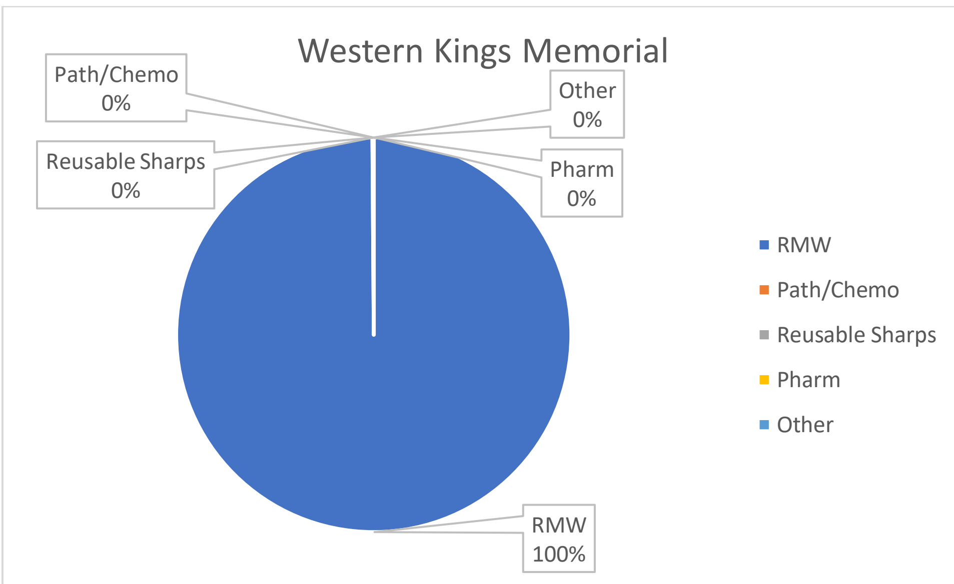

Figure B.17 Percentage of container waste from the Western Kings Memorial Hospital

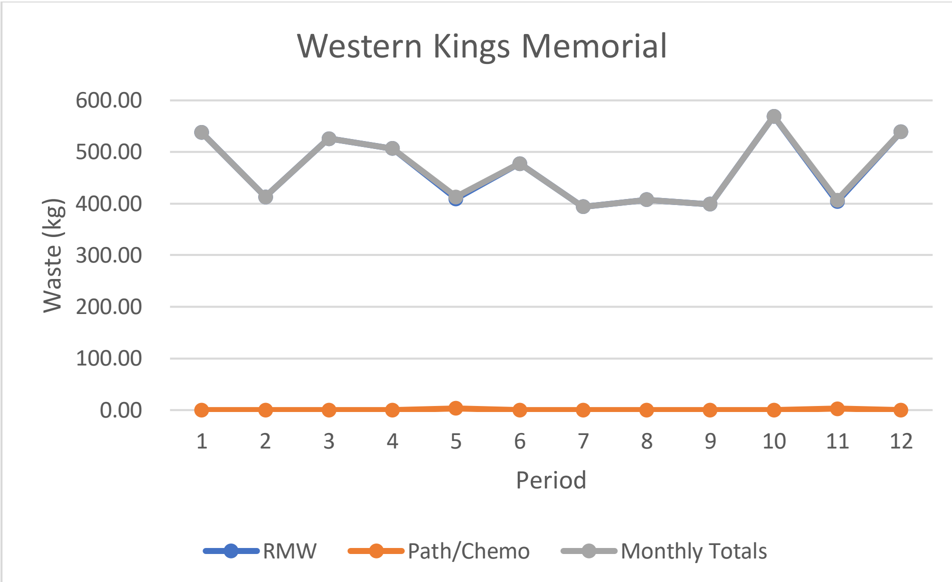

Figure B.18 Numeric values of waste generated per peiod in kg from the Western Kings Memorial Hospital

Table B.7.9 Numeric Values from the Western Kings Memorial Hospital

Monthly Totals	
Max (kg)	569.31
Min (kg)	393.75
Mean (kg)	465.78
Std Dev (kg)	63.73
Median (kg)	445.32
N	12

B.10. Soldier's Memorial

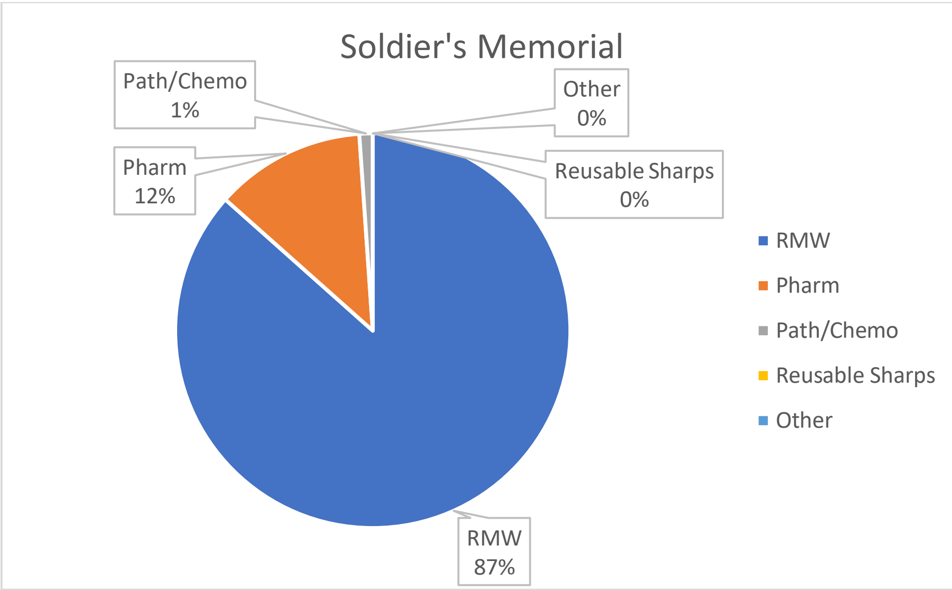

Figure B.19 Percentage of container waste from the Soldier's Memorial

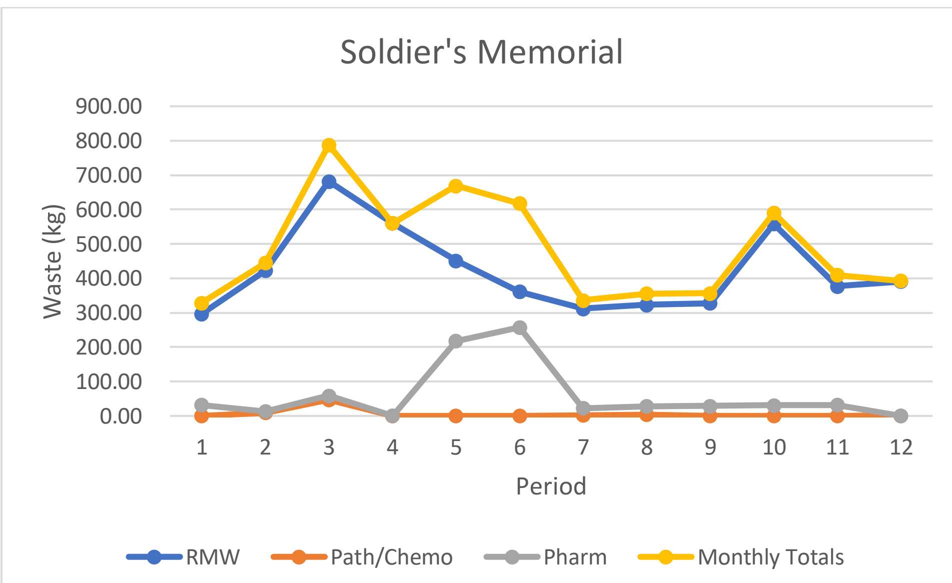

Figure B.20 Numeric values of waste generated per peiod in kg from the Soldier's Memorial Hospital

Table B.7.10 Numeric Values from the Soldier's Memorial Hospital

Monthly Totals	
Max (kg)	787.52
Min (kg)	328.90
Mean (kg)	487.36
Std Dev (kg)	145.86
Median (kg)	426.84
N	12

B.11. Valley Regional Hospital

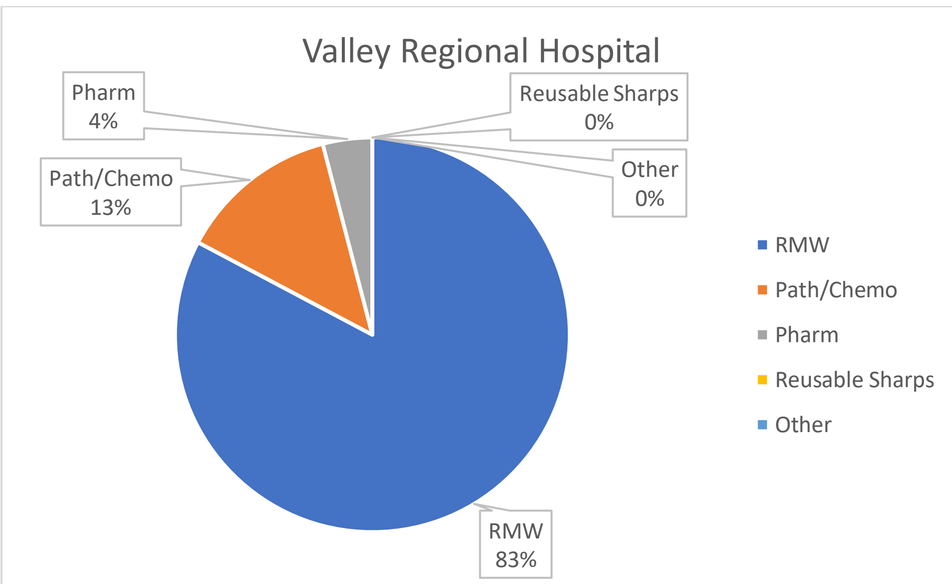

Figure B.21 Percentage of container waste from the Valley Regional Hospital

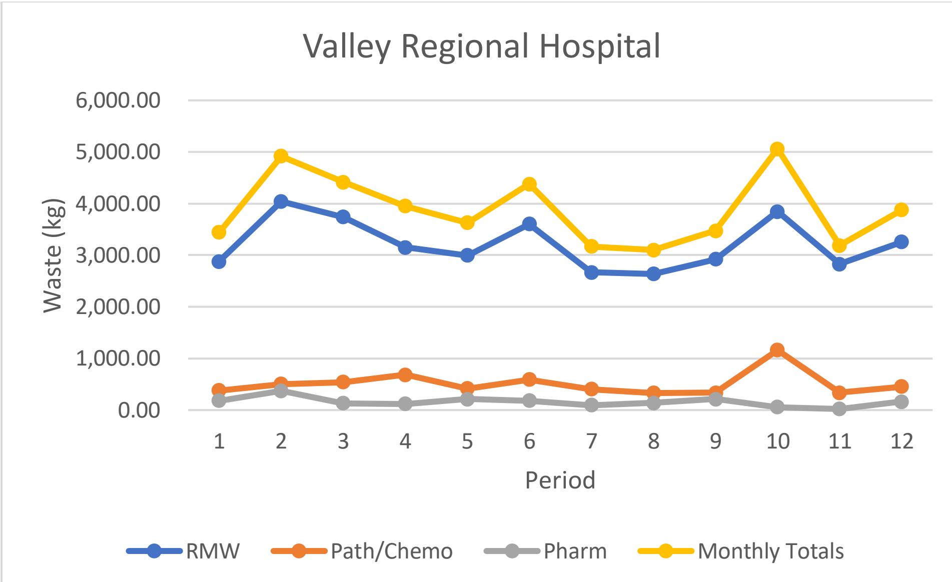

Figure B.22 Numeric values of waste generated per peiod in kg from the Valley Regional Hospital

Table B.7.11 Numeric values from the Valley Regional Hospital

Monthly Totals	
Max (kg)	5,062.89
Min (kg)	3,101.91
Mean (kg)	3,883.63
Std Dev (kg)	647.47
Median (kg)	3,753.96
N	12

B.12. Eastern Kings Memorial

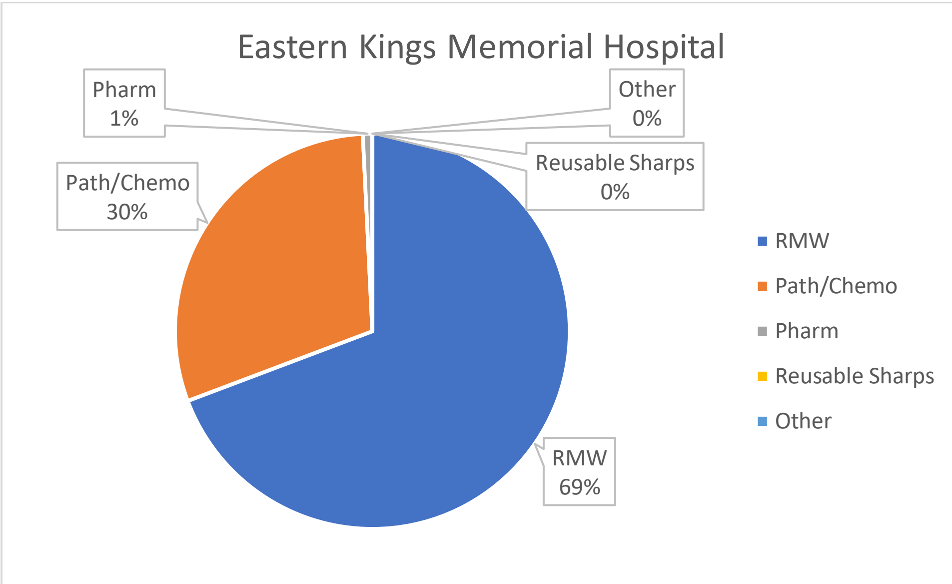

Figure B.23 Percentage of container waste from the Eastern Kings Memorial Hospital

Table B.7.12 Numeric values from the Eastern Kings Memorial Hospital

Monthly Totals	
Max (kg)	89.93
Min (kg)	67.20
Mean (kg)	81.01
Std Dev (kg)	9.90
Median (kg)	85.89
N	3

B.13. Lillian Fraser Hospital

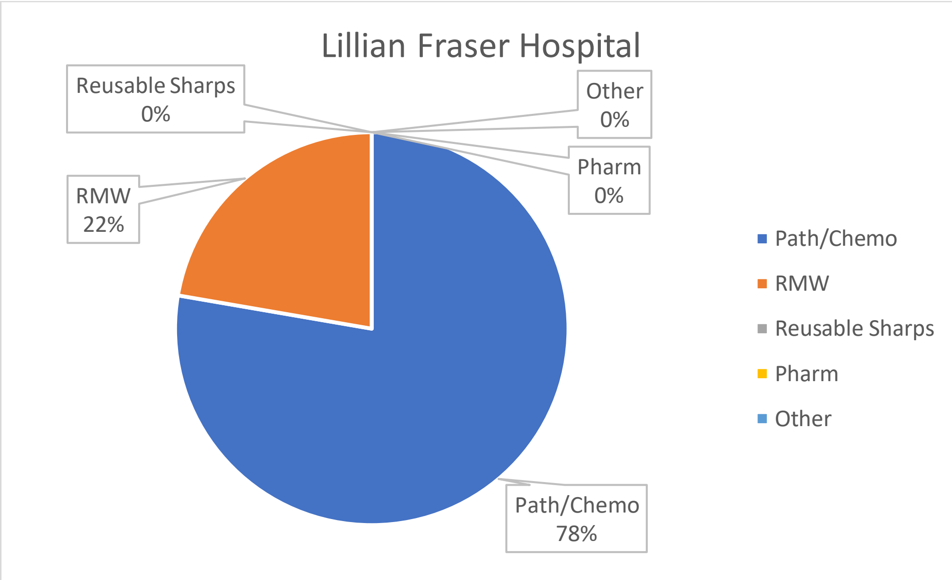

Figure B.24 Percentage of container waste from the Lillian Fraser Hospital

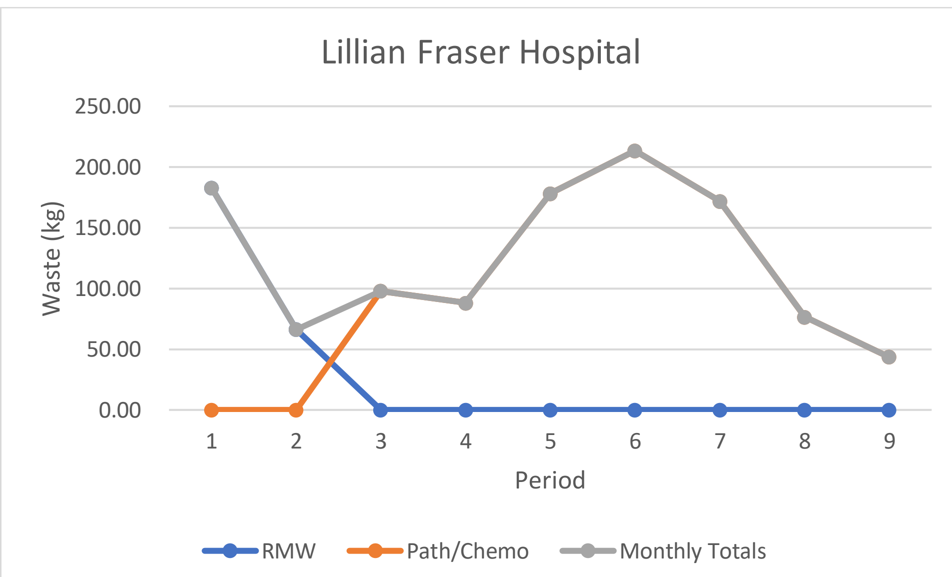

Figure B.25 Numeric values of waste generated per peiod in kg from the Lillian Fraser Hospital

Table B.7.13 Numeric values from the Lillian Fraser Hospital

Monthly Totals	
Max (kg)	213.36
Min (kg)	43.47
Mean (kg)	124.30
Std Dev (kg)	58.49

Median (kg)	97.75
N	9

B.14. Cumberland Regional Health Centre

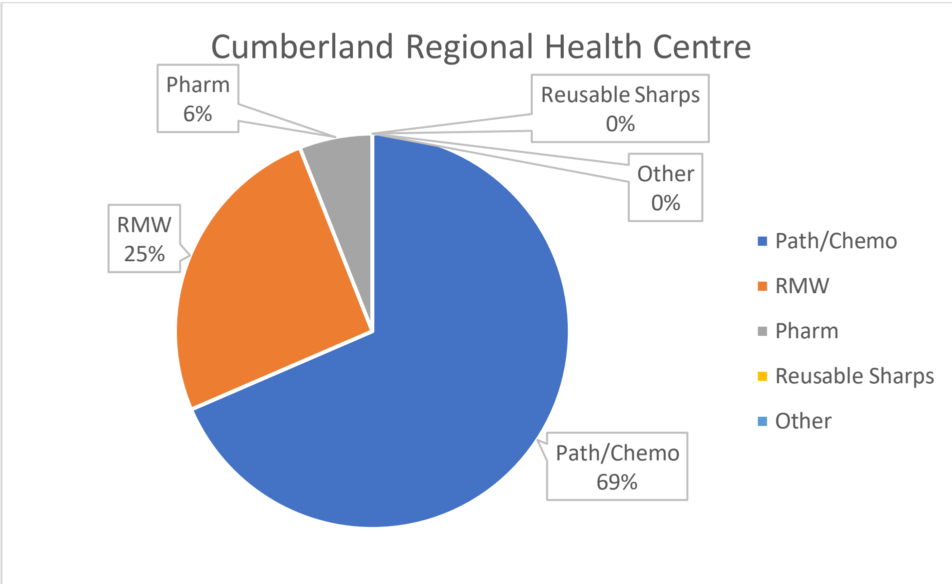

Figure B.26 Percentage of container waste from the Cumberland Regional Health Centre

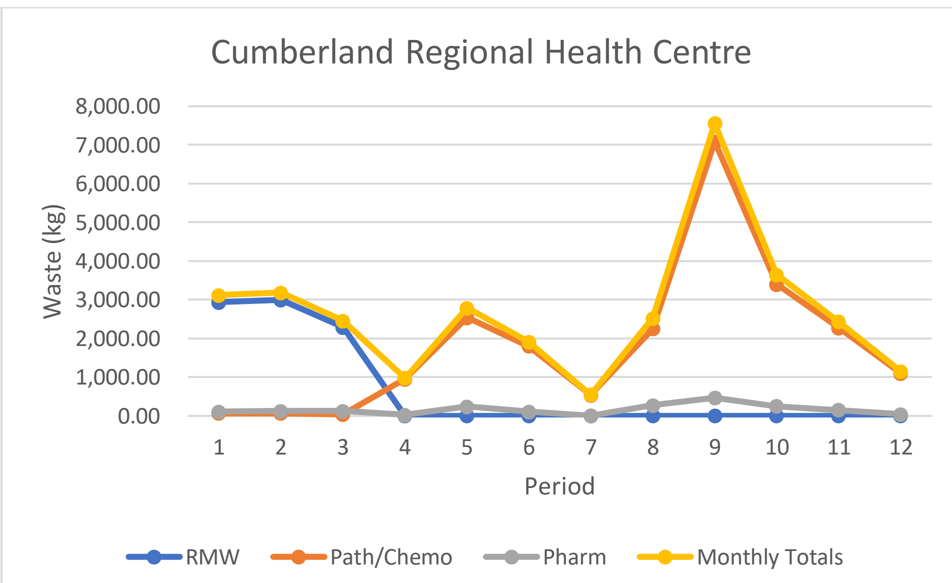

Figure B.27 Numeric values of waste generated per period in kg from the Cumberland Regional Health Centre

Table B.7.14 Numeric values from the Cumberland Regional Hospital

Monthly Totals	
Max (kg)	7,555.95
Min (kg)	545.10
Mean (kg)	2,691.07
Std Dev (kg)	1724.69
Median (kg)	2,490.08
N	12

B.15. Sutherland Harris memorial

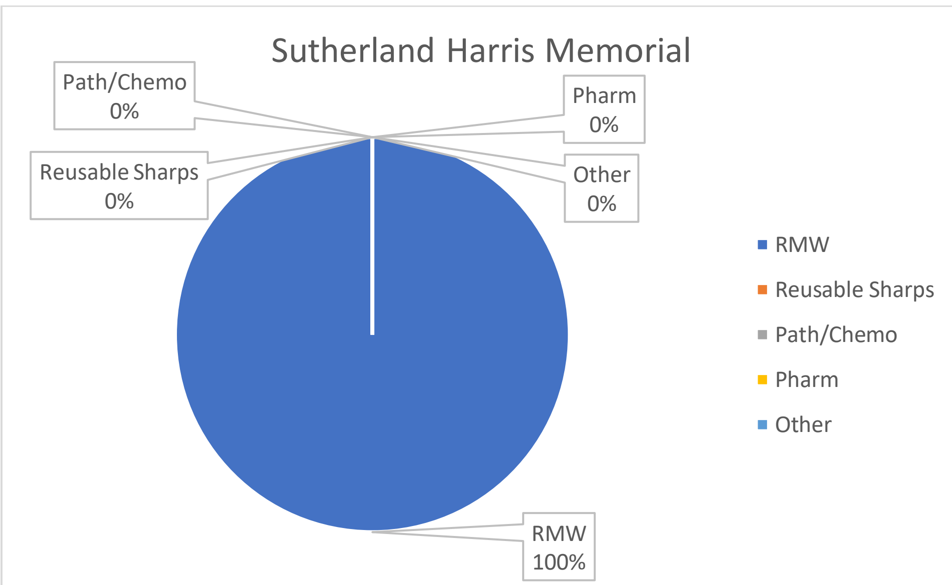

Figure B.28 Percentage of container waste from the Sutherland Harris Memorial

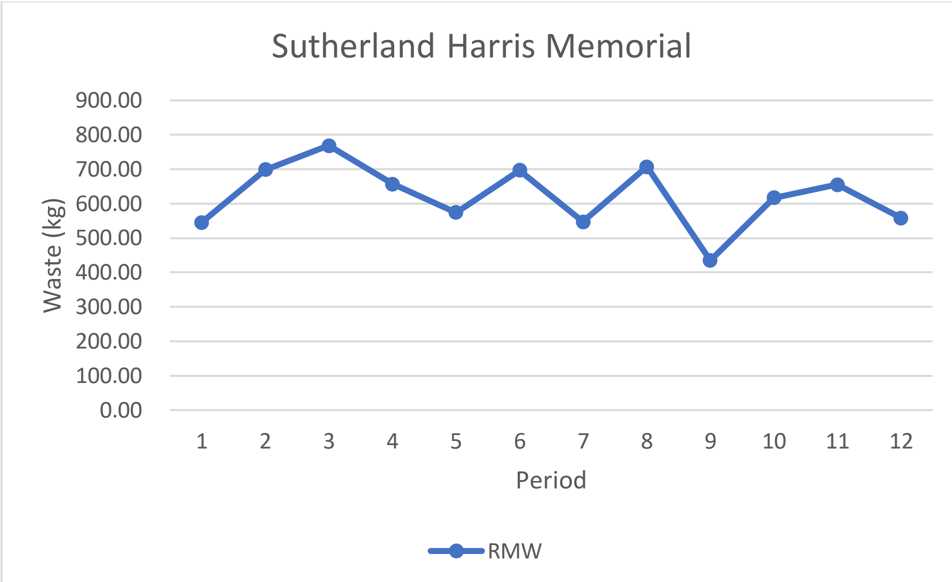

Figure B.29 Numeric values of waste generated per period in kg from the Sutherland Harris Memorial

Table B.7.15 Numeric values from the Sutherland Harris Memorial

Monthly Totals	
Max (kg)	768.89
Min (kg)	434.70
Mean (kg)	621.70
Std Dev (kg)	89.16
Median (kg)	635.88
N	12

B.16. Aberdeen Hospital

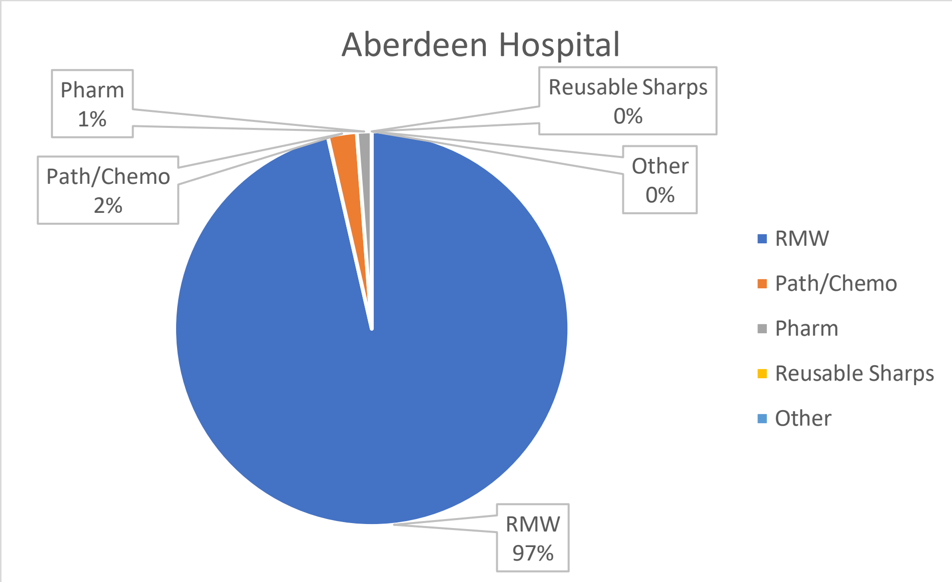

Figure B.30 Percentage of container waste from the Aberdeen Hospital

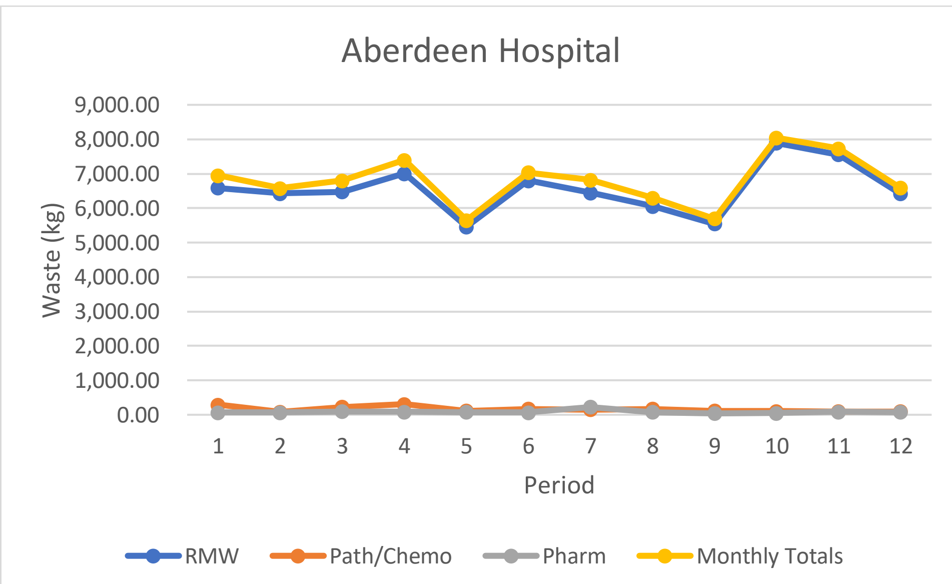

Figure B.31 Numeric values of waste generated per period in kg from the Aberdeen Hospital

Table B.7.16 Numeric values from the Aberdeen Hospital

Monthly Totals	
Max (kg)	8,042.37
Min (kg)	5,649.21
Mean (kg)	6,798.86
Std Dev (kg)	691.38
Median (kg)	6,807.58
N	12

B.17. Lab Building (QE II)

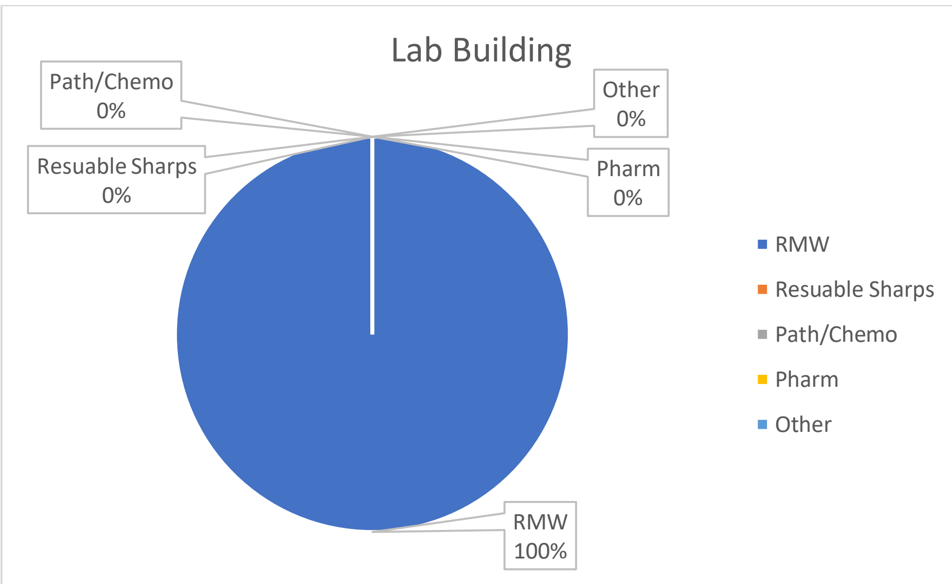

Figure B.32 Percentage of container waste from the Lab Building

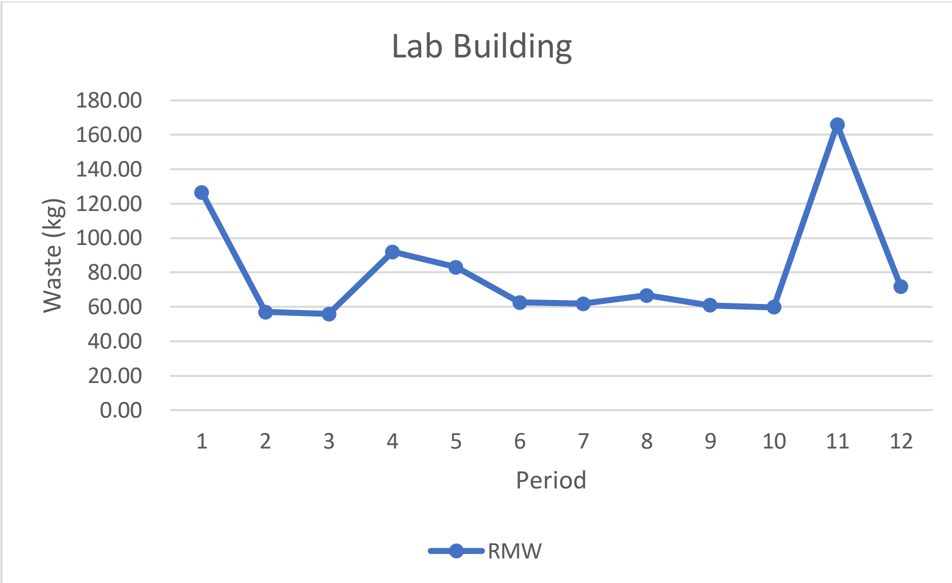

Figure B.33 Numeric values of waste generated per period in kg from the Lab Building

Table B.7.17 Numeric values from the Lab Building

Monthly Totals	
Max (kg)	165.90
Min (kg)	55.89
Mean (kg)	80.29
Std Dev (kg)	32.22
Median (kg)	64.58
N	12

B.18. St. Martha's Regional Hospital

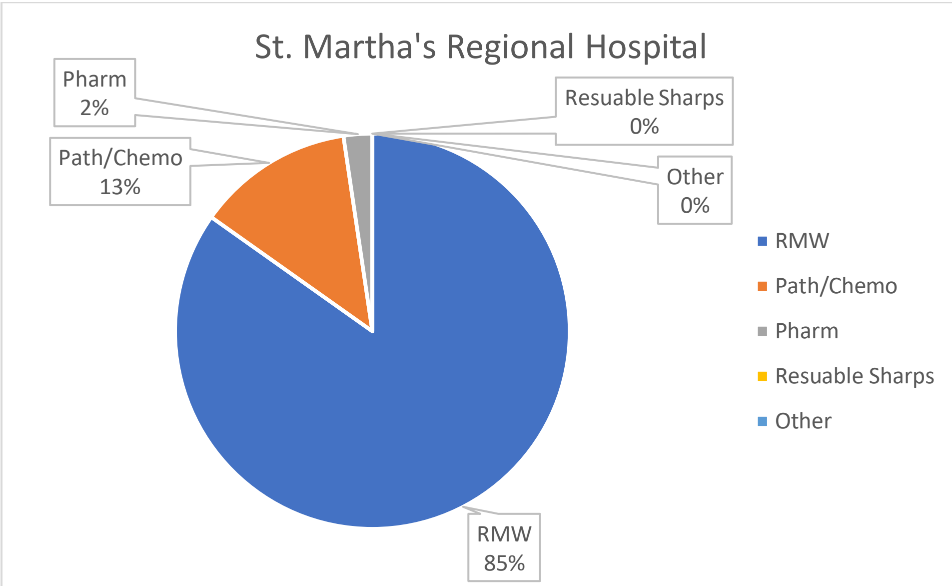

Figure B.34 Percentage of container waste from the St. Martha's Regional Hospital

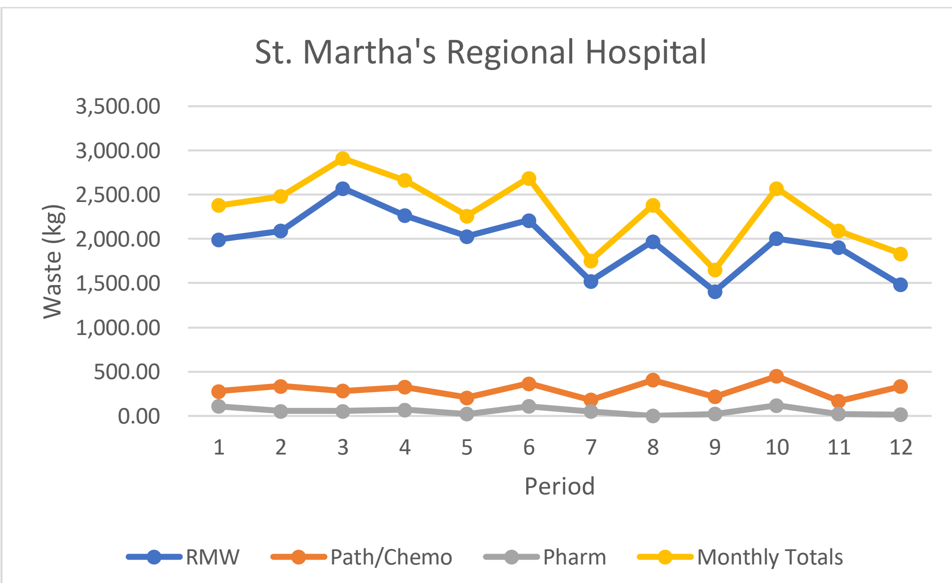

Figure B.35 Numeric values of waste generated per period in kg from St. Martha's Regional Hospital

Table B.7.18 Numeric values from the St. Martha's Regional Hospital

Monthly Totals	
Max (kg)	2,909.50
Min (kg)	1,648.71
Mean (kg)	2,305.24
Std Dev (kg)	382.88
Median (kg)	2,378.99
N	12

B.19. Strait Richmond Hospital

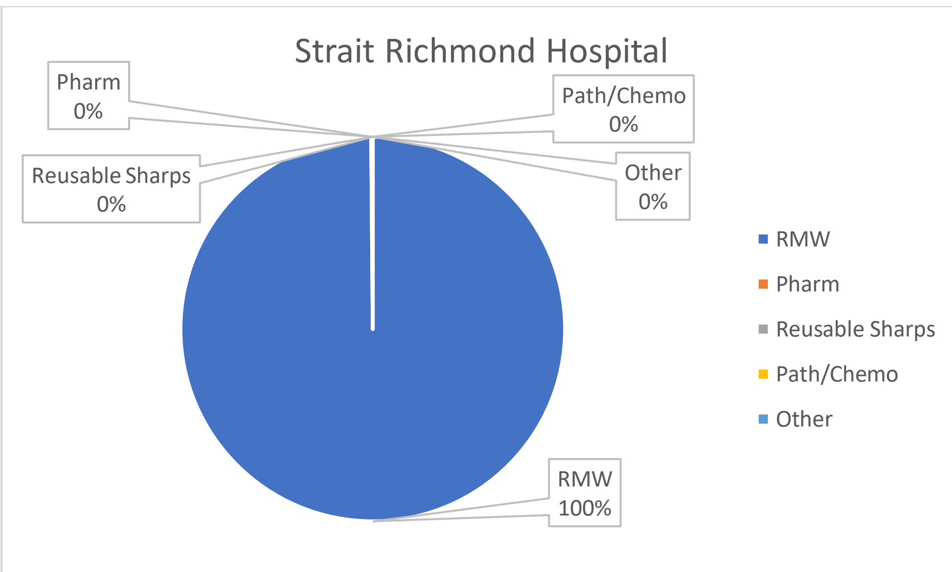

Figure B.36 Percentage of container waste from the Strait Richmond Hospital

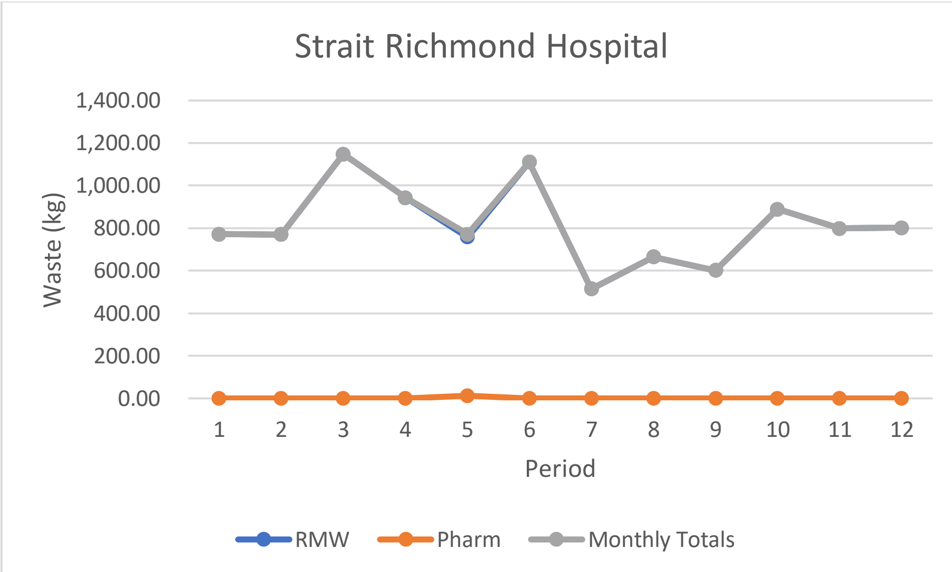

Figure B.37 Numeric values of waste generated per period in kg from the Strait Richmond Hospital

Table B.7.19 Numeric values from the Strait Richmond Hospital

Monthly Totals	
Max (kg)	1,148.16
Min (kg)	514.08
Mean (kg)	815.58
Std Dev (kg)	179.25
Median (kg)	785.80
N	12

B.20. Eastern Shore Memorial Hospital

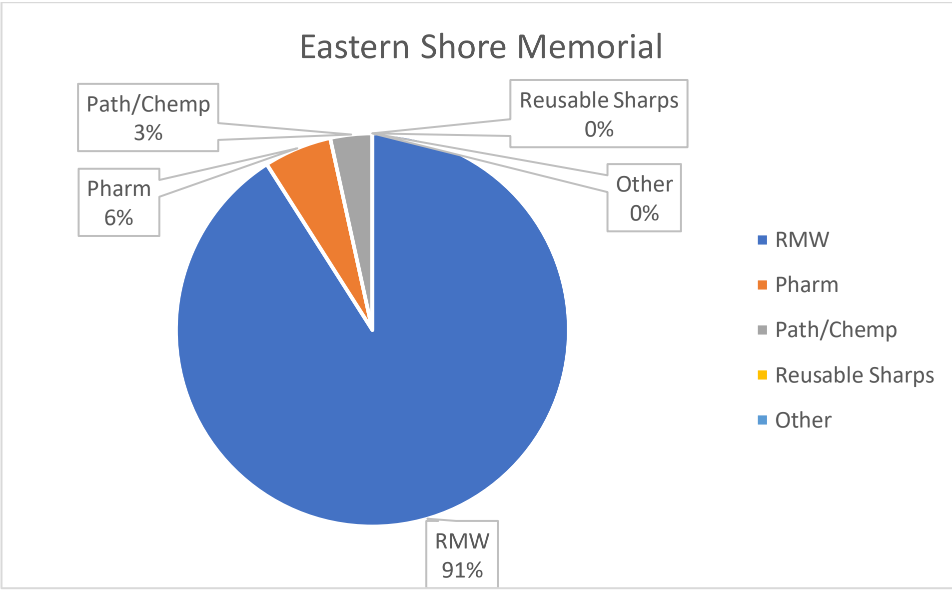

Figure B.38 Percentage of container waste from the Eastern Shore Memorial

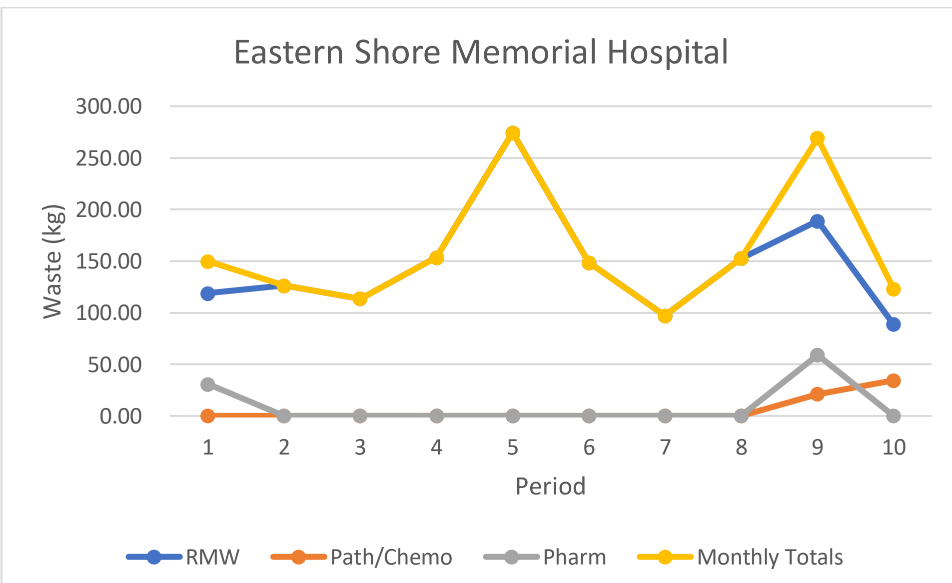

Figure B.39 Numeric values of waste generated per period in kg from the Eastern Shore Memorial Hospital

Table B.7.20 Numeric values from the Eastern Shore Memorial Hospital

Monthly Totals	
Max (kg)	274.47
Min (kg)	97.23
Mean (kg)	160.82

Std Dev (kg)	58.23
Median (kg)	149.10
N	10

B.21. Hants Community Hospital

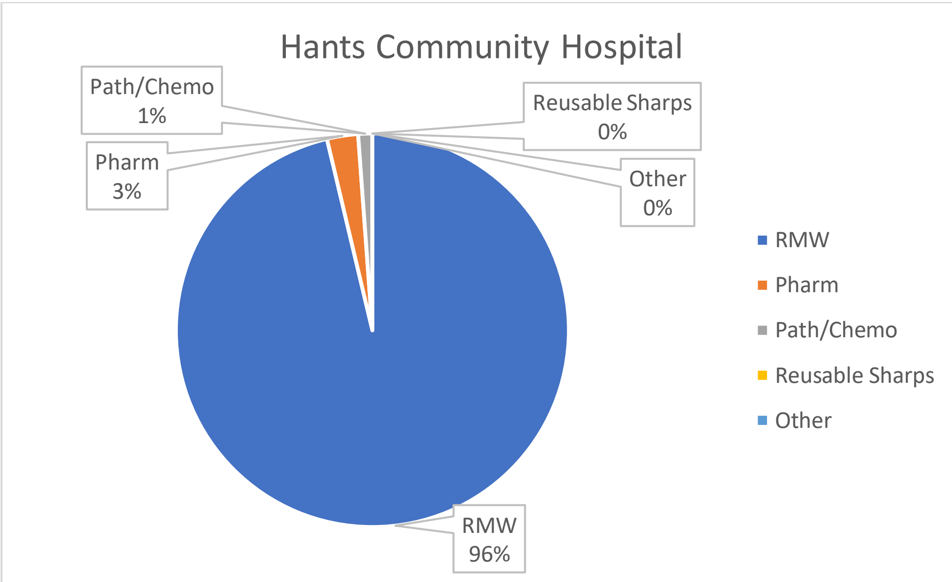

Figure B.40 Percentage of container waste from the Hants Community Hospital

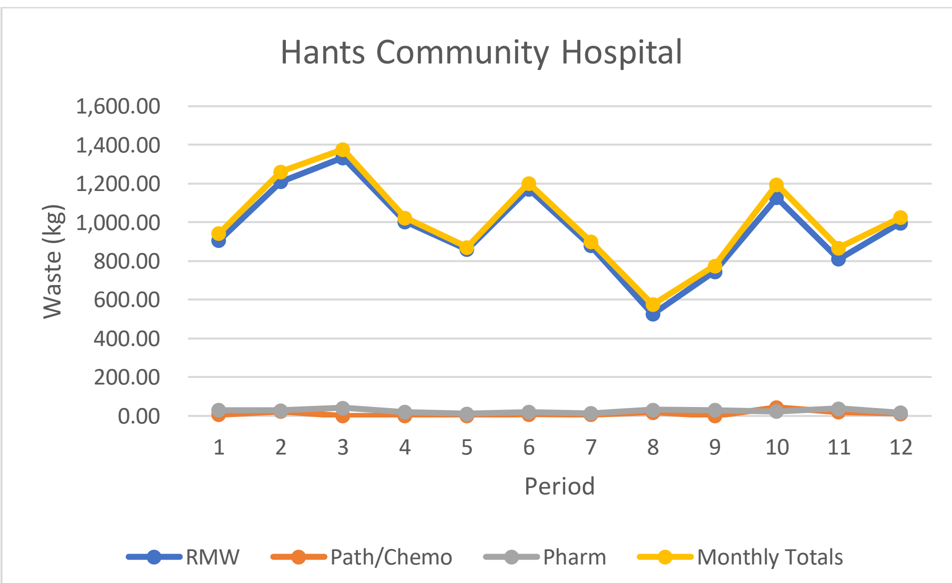

Figure B.41 Numeric values of waste generated per period in kg from the Hants Community Hospital

Table B.7.21 Numeric values from the Hants Community Hospital

Monthly Totals	
Max (kg)	1,377.24
Min (kg)	574.98
Mean (kg)	1,001.84
Std Dev (kg)	217.73
Median (kg)	983.37
N	12

B.22. Musquodoboit Valley Memorial

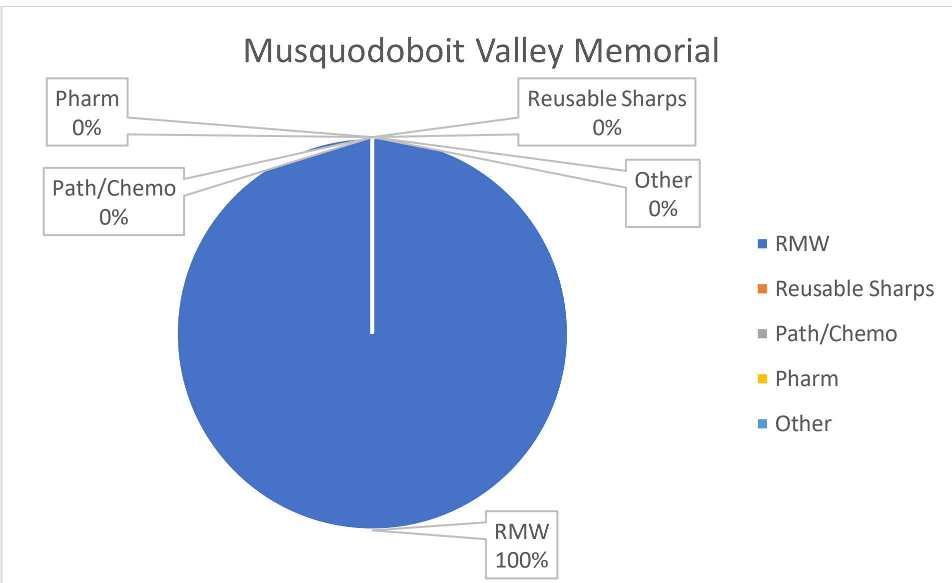

Figure B.42 Percentage of container waste from the Musquodoboit Valley Memorial

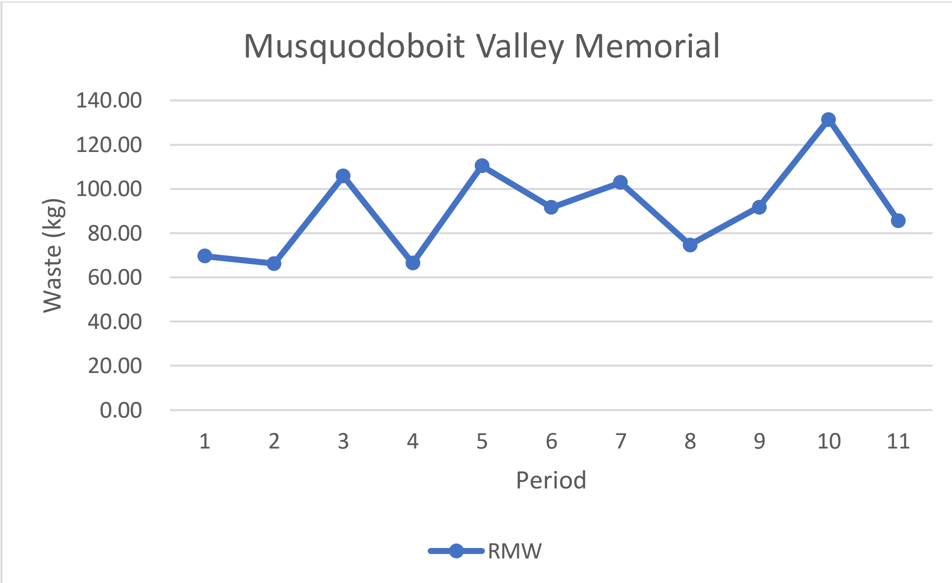

Figure B.43 Numeric values of waste generated per period in kg from the Musquodoboit Valley Memorial

Table B.7.22 Numeric values from the Musquodoboit Valley Memorial

Monthly Totals	
Max (kg)	131.46
Min (kg)	66.24
Mean (kg)	90.62
Std Dev (kg)	19.86
Median (kg)	91.56
N	11

B.23. NS Psych Hospital

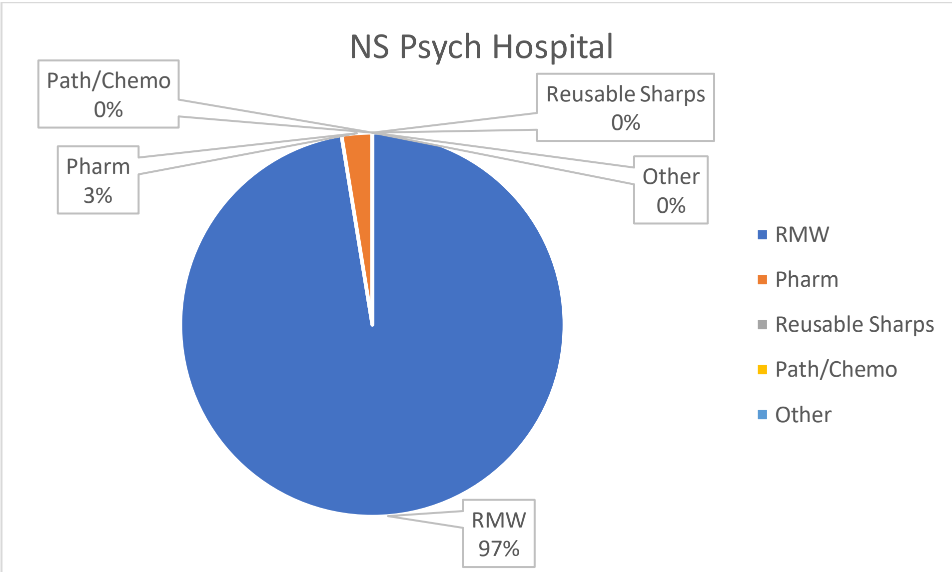

Figure B.44 Percentage of container waster from the NS Psych Hospital

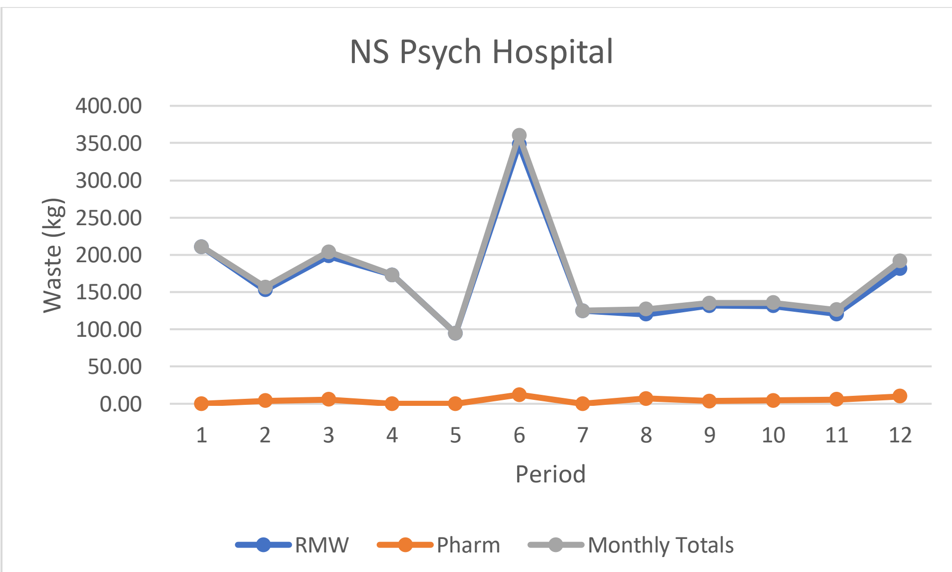

Figure B.45 Numeric values of waste generated per period in kg from the NS Psych Hospital

Table B.7.23 Numeric values from the NS Psych Hospital

Monthly Totals	
Max (kg)	360.36
Min (kg)	94.50
Mean (kg)	169.93
Std Dev (kg)	66.84
Median (kg)	146.15
N	12

B.24. Twin Oaks Memorial

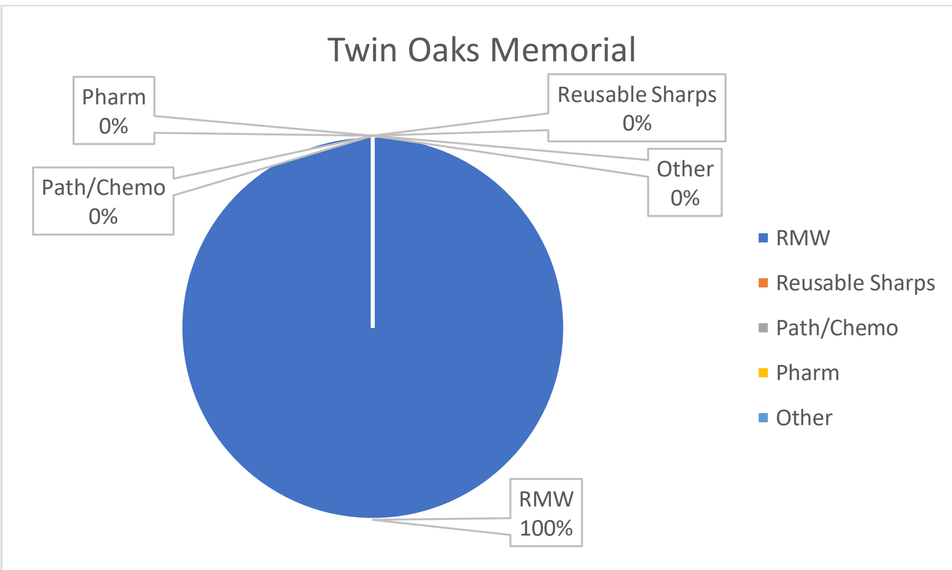

Figure B.46 Percentage of container waste from the Twin Oaks Memorial

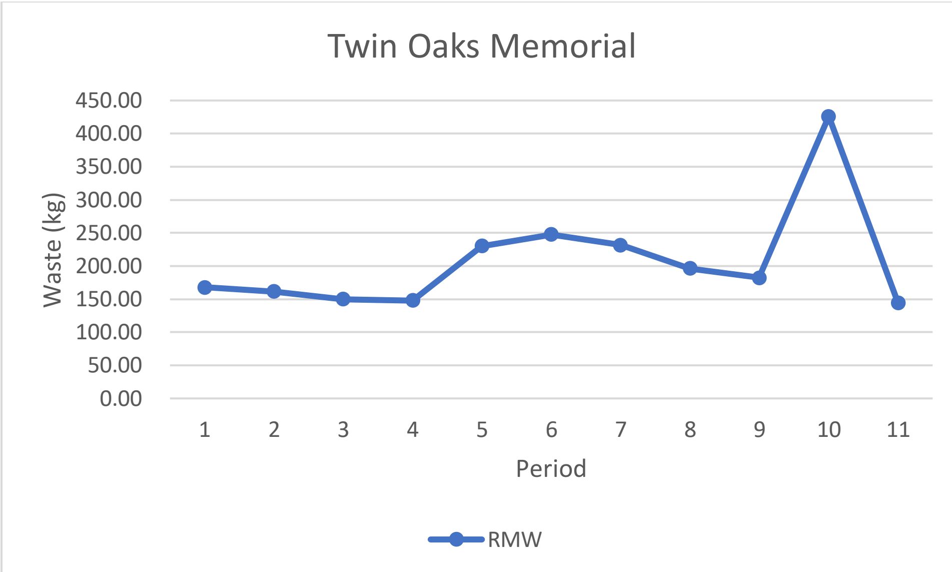

Figure B.47 Numeric values of waste generated per period in kg from the Twin Oaks Memorial

Table B.7.24 Numeric Values from the Twin Oaks Memorial

Monthly Totals	
Max (kg)	426.09
Min (kg)	144.48
Mean (kg)	207.86
Std Dev (kg)	77.33
Median (kg)	182.49
N	11

B.25. Cobequid Community Health Centre

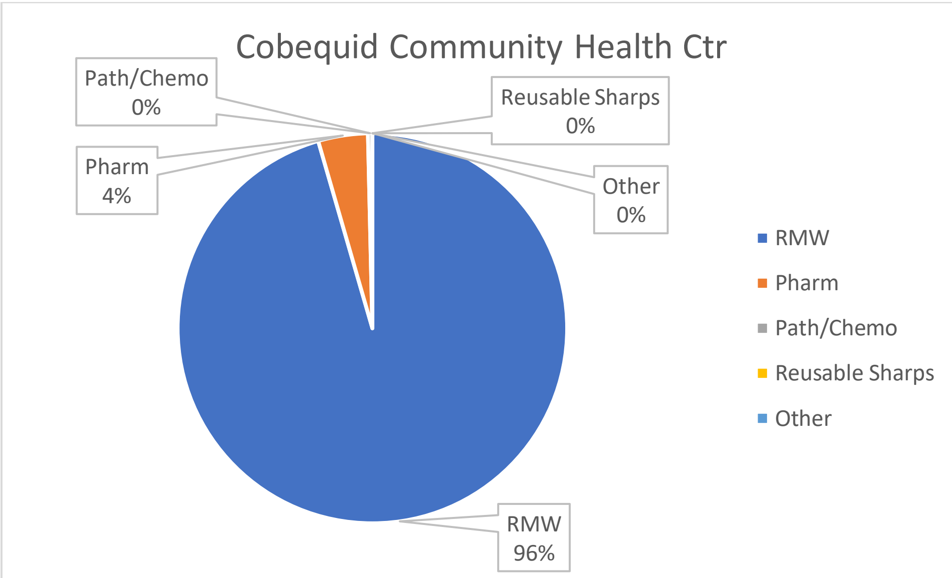

Figure B.48 Percentage of container waste from the Cobequid Community Health Centre

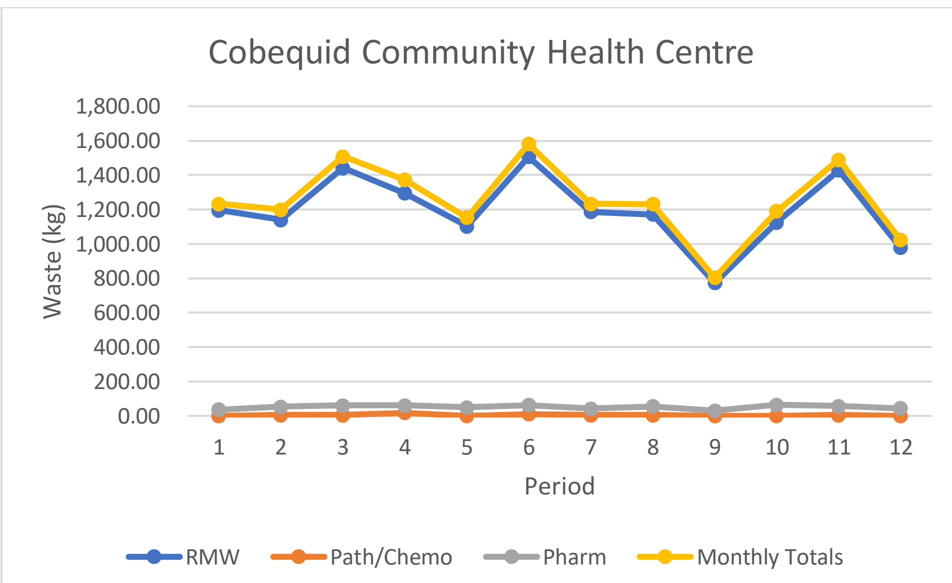

Figure B.49 Numeric values of waste generated per period in kg from the Cobequid Community Health Cetnre

Table B.7.25 Numeric values from the Cobequid Community Health Centre

Monthly Totals	
Max (kg)	1,579.62
Min (kg)	803.46
Mean (kg)	1,251.15
Std Dev (kg)	207.23
Median (kg)	1,231.66
N	12

B.26. Bayers Road Community Mental Health Centre

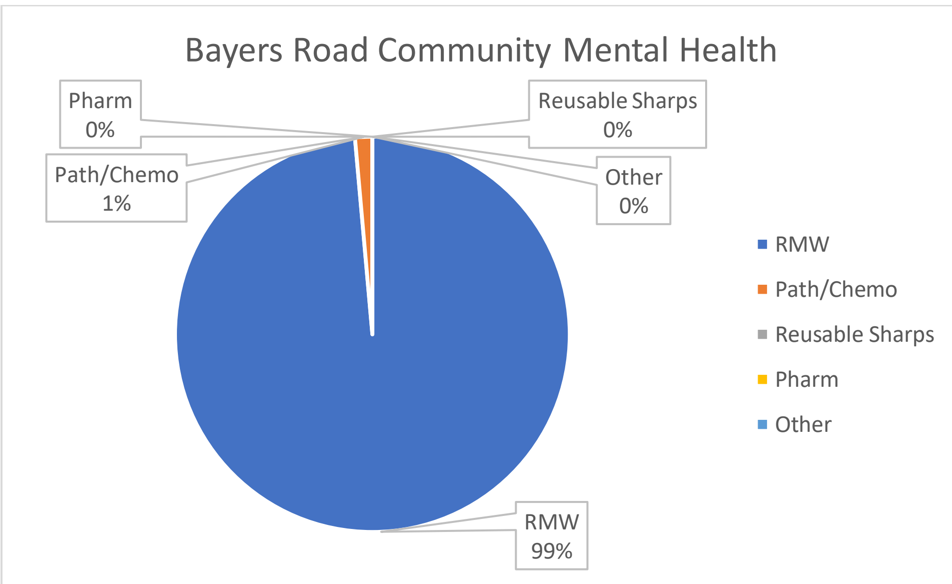

Figure B.50 Percentage of container waste from the Bayers Road Community Mental Health Centre

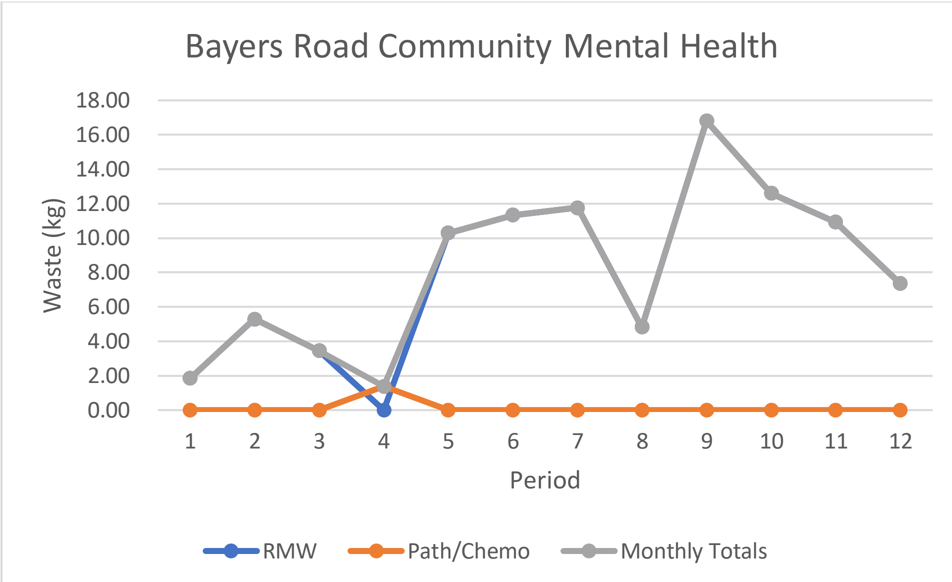

Figure B.51 Numeric values of waste generated per period in kg from the Bayers Road Community Health Centre

Table B.7.26 Numeric values from the Cobequid Community Mental Health Centre

Monthly Totals	
Max (kg)	16.80
Min (kg)	1.38
Mean (kg)	8.15
Std Dev (kg)	4.63
Median (kg)	8.82
N	12

B.27. CDHA Blood Collection Centre

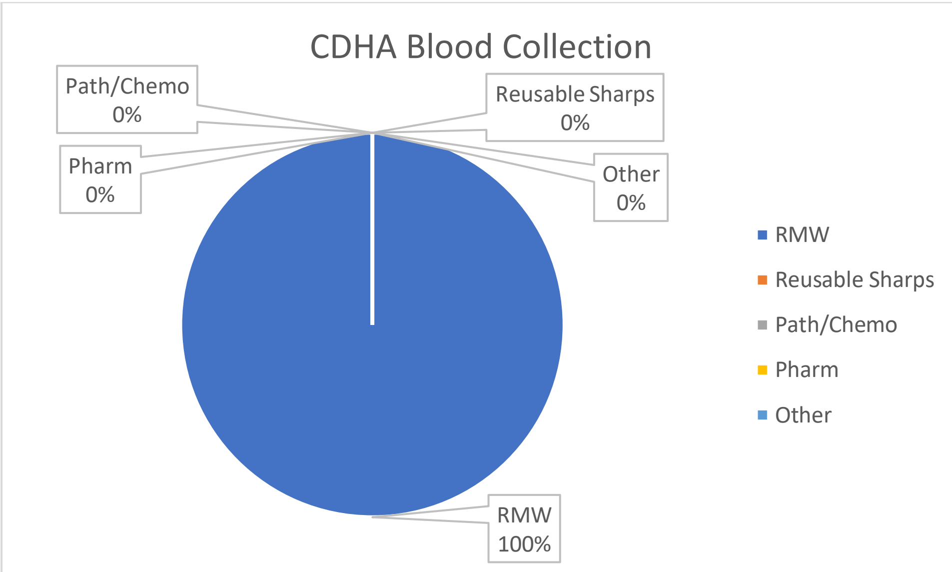

Figure B.52 Percentage of container waste from the CDHA Blood Collection Centre

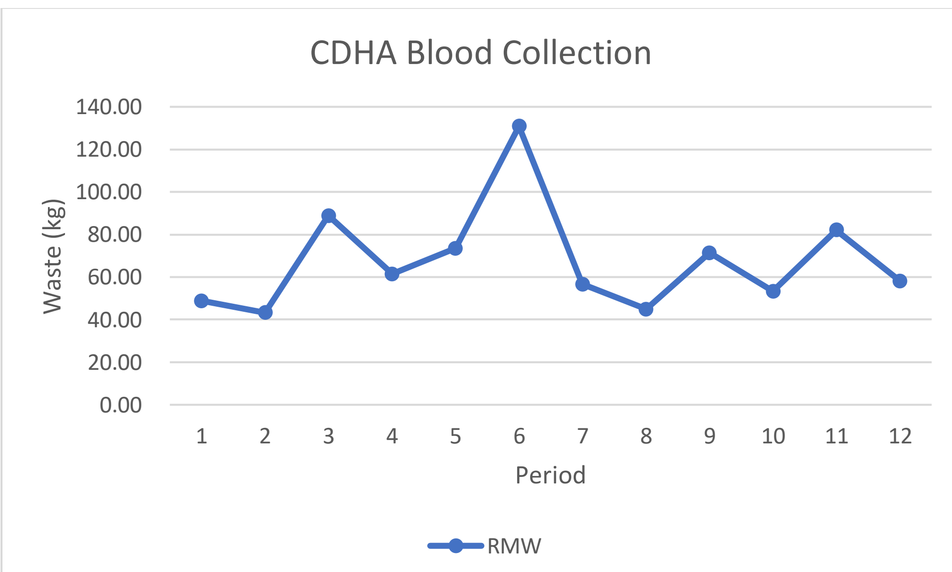

Figure B.53 Numeric values of waste generated per period in kg from the CDHA Blood Collection Centre

Table B.7.27 Numeric values from the CDHA Blood Collection Centre

Monthly Totals	
Max (kg)	130.82
Min (kg)	43.24
Mean (kg)	67.76
Std Dev (kg)	23.48
Median (kg)	59.79
N	12

B.28. Drug Distribution Centre, Victoria General

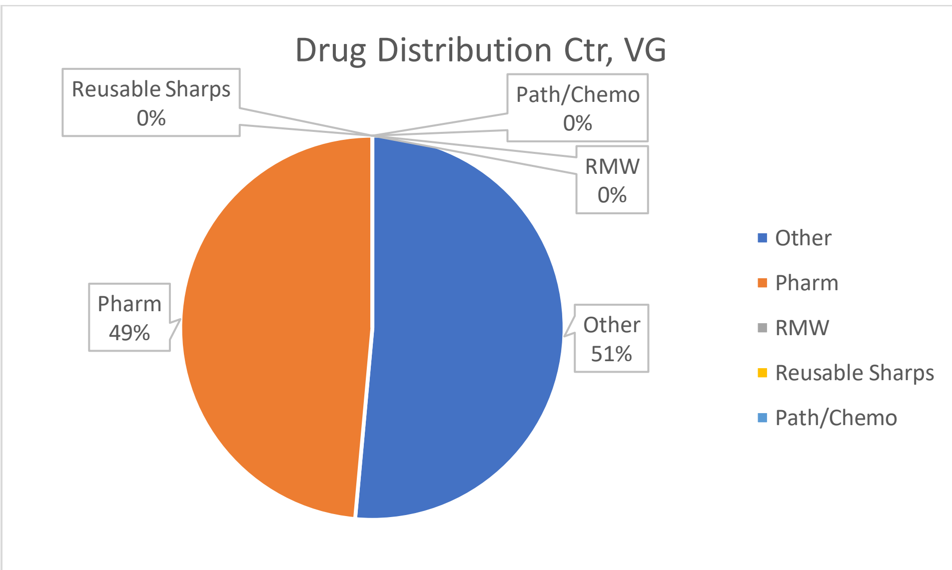

Figure B.54 Percentage of container waste from the Drug Distribution Centre, VG

Table B.7.28 Numeric values from the Drug Distribution Centre, VG

Monthly Totals	
Max (kg)	392.89
Min (kg)	370.98
Mean (kg)	381.94
Std Dev (kg)	10.96
Median (kg)	381.94
N	2

B.29. North Preston Community Health Centre

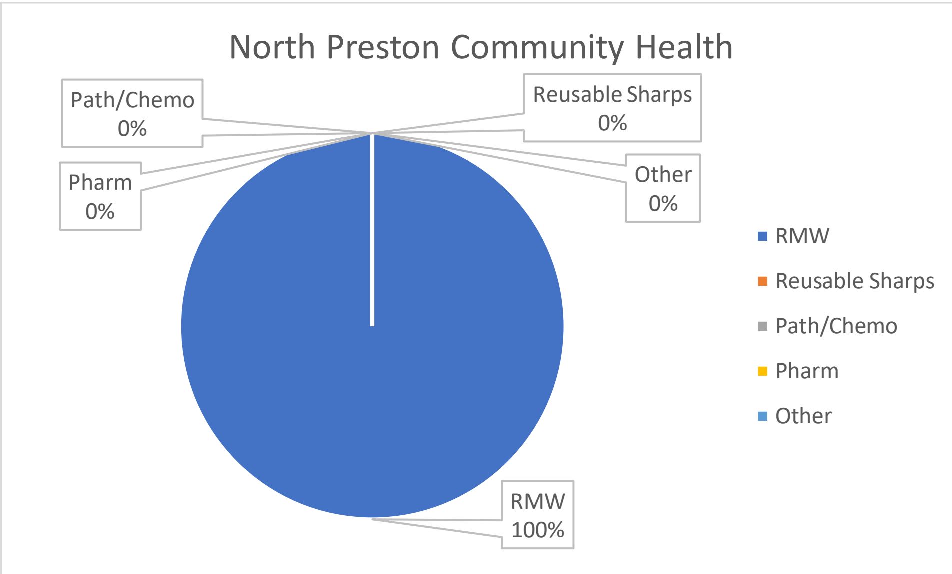

Figure B.55 Percentage of container waste from the North Preston Community Health Centre

Table B.7.29 Numeric values from the North Preston Community Health Centre

Monthly Totals	
Max (kg)	-
Min (kg)	-
Mean (kg)	-
Std Dev (kg)	-
Median (kg)	-
N	1

B.30. St. Margaret's Bay Road Collection Services

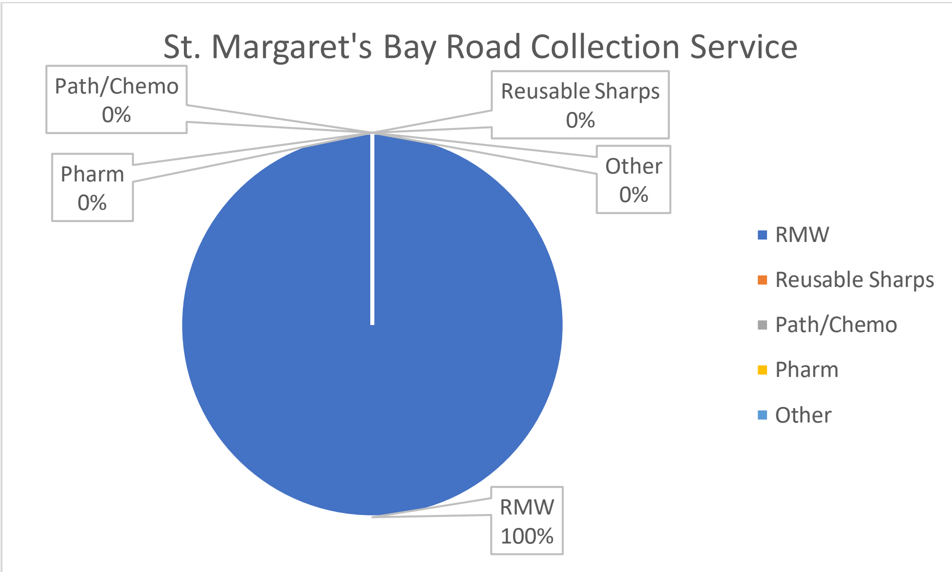

Figure B.56 Percentage of container waste from the St. Margaret's Bay Road Collection Service

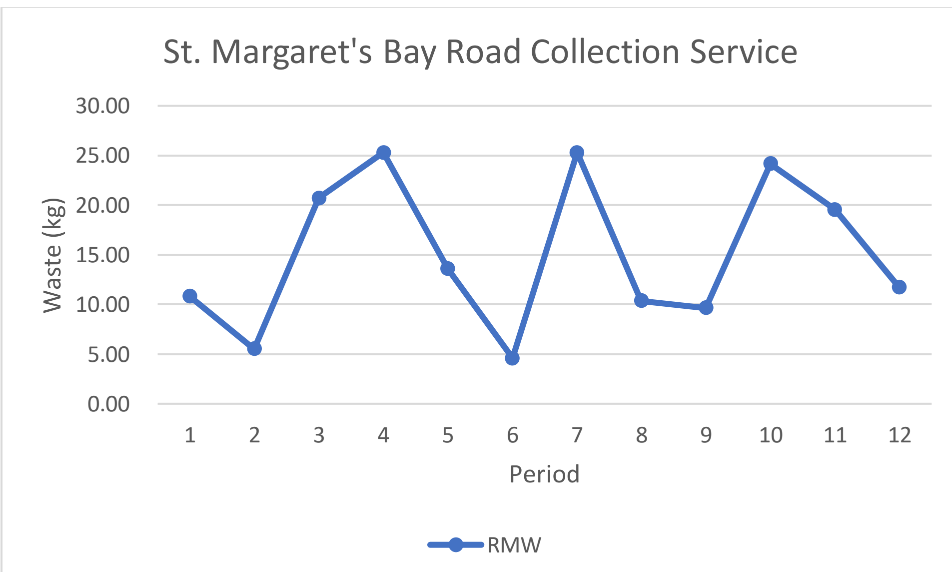

Figure B.57 Numeric values of waste generated per period in kg from the St. Margaret's Bay Road Collection Service

Table B.7.30 Numeric values from the St. Margaret's Bay Road Collection Service

Monthly Totals	
Max (kg)	25.30
Min (kg)	4.60
Mean (kg)	15.10
Std Dev (kg)	7.23
Median (kg)	12.65
N	12

B.31. Dartmouth Community Health Centre

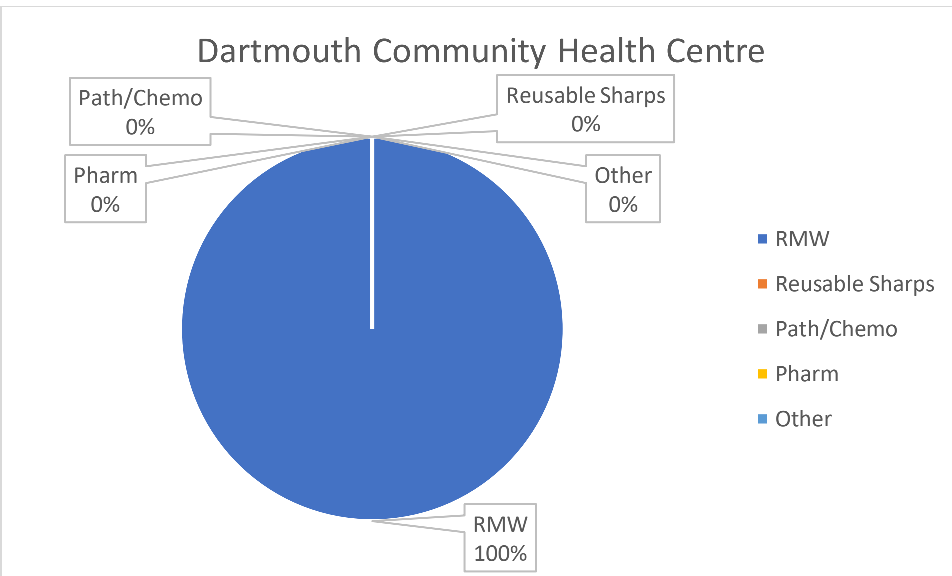

Figure B.58 Percentage of container waste from the Dartmouth Community Health Centre

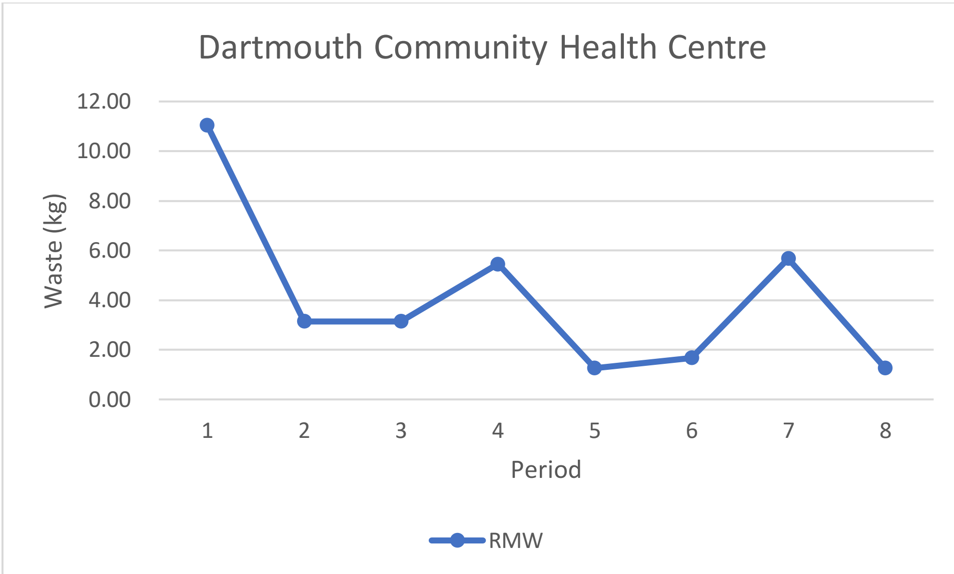

Figure B.59 Percentage of container waste from the Dartmouth Community Health Centre

Table B.7.31 Numeric values from the Dartmouth Community Health Centre

Monthly Totals	
Max (kg)	11.04
Min (kg)	1.26
Mean (kg)	4.08
Std Dev (kg)	3.09
Median (kg)	3.15
N	12

B.32. Woodlawn Blood Collection

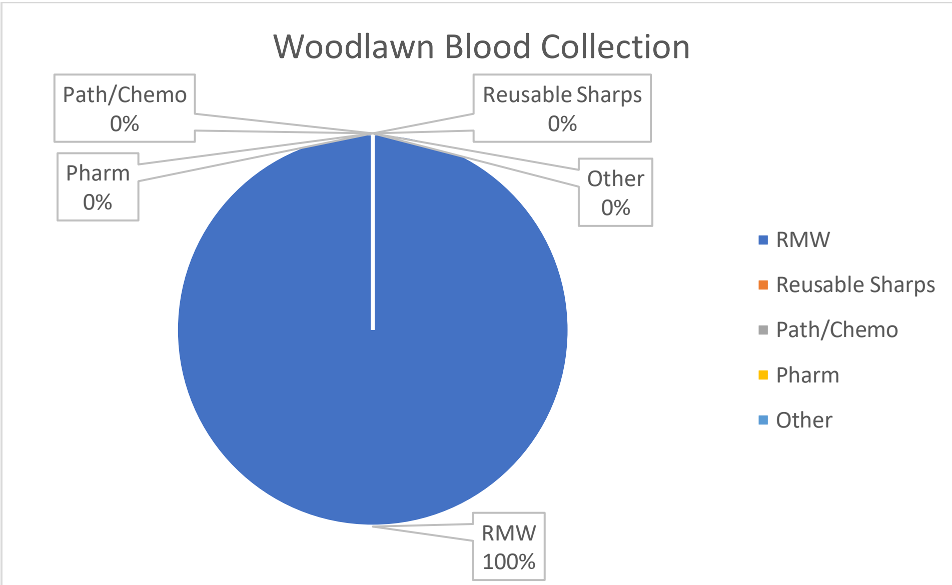

Figure B.60 Percentage of container waste from the Woodlawn Blood Collection Centre

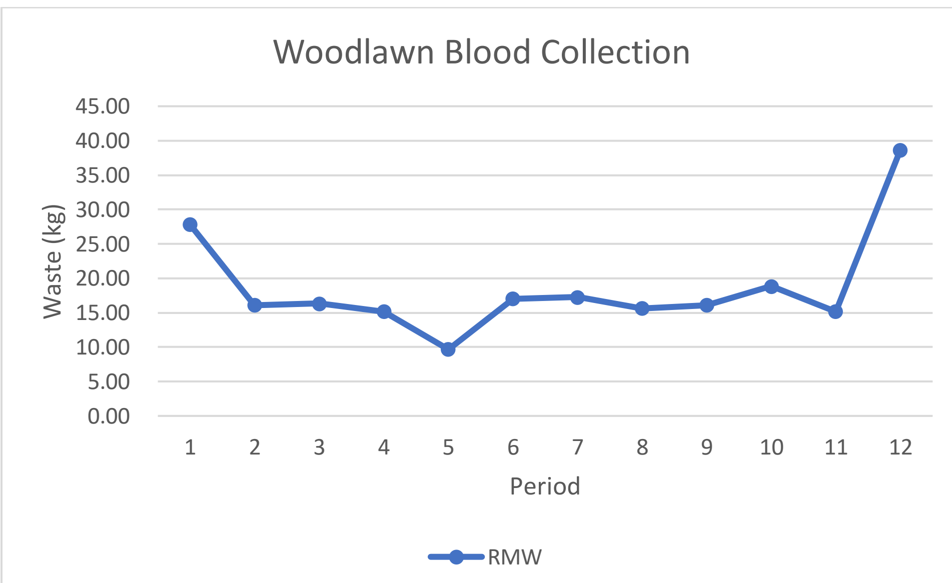

Figure B.61 Numeric values of waste generated per period in kg from the Woodlawn Blood Collection Centre

Table B.7.32 Numeric values from the Woodlawn Blood Collection Centre

Monthly Totals	
Max (kg)	38.64
Min (kg)	9.66
Mean (kg)	18.65
Std Dev (kg)	7.19
Median (kg)	16.22
N	12

B.33. Ocean View Continuing Care Centre

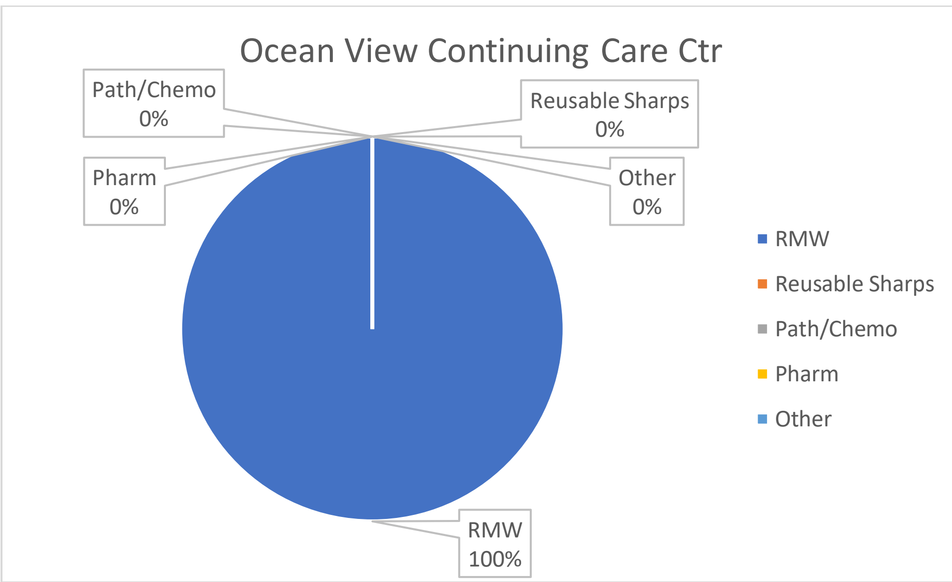

Figure B.62 Percentage of container waste from the Ocean View Continuing Care Centre

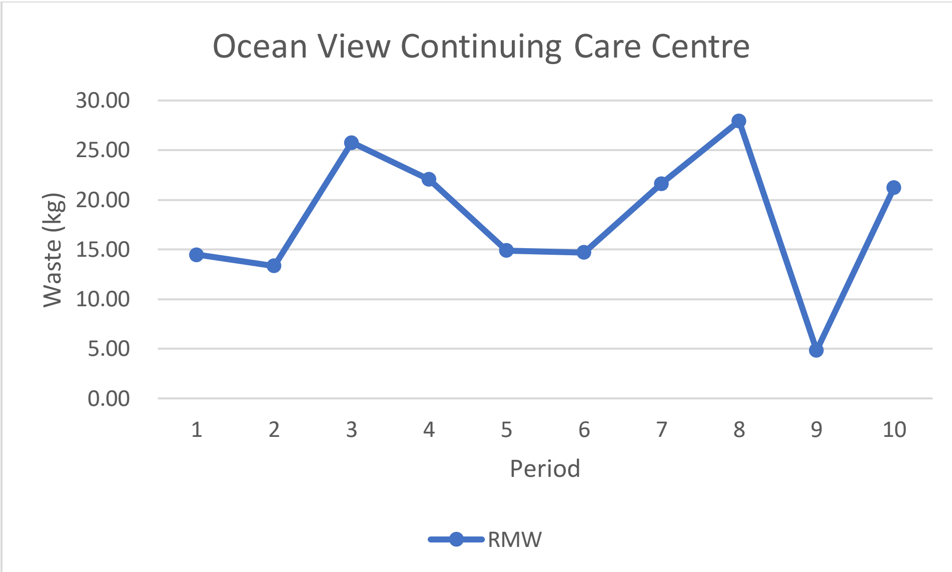

Figure B.63 Numeric values of waste generated per period in kg from the Ocean View Continuing Care Centre

Table B.7.33 Numeric values from the Ocean View Continuing Care Centre

Monthly Totals	
Max (kg)	27.93
Min (kg)	4.83
Mean (kg)	18.09
Std Dev (kg)	6.53
Median (kg)	18.06
N	10

B.34. Cardiovascular and Pulmonary

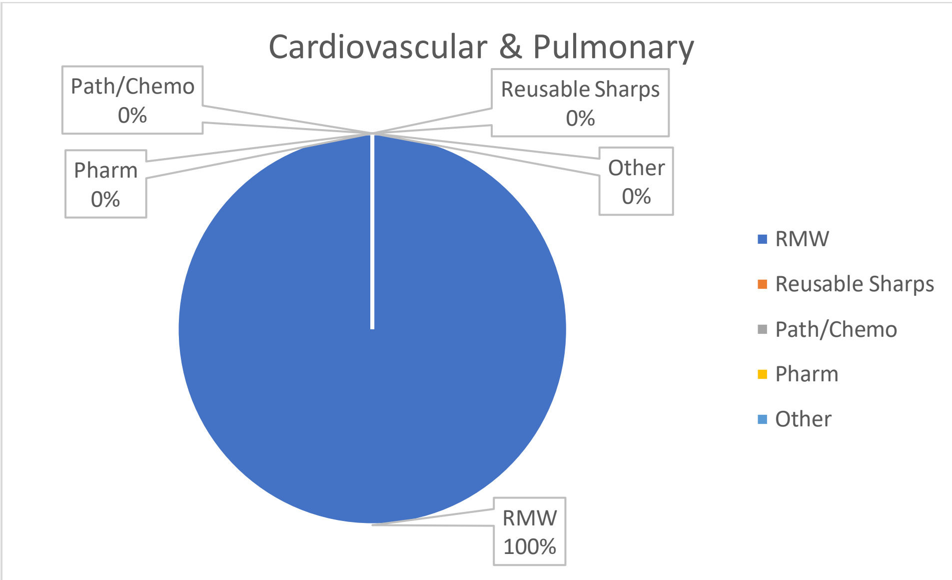

Figure B.64 Percentage of container waste from the Cardiovascular and Pulmonary

Table B.7.34 Numeric values from the Cardiovascular and Pulmonary

Monthly Totals	
Max (kg)	3.57
Min (kg)	1.68
Mean (kg)	2.66
Std Dev (kg)	0.77
Median (kg)	2.73
N	3

B.35. Glace Bay Healthcare Facility

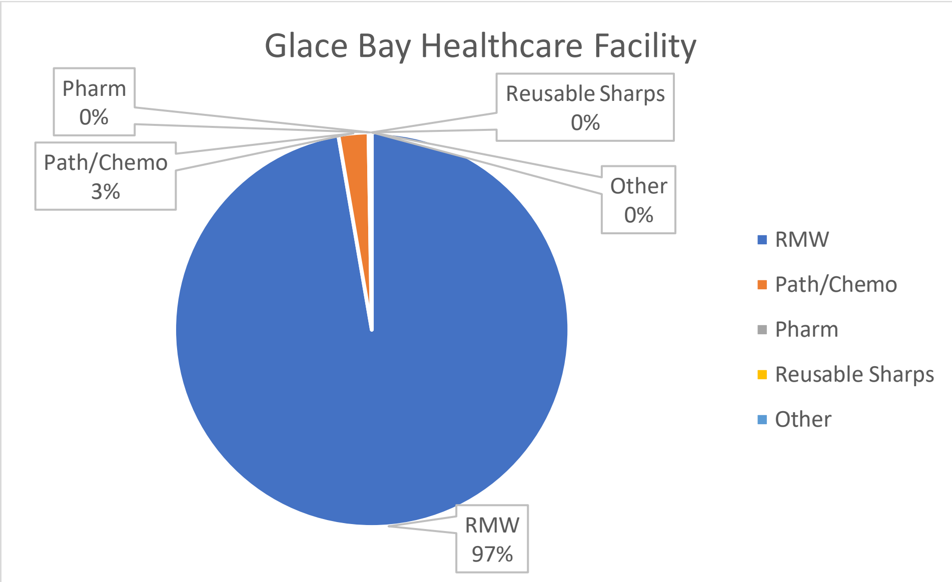

Figure B.65 Percentage of container waste from the Glace Bay Healthcare Facility

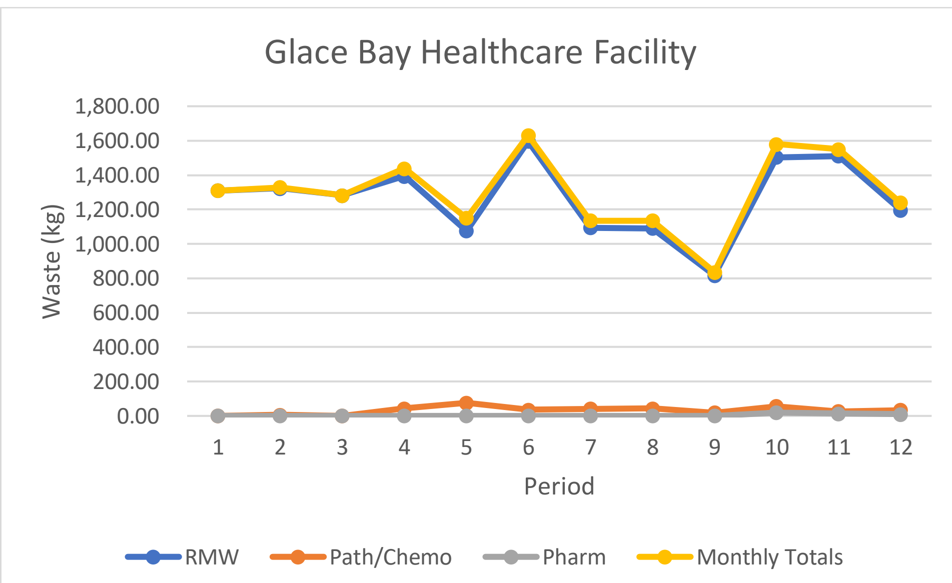

Figure B.66 Numeric values of waste generated per period in kg from the Glace Bay Healthcare Facility

Table B.7.35 Numeric values from the Glace Bay Healthcare Facility

Monthly Totals	
Max (kg)	1,630.65
Min (kg)	836.01
Mean (kg)	1,301.34

Std Dev (kg)	217.19
Median (kg)	1,296.40
N	12

B.36. New Waterford Consolidated

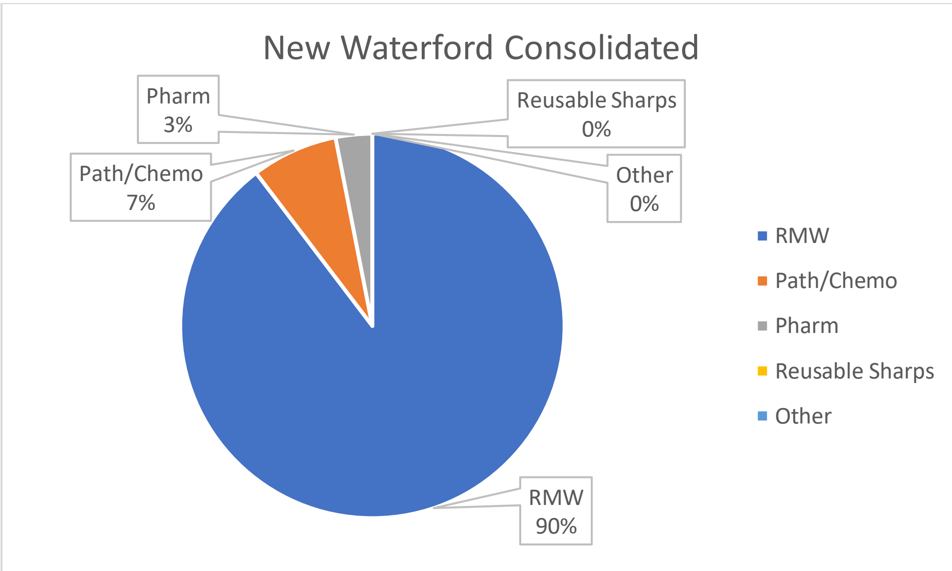

Figure B.67 Percentage of container waste from the New Waterford Consolidated

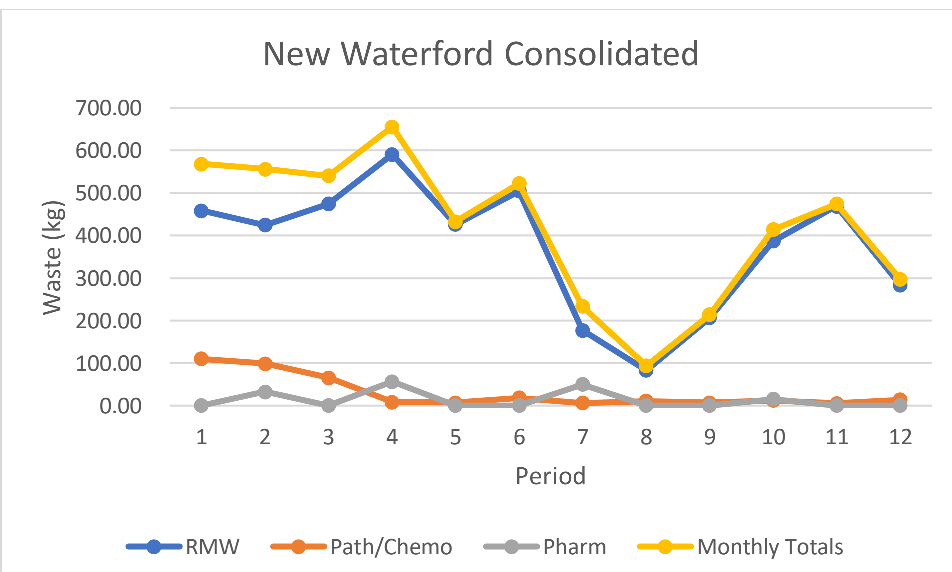

Figure B.68 Numeric values of waste generated per period in kg from the New Waterford Consolidated

Table B.7.36 Numeric values from the New Waterford Consolidated

Monthly Totals	
Max (kg)	655.73
Min (kg)	93.66
Mean (kg)	416.87
Std Dev (kg)	164.10
Median (kg)	453.71
N	12

B.37. Taigh Na Mara

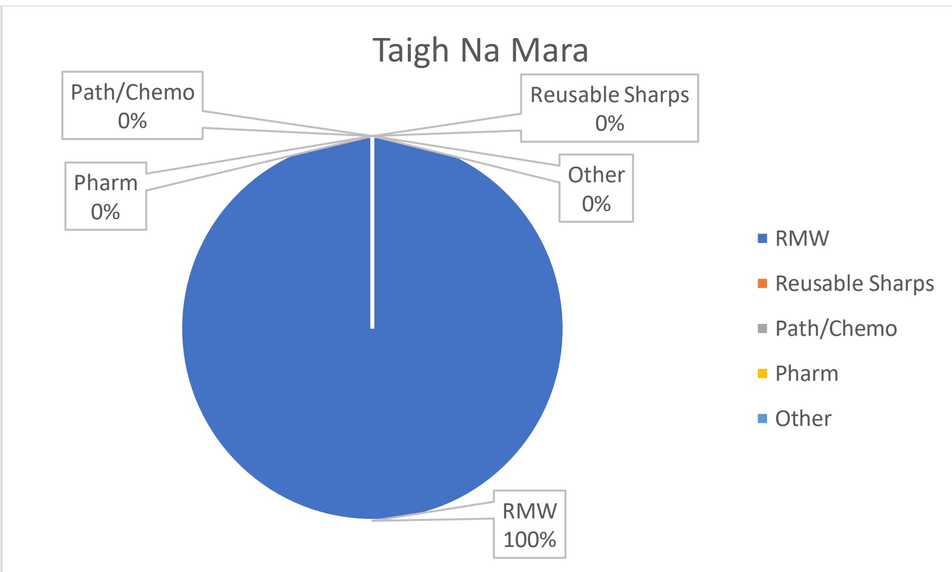

Figure B.69 Percentage of container waste from the Taigh Na Mara

Table B.7.37 Numeric values from the Taigh Na Mara

Monthly Totals	
Max (kg)	65.78
Min (kg)	50.40
Mean (kg)	60.15
Std Dev (kg)	6.92
Median (kg)	64.26
N	3

B.38. North Side General

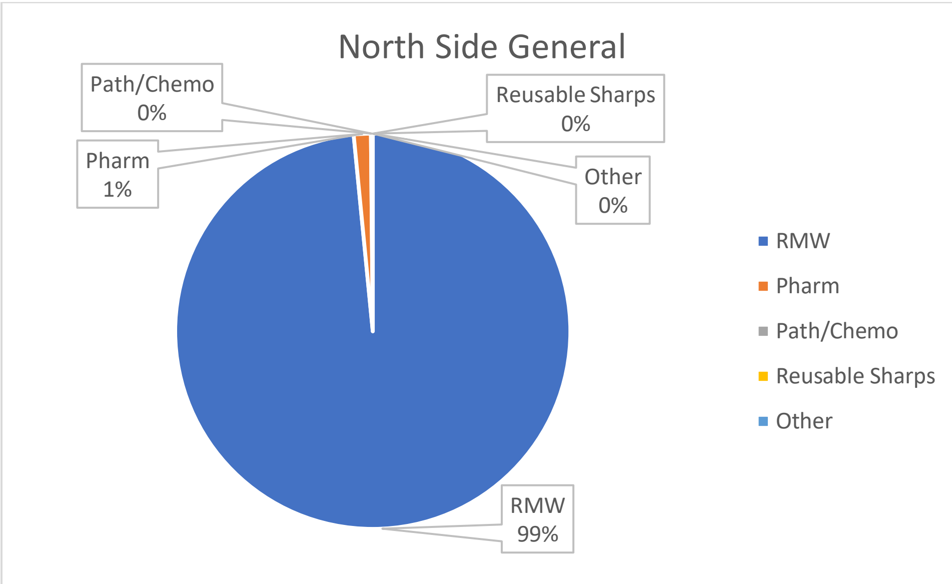

Figure B.70 Percentage of container waste from the North Side General

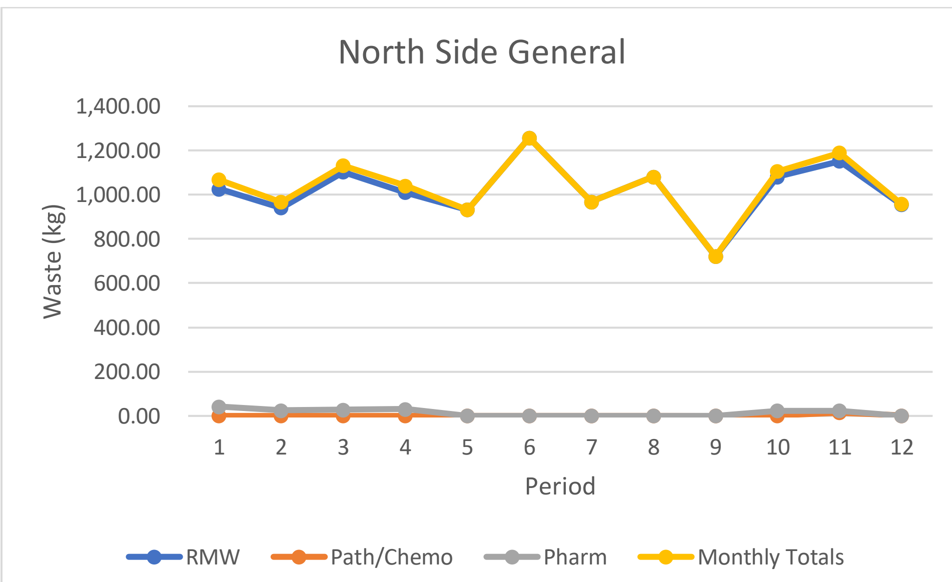

Figure B.71 Numeric values of waste generated per period in kg from the North Side General

Table B.7.38 Numeric values from the North Side General

Monthly Totals	
Max (kg)	1,256.85
Min (kg)	721.77
Mean (kg)	1,034.93
Std Dev (kg)	133.78
Median (kg)	1,054.32
N	12

B.39. Harbour View Hospital

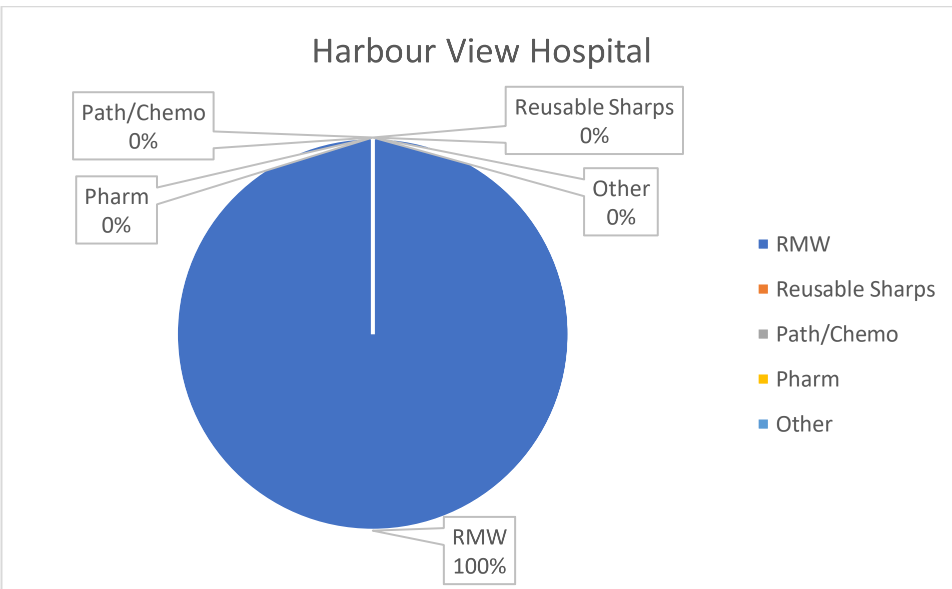

Figure B.72 Percentage of container waste from the Harbor View Hospital

Table B.7.39 Numeric values from the Harbor View Hospital

Monthly Totals	
Max (kg)	122.36
Min (kg)	65.55
Mean (kg)	87.72
Std Dev (kg)	23.08
Median (kg)	81.48
N	4

B.40. Victoria County Memorial Hospital

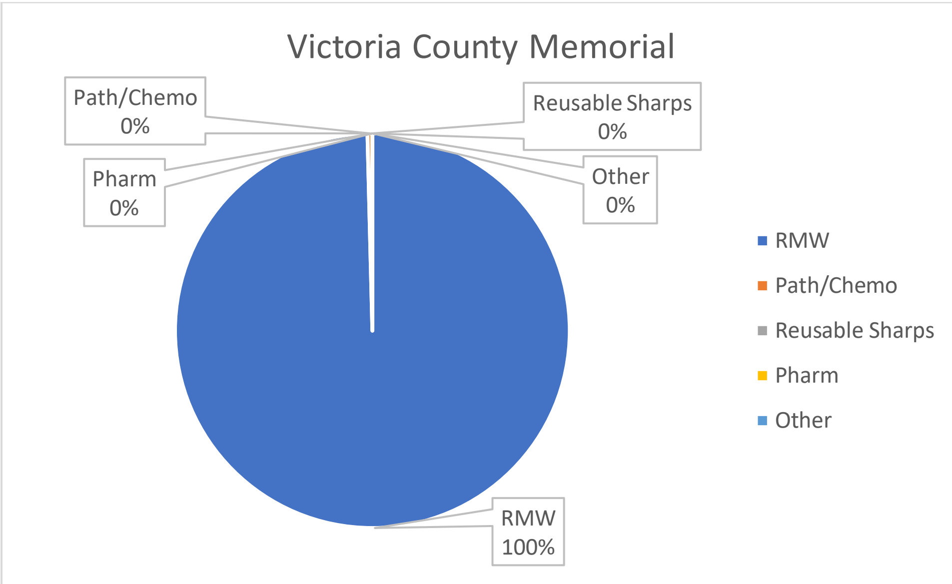

Figure B.73 Percentage of container waste from the Victoria County Memorial

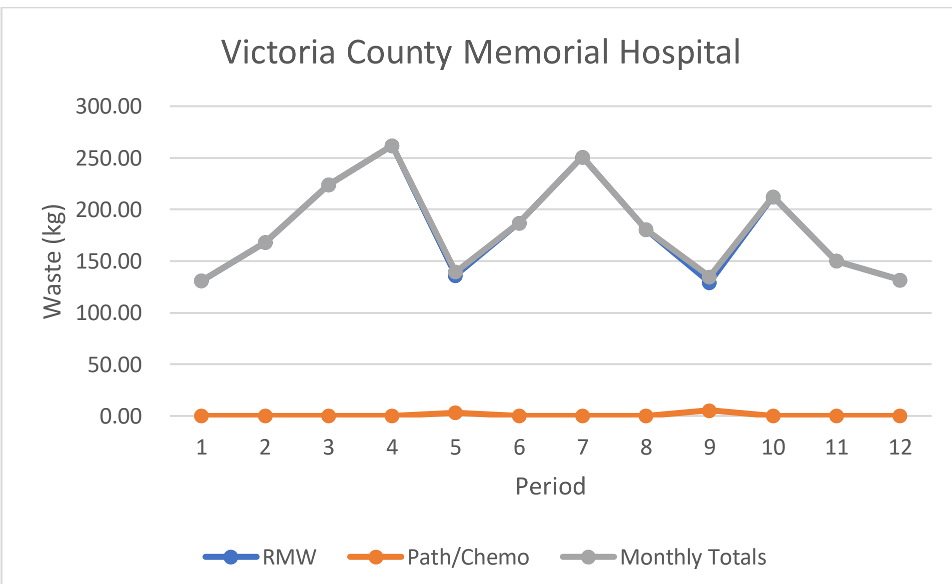

Figure B.74 Numeric values of waste generated per period in kg from the Victoria County Memorial Hospital

Table B.7.40 Numeric values from the Victoria County Memorial Hospital

Monthly Totals	
Max (kg)	261.97
Min (kg)	130.87
Mean (kg)	180.95
Std Dev (kg)	44.93
Median (kg)	174.26
N	12

B.41. Inverness Consolidated Memorial

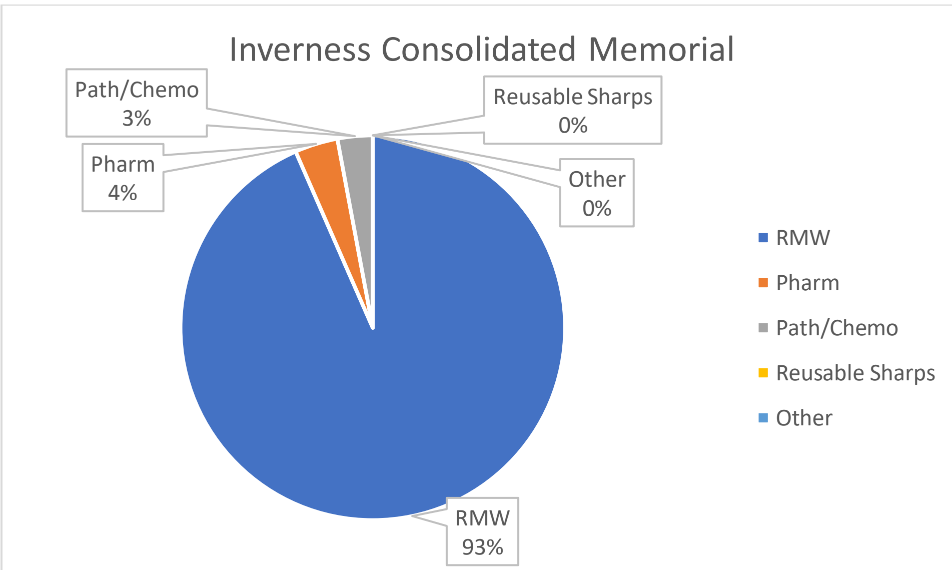

Figure B.75 Percentage of container waste from the Inverness Consolidated Memorial

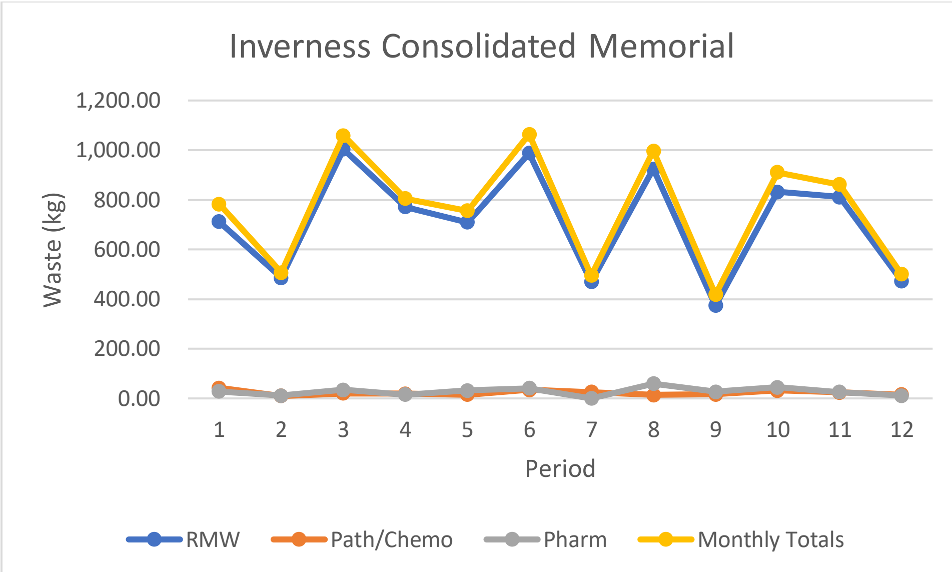

Figure B.76 Numeric values of waste generated per period in kg from the Inverness Consolidated Memorial

Table B.7.41 Numeric values from the Inverness Consolidated Memorial

Monthly Totals	
Max (kg)	1,063.86
Min (kg)	417.48
Mean (kg)	762.72
Std Dev (kg)	222.17
Median (kg)	793.62
N	12

B.42. Sacred Heart Community Hospital

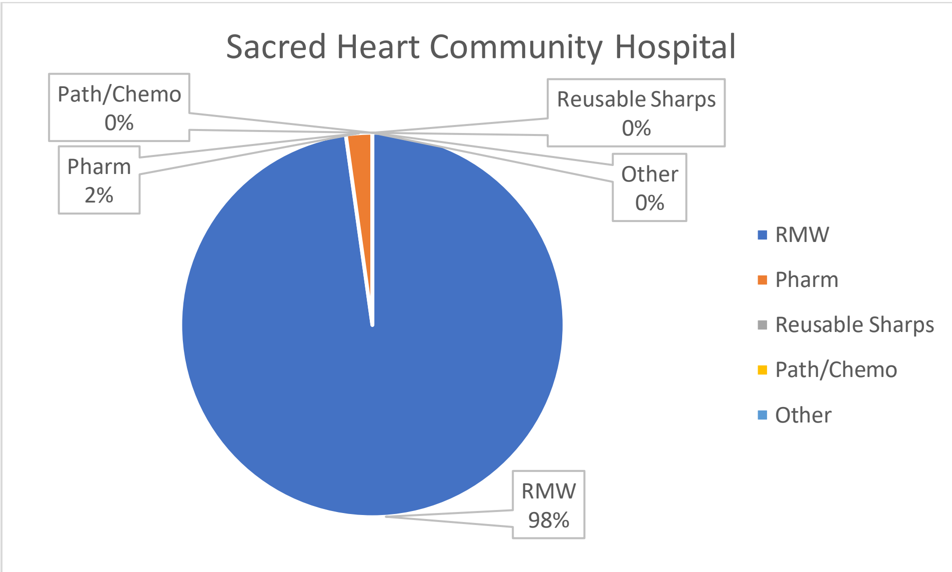

Figure B.77 Percentage of container waste from the Sacred Heart Community Hospital

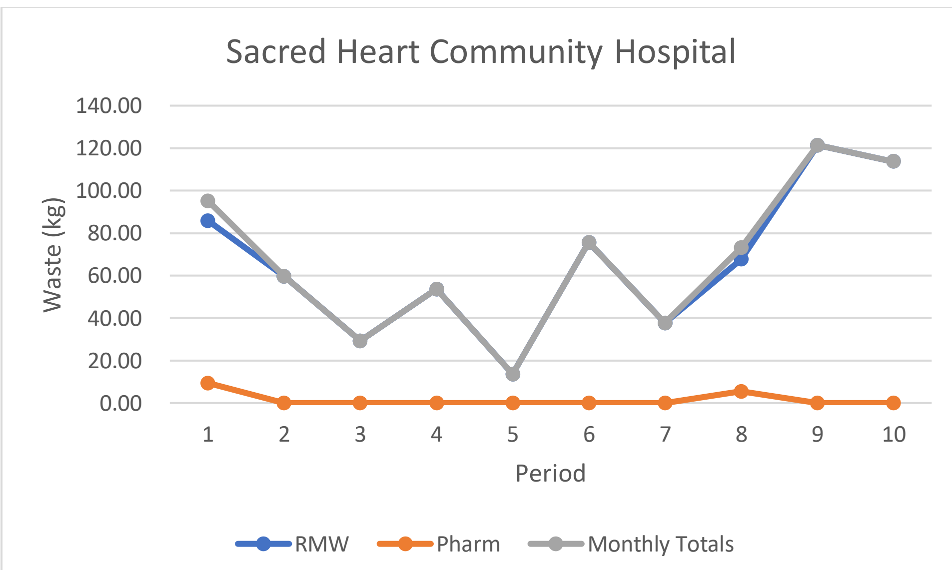

Figure B.78 Numeric values of waste generated per period in kg from the Sacred Heart Community Hospital

Table B.7.42 Numeric values from the Sacred Heart Community Hospital

Monthly Totals	
Max (kg)	121.38
Min (kg)	13.65
Mean (kg)	67.25
Std Dev (kg)	33.78
Median (kg)	66.33
N	12

B.43. Buchanan Memorial Hospital

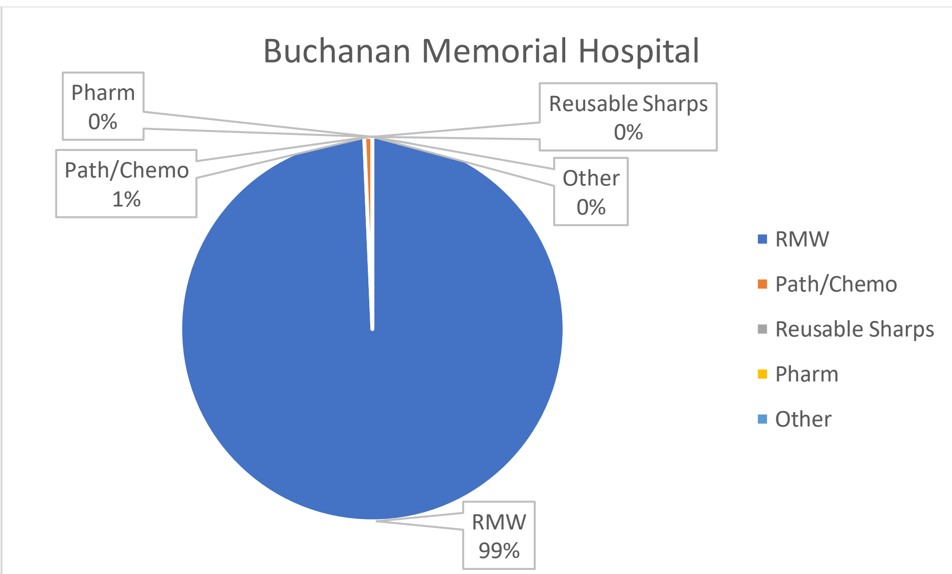

Figure B.79 Percentage of container waste from the Buchanan Memroial Hospital

Table B.7.43 Numeric value from the Buchanan Memorial Hospital

Monthly Totals	
Max (kg)	201.81
Min (kg)	115.23
Mean (kg)	165.46
Std Dev (kg)	36.68
Median (kg)	179.34
N	3

B.44. AIDS Coalition of Cape Breton

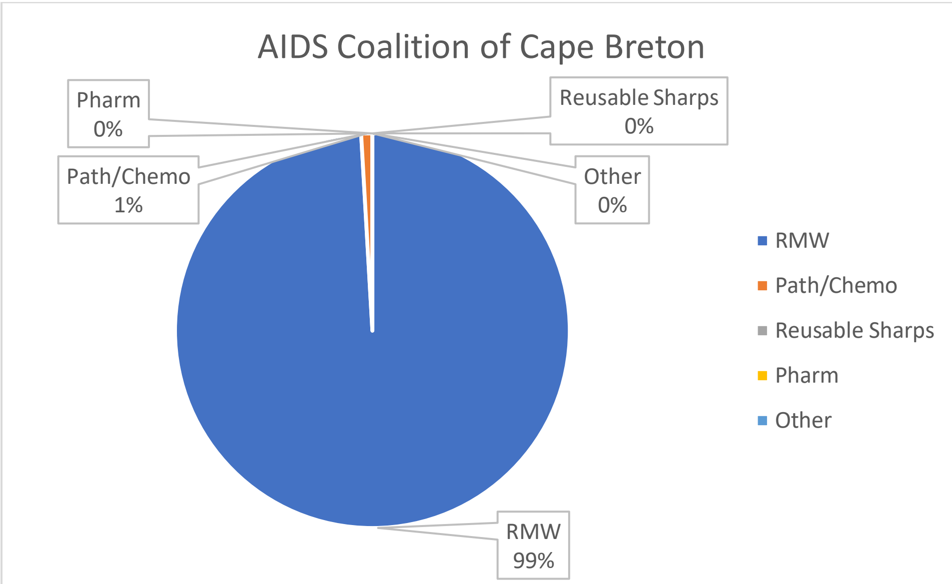

Figure B.80 Percentage of container waste from the AIDS Coalition of Cape Breton

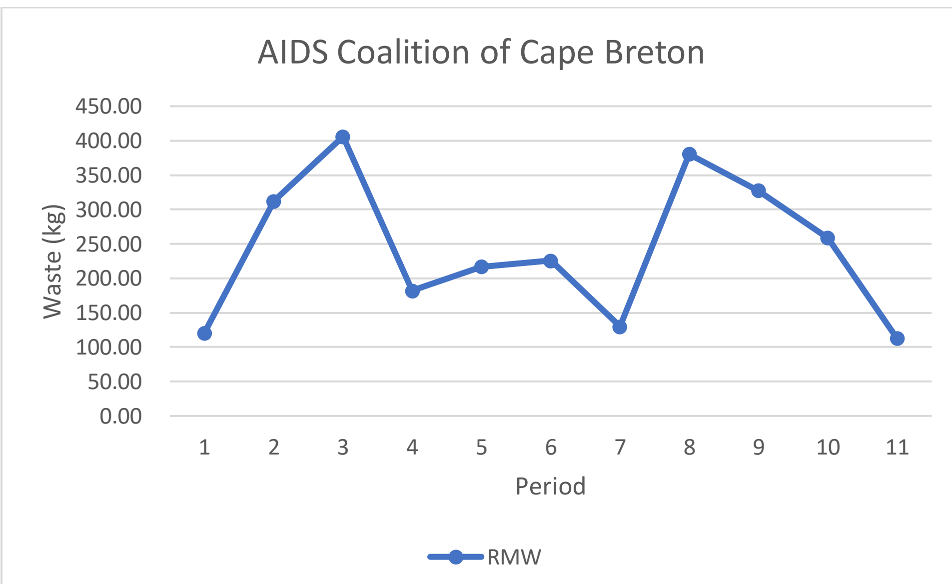

Figure B.81 Numeric values of waste generated per period in kg from the AIDS Coalition of Cape Breton

Table B.7.44 Numeric values from the AIDS Coalition of Cape Breton

Monthly Totals	
Max (kg)	405.92
Min (kg)	112.55
Mean (kg)	242.94
Std Dev (kg)	98.63
Median (kg)	225.73
N	12

B.45. Sterling Health Centre

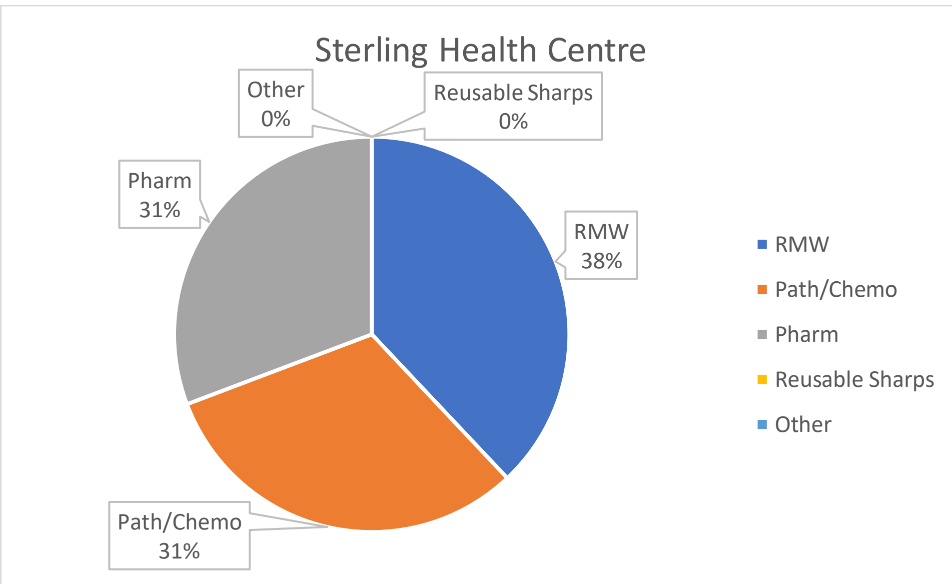

Figure B.82 Percentage of container waste from the Sterling Health Centre

Table B.7.45 Numeric values from the Sterling Health Centre

Monthly Totals	
Max (kg)	50.19
Min (kg)	28.35
Mean (kg)	39.27
Std Dev (kg)	10.92
Median (kg)	39.27
N	2

Appendix C: Waste Policies

Capital Health

ADMINISTRATIVE MANUAL

Policy and Procedure

TITLE:	Confidential Waste Management	**NUMBER:**	CH 20-015
Effective Date::	May 2014	Page	1 of 2
Applies To:	Holders of Administrative Manual		

POLICY

1. Capital Health will maintain the privacy of all patient and sensitive organizational information through the appropriate disposal of confidential waste generated within Capital Health.
2. This policy **does not address** disposal of the following:
   2.1. Disposal of electronic media (addressed in the *Disposition of Surplus/Obsolete CH IT Hardware& Software/Application Assets CH 05-066* policy.)
   2.2. X-ray films (disposed of by the originating department.)

DEFINITIONS

Confidential waste: Any material which contains a patient's/client's name and medical condition and/or treatment. This may include but is not limited to, medical reports, addressograph cards/labels and any items which have an addressograph label such as IV bags, pill bottles:

OR

Any hospital document identified as confidential administrative documentation by the originating department. This may include but is not limited to, all documents pertaining to staff performance evaluations, payroll and benefits.

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Figure C. 1 Policy CH 20-015 Confidential Waste Management

Confidential Waste Management *Page 2 of 2*
CH 20-015

PROCEDURE

1. **Separation**

 1.1. Separate, at source, confidential waste from all other waste types.

  1.1.1. Collect **all confidential materials** and deposit into the confidential shredding consoles.

   1.1.1.1. All paper based confidential waste is to be placed in the confidential shredding console, any medical waste that contains any patient identifiers/patient labeling (IV bag, pill bottle etc..) is to be disposed of in the yellow biohazardous bag with other biohazardous waste.

2. **Storage**

 2.1. Employees may temporarily store confidential waste at workstations until depositing it directly into the confidential paper consoles.

3. **Disposal**

 3.1. Housekeeping Services arranges to have confidential waste removed from Capital Health facilities and destroyed onsite by a competent and reliable external vendor.

 3.2. Employees continuing to use existing office shredders assume total responsibility for the effective storage and destruction of the waste.

RELATED DOCUMENTS

Policies

CH 05-066 Disposition of Surplus/Obsolete CH IT Hardware& Software/Application Assets

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Capital Health

ADMINISTRATIVE MANUAL

Policy & Procedure

TITLE:	Recycled and General Waste Management	**NUMBER:**	CH 20-016
Date Issued:	December 2014	Page	1 of 3
Applies To:	Holders of Administrative Manual		

POLICY

1. Capital Health will strive to maximize the material diverted from the general waste stream by recycling and composting.
2. Capital Health is to comply with:
   2.1 Province of Nova Scotia Solid Waste- Resource Management regulations made under section 102 of the Environment Act.
   2.2 Halifax Regional Municipality Solid Waste Resource Collection and Disposal By- Law S-600.
3. Disposal of the remaining general waste is to be carried out with as much emphasis as possible on safety, environmental impact and cost control.

DEFINITIONS

Recycling Waste: The process of collecting and preparing recyclable materials and reusing the materials in their original forms that do not cause the destruction of recyclable materials in a manner that precludes further use.

Staff: For the purpose of this policy, 'staff' includes any employee, physician, volunteer, learner, board member, contractor, contract worker, franchise employee, any Capital Health Foundation employee and any other individual performing work activities within Capital Health.

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Figure C. 2 Policy CH 20-016 Recycled and General Waste Management

PROCEDURE

1. **Collection, Separation And Storage Of Waste**

1.1. All staff, visitors and patients deposit their waste into the appropriate waste receptacle.

1.2. Each facility ensures there:

1.2.1. are separate containers for collecting paper, organics, garbage, refundable and recyclables where they are generated.

1.2.2. is signage on all containers to indicate the material designated for each bin.

1.3. Designated Housekeeping employees at each site:

1.3.1. collect waste from approved receptacles;

1.3.2. transport, separate and transfer waste to a designated waste storage area.

1.4. An approved vendor removes waste from the designated waste storage area in each facility.

1.5. Housekeeping Management ensures all housekeeping employees are properly trained and provided with the required Personal Protective Equipment (PPE).

2. **Recycled Waste**

2.1. **Corrugated cardboard:** Break down boxes, remove tape and place outside of the office or in designated bins or receptacles.

2.2. **Mixed office paper:** Recycle office paper, newsprint, scrap paper, notebook paper, phone books and cardstock in office blue bins as well as any of the centralized recycling stations.

2.3. **Plastic bottles, glass bottles, bags, wrap & plastic containers:** Dispose of recyclable bottles, jars, cans and hard plastic containers in any designated receptacles and in centralized recycling stations. Rinse out containers prior to disposal.

2.3.1. ***Do not recycle broken glass or mirrors.***

2.4. **Metal and aluminum tins and cans:** Dispose of recyclable metal, foil and aluminum tins in any designated receptacle and in centralized recycling bins. Rinse out containers prior to disposal.

2.5. **Organic Waste:** Dispose of compostable materials including fruits, vegetables, meat, dairy, soiled paper, box board (cereal boxes) in any designated receptacles and in centralized recycling stations.

3. **General Waste**

3.1. Dispose of solid waste that cannot be recycled, composted, or reused in any designated receptacles and in centralized recycling stations.

4. **Safety**
   4.1. Box, tape securely and label clearly, any waste with physically hazardous properties capable of cutting or puncturing, including but not limited to broken glass or sharp metals.
      4.1.1. Place in or beside a general waste receptacle.
   4.2. Use precautionary measures, such as gloves, eye protection and handling tools, to avoid direct contact with waste during collection, separation and clean up.

REFERENCES

Province of Nova Scotia Solid Waste- Resource Management regulations made under section 102 of the Environment Act. October 1995

Halifax Regional Municipality Solid Waste Resource Collection and Disposal By- Law S-600. September 2010

RELATED DOCUMENTS

Policies

CH 20-017 Biomedical Waste Management

CH 20-015 Confidential Waste Management

* * *

Capital Health

ADMINISTRATIVE MANUAL

Policy & Procedure

TITLE:	Biomedical Waste Management	**NUMBER:**	CH 20-017
Effective Date:	March 2015	**Page**	1 of 7
Applies To:	Holders of Administrative Manual		

POLICY

1. Capital Health will manage its biomedical waste in as close accordance as possible with the Canadian Council of Ministers of the Environment (CCME) Guidelines for the Management of Biomedical Waste in Canada, and discuss and agree on strategies with the waste management vendor for Capital Health for the appropriate disposal of biomedical waste.
2. Housekeeping services is responsible for the overall administration of biomedical waste, including:

   2.1. all processes involving collection, handling, storage, transportation and disposal

   2.2. the implementation of procedures/plans for:

   - spill response (see Related Documents for policies in regards to spills and rooms with special precautions)
   - storage of biomedical waste due to the disruption of service.
3. Capital Health staff are not to accept the drop-off of biomedical waste at Capital Health facilities by any external party.
4. Capital Health staff are to minimize the amount of biomedical waste generated, ensuring that all waste streams are properly identified and segregated as per Capital Health's Position Statement for Waste Handling. (Refer to Appendix A and/or CH website page for Housekeeping Services.

   http://www.cdha.nshealth.ca/managed-services/housekeeping)
5. Pharmaceutical waste is not to be poured down the sink or into sharps containers.

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Figure C. 3 Policy CH 20-017 Biomedical Waste Management

6. All departmental managers are responsible for ensuring their staff are knowledgeable about, and properly trained in, waste segregation and safe handling procedures.

DEFINITIONS

Additional Precautions (Contact Precautions, Droplet Precautions, & Airborne Precautions):	Interventions implemented for certain pathogens or clinical presentations in addition to routine infection control practices, to reduce the risk of transmission of microorganisms from patient to patient, patient to Health Care Provider (HCP), and HCP to patient.
Anatomical waste (Red):	Includes tissues, organs, and body parts, but does not include teeth, hair and nails. Also includes biologicals containing chemicals.
Appropriately labeled:	Container of waste labeled with appropriate label i.e. biological, anatomical, cytotoxic, radiation, Rx etc.
Approved sharps container:	Puncture-resistant container as per CSA Standard Z316.6-07: *Evaluation of Single-Use and Reusable Medical Sharps Containers for Biomedical and Cytotoxic Waste*. Containers should remain functional during their entire usage. They should be durable, closable, leak resistant on their sides and bottoms, and puncture resistant until final disposal **(USDHHS, 1998).**
Biological waste (Yellow):	Blood, laboratory waste and items contaminated with blood. Includes teeth, hair and nails.
Biomedical waste:	Anatomical waste, biological waste, animal waste, laboratory waste, human blood and body fluid waste, waste sharps, cytotoxic waste, radioactive waste and (for the purposes of this policy) pharmaceutical waste.
Blood and body fluid waste:	Blood, blood products, body fluids and any contaminated materials (excludes urine, feces, diapers, personal hygiene and incontinence products – clinical areas).
Contaminated:	Soiled, stained, corrupted, or infected by contact or association or otherwise exposed to harmful agents. Includes anatomical, biological, biomedical, cytotoxic, laboratory, radioactive and blood and body

	fluid wastes.
Cytotoxic waste:	Has a toxic effect on cells and commonly refers to chemotherapy drugs (and contaminated materials).
Laboratory waste:	Laboratory cultures, stocks or specimens of microorganisms, live or attenuated vaccines and contaminated laboratory material. Includes blood and body fluids (urine and feces).
Non-contaminated:	Any items NOT contaminated with blood and body fluid waste, as well as anatomical, biological, biomedical, cytotoxic, laboratory and radioactive wastes.
Pharmaceutical Waste:	Waste containing pharmaceutical substances and includes: • expired, unused and contaminated medications • opened multidose vials, creams, ointments, inhalers, and patches • opened bottles of liquids • opened unit-dose packages (i.e. when a partial tablet is to be administered, and the remainder is discarded)
Radioactive waste:	Any waste that contains nuclear substances with a dose rate above background levels. (Refer to CH 15-010 *Radiation Safety Program* for more details)
Sharps:	Clinical and laboratory materials including needles, syringes, blades, or laboratory material capable of causing punctures or cuts.
Staff:	Capital Health employees, physicians, other practitioners, volunteers, students, contractors, associates of Capital Health, and employees of Capital Health Foundations.
Waste generators:	Persons generating waste
Waste management vendor:	Contracted service through Capital Health's Housekeeping Services for waste removal and destruction.
Vector:	Insects, pests or other organisms capable of transmitting diseases.

PROCEDURE

1. **Segregation, collection and handling**

   1.1. Waste generator:

   1.1.1. Segregate biomedical waste at the source and deposit it into the proper receptacle (refer to Appendix A).

   1.1.2. Do not overfill or remove waste from receptacles.

   Note: Do not exceed manufacturer's indicator line or 2/3 full for sharps containers.

   1.2. Housekeeping Services removes waste on a scheduled basis and transports it to the facility's storage area.

   1.3. When waste volume increase, notify Housekeeping Services.

   1.4. Secure and handle the bags safely and as little as possible. If biomedical waste needs to be removed from the receptacle before Housekeeping Services removes it, ensure it is stored in a safe location. Refer to section 2 for safe location storage requirements.

2. **Storage**

   2.1. Housekeeping Services:

   2.1.1. Stores waste in designated storage facilities until removed for disposal.

   2.1.2. Ensures storage areas are totally enclosed and used exclusively for biomedical waste storage.

   2.1.3. Clearly labels access doors with the BioMedical waste symbol.

   2.1.4. Keeps the storage areas locked at all times to restrict access to authorized employees; keep clean to eliminate vectors and unsightly appearance.

   2.1.5. Do not leave large carts/bins of waste unattended in hallways.

   2.1.6. Stores boxes, red bags and sharps containers on top of approved grey biomedical shipping containers.

REFERENCES

Guidelines for the Management of Biomedical Waste in Canada Canadian Council of Ministers of the Environment (CCME) (1992)

Laboratory Biosafety Guidelines, 3rd edition (2004), Public Health Agency of Canada

Selecting, Evaluating, and Using Sharps Disposal Containers, U.S. Department of Healthand Human Services, 1998

Infection Control Guidelines, Classic Creutzfeldt-Jakob Disease in Canada Public Health Agency of Canada, Quick Reference Guide 2007

Infection Control Guidelines: Hand Washing, Cleaning, Disinfection and Sterilization in Health Care, Public Health Agency of Canada (PHAC): December 1998 Vol 24S8. pg 37-40 and including appendix 2.

Best Practices for Environmental Cleaning for Prevention and Control of Infections, In all Health Care Settings, Provincial Infectious Diseases Advisory Committee (PIDAC): May 2012. pg. 48-52

Routine Practices and Additional Precautions for Preventing the Transmission of Infection in Health Care: Health Canada, Laboratory Center for Disease Control, Bureau of Infectious Diseases, Division of Nosocomial and Occupational Infections: July 1999

Infection Prevention and Control Best Practices, for Long Term Care, Community Care including Health Care Offices and Ambulatory Clinics: Canadian Committee on Antibiotic Resistance (CCAR) June 2007

Best Practices For Cleaning, Disinfection and Sterilization, In all Health Care Setting, Provincial Infectious Diseases Advisory Committee (PIDAC)

RELATED DOCUMENTS
Policies

CC 05-055	Safe Handling of Cytotoxic Drugs/Waste
CH 15-010	Radiation Safety Program
CH 20-060	Sharps Disposal
CH 20-015	Confidential Waste Management
CH 20-016	Recycled and General Waste Management
IC 04-008	Contact Precautions
IC 04-010	Airborne Precautions
IC 04-011	Droplet Precautions
IC 06-005	Management of Patients with Suspect/Clinically Diagnosed Creutzfeld-Jakob Disease in the Operating Room
MM 35-001	Narcotic and Controlled Drugs for the disposal of narcotics and controlled substances.

Radiation Safety Policies and Procedures Manual – Waste Management
http://www.cdha.nshealth.ca/safety-injury-prevention/radiation-safety

Appendices:

Appendix A	Capital Health Position Statement for Waste Handling (also available at http://www.cdha.nshealth.ca/managed-services/housekeeping/waste-management

* * *

Capital Health's Position Statement for Waste Handling
Appendix A

Waste Type		Handling Procedures
Biomedical		
i.	**anatomical** i.e. tissues (fixed in wax or not, including tissues on slides), organs, body parts, biologicals that include chemical residues	red bag/bucket or appropriately labeled* box lined with red bag
ii.	**animal fluid waste**	yellow bag/bucket or appropriately labeled box lined with yellow bag
iii.	**inpatient/outpatient waste –** **a. waste including diapers, personal hygiene, feminine hygiene products and incontinence pads**	black bag (regular waste stream)
	b. rooms/spaces under additional precautions (except CJD)	yellow bag/bucket or appropriately labeled box lined with yellow bag
iv.	**IV tubing and catheters** **a. contaminated (blood and body fluids)**	yellow bag/bucket or appropriately labeled box lined with yellow bag
	b. non-contaminated	black bag (regular waste stream)
v.	**laboratory waste** **a. cultures, stocks or specimens, live or attenuated vaccines**	yellow bag/bucket or appropriately labeled box lined with yellow bag
	b. blood and body fluids, including urine and feces and items contaminated with blood, body fluids, urine and feces (ie gloves, sticky labels, paper etc.)	yellow bag/bucket or appropriately labeled box lined with yellow bag
	c. lab materials that have contacted above wastes ie vials, test tubes, blood culture bottles and plates, pipettes etc.	yellow bag/bucket or appropriately labeled box lined with yellow bag
	d. CJD suspected waste	Place in a rigid impervious container. Label: ***Biomedical- for Incineration. DO NOT OPEN"***. (IC 06-005) Incinerate all tray supplies, linen, incontinent pads, gloves, gowns, and all sharps. Place in the 5-gallon sharps containers. When a container is full, ensure the top is properly sealed and secured, label "Biomedical – For Incineration".(IC09-003)
	e. VHF suspected waste	Place in a securely closed red plastic bag. Place red plastic bag into second securely closed red plastic bag. Place bags into securely closed blue UN standardized plastic drum which contains sufficient absorbent material to absorb any free liquid visible in the plastic bags. Secure the blue UN standardized plastic drum. Disinfect drum. Label drum "Biomedical – For Incineration".(IC09-003) Place in segregated storage. Contact Biomedical Waste removal vendor.
vi.	**sharps** ie needles, syringes, blades or lab glass capable of causing punctures or cuts **a. Contaminated**	approved* sharps container/box labeled with biohazard and sharps label, then seal when 2/3 full.
	b. non-contaminated	side approved container, securely closed, labeled sharps.
vii.	**cytotoxic** ie chemotherapy agents, antineoplastics	use approved labeled red sharps container, bucket, red bag – placed in a cardboard box, labeled with a

	cytotoxic label (for areas that do not generate this waste on a regular basis, please contact Housekeeping Services.)
viii. **radioactive waste**	Remains stored until decay then disposed of as per CH's Position Statement for Waste Disposal.
ix. **pharmaceutical ie vaccines, vials, ampoules etc.**	White pail or box lined with red or clear bag, labeled with Rx symbol. Remove the center ring and re-seal after each use. Call housekeeping for pick-up when the bucket is three-quarters full. For narcotic waste, add one-quarter cup of kitty litter in order to render unusable.
x. **all remaining regular waste (i.e. paper towels used for hand washing, specimen bags etc.)**	black bag (regular waste stream)
Recycled **mixed office paper** ie all colours, including bond, photocopy, computer, letterhead, non carbon copy paper.	deskside to central blue box
ii. **newspaper/magazines**	central blue box
iii. **containers** ie juice/water/pop cans and bottles, etc	container blue box
iv. **cardboard,** corrugated and boxboard (cereal box)	place flattened beside general waste
v. **organics** ie food waste, soiled and non-recyclable paper	little green box to big green cart
Confidential (anything containing patient name or sensitive information) i. **paper, sticky labels**	Confidential document destruction receptacle
ii. **non-paper** ie addressograph/hard plastic cards, carbon paper.	Identified confidential document destruction receptacle

If you require labels, or have any questions in regards to waste disposal, contact Housekeeping Services at http://www.cdha.nshealth.ca/managed-services/housekeeping

Capital Health

ADMINISTRATIVE MANUAL

Policy & Procedure

TITLE:	Sharps Disposal	**NUMBER:**	CH 20-060
Section: Source:	Safety and Security Occupational Health	Date Approved: Date Reviewed: *Date To Be Reviewed:*	July, 2003 *July 2006*
Distribution:	All	Approval:	Executive Management Team

POLICY

1. Departments/programs are responsible for:

   1.1 Providing equipment required to safely dispose of sharps that have been exposed to blood and/or potentially infectious body substances.

   1.2 The safe placement of sharps containers.

   1.3 Providing education on the safe use and disposal of sharps.

2. Users of any sharp item are responsible for:

   2.1 Disposing of sharps in a sharp's container that has been properly assembled with a secured lid, not filled above the manufacturer's indicated full line.

   2.2 Ensuring that needles that have been exposed to blood and/or potentially infectious body substances are **not** recapped prior to disposal in the sharps container at point of use.

   2.3 Ensuring that disposable syringes are **not** separated from the needle. Blades from non-disposable scalpels are removed with extreme care.

   2.4 Ensuring that if the needle is multi-use or if it is not immediately feasible to dispose of the needle/sharp at point of use, to recap only by using a single-handed scoop method.

3. Operating Rooms are responsible for ensuring that Stapling Devices are closed after use and replaced in their original box and that the ends of the box are taped shut prior to disposal.

Sharps Disposal **CH 20-060** **Page 1 of 2**

Figure C. 4 Policy CH 20-060 Sharps Disposal

PROCEDURE

Employees/Users of any sharp item must:

1. Safely dispose of single-use needles and sharps in a sharps container.
2. Close the sharps container properly and replace the container that is full to the manufacturer's full line mark, or notify the appropriate personnel to immediately replace the container.
3. Notify their manager/supervisor of any hazards associated with needles or sharps that have the potential to cause accidental exposure to blood and/or body substances.
4. Seal containers before transporting, where injections are administered off site and sharps containers are transported by employees in the community, including schools and homes.

Managers/Supervisors or Delegates shall:

1. Provide education to staff on the safe use of needles and sharps and the disposal of used sharps within the unit/department.
2. Provide an appropriate number of sharps containers within their units, located at the sharps point of use, in order to prevent accidental exposure.
3. Place sharps containers within the unit/department, and regularly evaluate their use, ensuring the safety to the user and others present in the area.
4. Oversee and have procedures in place so that full sharps containers are replaced to prevent accidental exposure when using the sharps disposal.

Capital Health

INTERDISCIPLINARY CLINICAL MANUAL

Policy and Procedure

TITLE:	Safe Handling of Cytotoxic Drugs/Waste	**NUMBER:**	CC 05-055
Effective Date:	January 2014	Page	1 of 11
Applies To:	Holders of Interdisciplinary Clinical Manual		

TABLE OF CONTENTS

POLICY

1. Adherence to appropriate safety practices when handling cytotoxic agents is required to ensure the safety of patients, families, health care providers, and the protection of the environment.
2. All employees involved in any aspect of the handling of cytotoxic drugs and/or waste are to be informed about the potential risks of occupational exposure.
3. All employees who routinely handle cytotoxic drugs or waste are to receive training in proper spill management and cleanup procedures.
4. Spill kits, containing all materials and equipment necessary to clean a spill, are to be available and readily accessible in each area where cytotoxic drugs are handled.

Note: A written procedure for spill management is included in each spill kit.

5. Personal Protective equipment (PPE) is to be used by all health care providers to reduce the risk of exposure to cytotoxic agents and waste.
   5.1. To minimize cytotoxic exposure, protective equipment is not to be worn outside of the preparation or administration area except when managing a cytotoxic spill.
6. Areas involved in the preparation and/or administration of cytotoxic agents are to have access to an eye wash station and a safety shower or equivalent (e.g. hand held spray device).
7. Employees are not to eat, drink, chew gum, apply cosmetics or store food in or near the chemotherapy preparation or administration area.

DEFINITIONS

Closed System Device: A drug transfer device which mechanically prohibits the transfer of environmental contaminants into the system and the escape of hazardous drug or vapour concentrations outside the system

Cytotoxic Drug: An agent that possesses a specific destructive action on cells, which may be genotoxic, oncogenic, mutagenic, teratogenic, or other hazardous mechanisms. This term typically denotes cancer chemotherapy drugs.

Cytotoxic Materials: All cytotoxic medication and patient excreta (i.e. urine, feces, emesis) which may be contaminated with cytotoxic drugs or their metabolic byproducts. Any item used in the care of the patient that could be contaminated by medication or body fluid should be handled as potentially cytotoxic.

Cytotoxic Protective Practices (Cytotoxic Precautions): Protective practices to protect individuals and the environment from coming in contact with cytotoxic materials. These protective practices include the use of protective equipment and other safe handling practices.

Cytotoxic Spills: Uncontained spills of cytotoxic drugs or body fluids.

Cytotoxic Waste: Includes all materials used for the preparation and administration of cytotoxic drugs and the patient's excreta following administration.

GUIDING PRINCIPLES

1. By their design, cytotoxic drugs are harmful to cells. Handling cytotoxic drugs or their byproducts is an area of potential occupational exposure for employees. The long term effects of frequent or prolonged low-dose exposure are not known for most cytotoxic agents. The risk of such exposure is most effectively reduced by strict adherence to PPE and best practice procedures.
2. To date, there is no confirmed safe occupational exposure limit to chemotherapy / cytotoxic agents, and no reliable method of monitoring worker exposure exists. It is therefore imperative that those who work with cytotoxic drugs adhere to practices designed to minimize occupational exposure as much as reasonably possible. Health care providers risk exposure to cytotoxic agents when safe handling practices fail or are not properly used.
3. The potential for exposure may occur during drug preparation, transportation, administration, disposal of equipment/waste, when handling patient excreta and in the event of a spill.
4. The major routes by which employees can be unintentionally exposed to cytotoxic drugs are through:
   4.1. absorption through skin or mucous membranes after direct contact with the drugs or from surfaces or objects that are contaminated with cytotoxic drugs
   4.2. inhalation of drug aerosols or droplets
   4.3. ingestion through contaminated food, beverages, chewing gum, or other hand-to-mouth activity
5. It is possible that employees' personal medical conditions may place them at increased risk of exposure (e.g. broken skin in eczema) or increased susceptibility (e.g. concurrent infection) to cytotoxic agents.
6. Employees concerned about the potential impact of any exposure to cytotoxic materials on his/her personal health status should discuss their concerns with Employee Health staff.
7. Health care professionals who routinely prepare or administer cytotoxic agents may consult with Employee Health to discuss if a reassignment to a less hazardous area is recommended in the event of known or suspected pregnancy, or if they are breast feeding or actively trying to conceive.
   7.1. If an employee decides to continue working with cytotoxic agents subsequent to their discussion(s) with Employee Health staff, they should not participate in higher risk tasks such as spill management.

PROCEDURE

Equipment

- Disposable Protective Gown - long sleeve, back closure, water/drug repellent, with solid front and tight fitting cuffs (elastic or knit)
- Gloves - Disposable, powder-free non-latex gloves designed and validated for chemotherapy preparation / administration (e.g. Nitrile glove)
- N95 Respirator Mask
- Goggles / Face shield
- Closed-Toe Footwear
- Cytotoxic Sharps Container
- Cytotoxic Non-Sharps Container

1. **Personal Protective Equipment (PPE)**

1.1. Wear PPE when preparing / administering cytotoxic drugs and handling cytotoxic waste. Wash hands before donning PPE and immediately after removing.

1.2. *Gowns (Disposable)*

1.2.1. Change immediately if soiled or torn

1.2.2. Discard daily to reduce the risk of environmental contamination

1.2.3. Do not wear outside the chemotherapy preparation / administration area except when managing a cytotoxic spill or disposing of waste.

1.3. *Gloves*

1.3.1. Wash hands thoroughly with soap and water before donning and immediately after removing gloves.

1.3.2. Change between each patient.

1.3.3. Change regularly, preferably every 30 minutes or immediately if torn, punctured or contaminated.

1.4. *N95 Respiratory Mask*

1.4.1. Use properly fitted masks meeting respiratory protection standards when inhalation is a concern (i.e. suctioning a patient who is on cytotoxic precautions, spill clean up).

1.5. *Goggles/Face Shield*

1.5.1. Use protective eyewear (i.e. safety glasses with side shields) during cleaning procedures or when there is a risk of aerosolization of cytotoxic drugs and during the clean up of any spill.

1.5.2. Wear masks with face shields if there is any risk of splashing

1.6. *Closed Toe Footwear*

B.46.

1.6.1. Wear closed-toe footwear when handling or administering cytotoxic medications / waste.

2. **Preparation**

2.1. The Pharmacy department prepares all cytotoxic medications.

2.1.1. Once prepared, clearly label cytotoxic drugs as cytotoxic.

2.1.2. If cytotoxic medications require refrigeration, label as such.

2.1.3. If required, the crushing or splitting of tablets, compounding of liquid oral or nasogastric doses will be prepared by pharmacy.

3. **Transport and Labeling**

3.1. Wear a lab coat and closed-toe footwear when transporting cytotoxic drugs.

3.2. Transport cytotoxic drugs in containers designed to contain leakage and spills.

3.3. Clearly label containers as containing hazardous drugs.

3.4. Do not transport cytotoxic drugs using a lift or tube device.

3.5. Store all cancer chemotherapy drugs in a designated storage area either in the medication room or other specified area.

3.6. Ensure that storage shelves are not above eye level and have a ledge to prevent potential slippage and breakage.

4. **Administration**

Note: Administration of Cancer Chemotherapy is a Post-Entry Level Competency for Registered Nurses (refer to MM 40-005 *Administration of Cancer Chemotherapy*) which requires assessment of competency prior to performing. Registered Nurses, other than those certified in chemotherapy administration, may administer cytotoxic medications for *non-oncology* indications if the Registered Nurse is knowledgeable about cytotoxic precautions / safe handling practices and the management of expected toxicities / side effects.

4.1. Prepare cytotoxic drugs for administration at the bedside, not in the medication or clean utility room.

4.1.1. Place a plastic backed absorbent pad on the work surface to decrease the risk of contamination.

4.1.2. Perform all work at waist level over the absorbent pad.

4.2. Handle cytotoxic tablets and capsules in a manner that avoids skin contact, spread of drug into the air and chemical cross contamination with other drugs.

4.3. When available, use closed system devices for preparation and administration of cytotoxic and occupationally hazardous drugs.

4.4. Prime all IV sets with the flushing solution before the IV bag containing the cytotoxic medication is connected.

4.5. If it is necessary to spike an IV bag containing a cytotoxic medication, spike at waist level over a plastic backed absorbent pad.

4.6. Use luer-lock connections for delivery of cytotoxic drugs.

4.7. When disconnecting tubing, needles and other equipment, cover the connection site with gauze to catch any droplets.

4.8. At the end of the infusion(s) dispose of the IV administration set intact into the cytotoxic disposal container. DO NOT DISCONNECT the IV bag from the tubing.

4.9. When disconnecting a used secondary line and bag, flush the line with the primary line before disconnecting. Cover the connection with gauze to catch any droplets.

4.10. Discard all equipment used in the administration of these drugs in an appropriate cytotoxic waste container. (Refer to Cytotoxic Waste Disposal)

Note: Once the equipment is used for chemotherapy administration, it is considered cytotoxic.

5. **Cytotoxic Waste Disposal**

5.1. Ensure the availability of a cytotoxic non-sharps container in the room so the patient is able to dispose of wastes.

5.2. Separate all cytotoxic drug waste and dispose of differently than other hazardous waste.

Note: Cytotoxic waste cannot be autoclaved; it must be incinerated at a higher temperature.

5.3. As cytotoxic waste is not mechanically or manually compacted, avoid overfilling waste containers.

5.4. Clearly label all cytotoxic waste receptacles.

5.5. *Cytotoxic Sharps Containers*

5.5.1. Use cytotoxic sharps containers that are leak-proof, puncture proof with a secure lid and clearly labeled with the cytotoxic hazard symbol.

5.5.2. Use for disposal of contaminated preparation / administration equipment such as needles, syringes, glass bottles and intravenous catheters, bags and tubing.

5.6. *Cytotoxic Non-Sharps Container*

5.6.1. Use a closed-lid waste container lined with a red plastic bag that clearly and visibly displays the cytotoxic hazard symbol.

5.6.2. Use for disposal of contaminated non-breakable materials such as disposable PPE, dressings, gauzes or ostomy equipment.

5.6.3. In preparation for removal of non-sharps cytotoxic waste from the unit, securely tie all cytotoxic waste bags (red bags) and place in a cardboard box.

5.6.4. Tape the box closed and label as cytotoxic.

5.7. Place all cytotoxic waste containers in the soiled utility room for removal by housekeeping.

5.7.1. Housekeeping removes all cytotoxic waste from the unit on a regular basis.

6. **Patient Excreta**

6.1. Handle patient excreta (i.e. urine, feces, vomit) which may be contaminated with **cytotoxic drugs or their metabolic byproducts as cytotoxic waste materials.**

Note: Generally, a time frame of 48 hours following the last dose of cytotoxic drug administered is recommended.

6.2. Wear a gown and gloves when emptying bedpans, changing wet soiled linen, changing dressings and/or other care where there is risk of exposure,.

6.3. Cover waste containers with a plastic backed absorbent pad for transport (i.e. cover bedpan while taking to toilet) to protect from spillage.

6.4. To decrease the risk of exposure by aerosol or droplets, close the toilet lid or cover the toilet bowl with an incontinent pad when flushing.

6.5. If the patient is sharing a room, store the bedpan, basin, urinal and other equipment at the patient's bedside.

6.6. **Do not use** hoppers for disposal, as they cannot be adequately covered to prevent aerosol release or splashing.

6.7. Encourage men to void while sitting rather than standing, to reduce the risk of aerosolization. Encourage use of toilets rather than urinals.

7. **Cleaning Chemotherapy Administration Area and Equipment**

7.1. Clean the Chemotherapy Administration Area at least once daily when in use.

7.1.1. If a specific bed space area is used for more than one patient during the day, clean the bed space area and disinfect between each patient.

7.2. Wear safety glasses / face shield, gowns, and protective chemotherapy gloves for cleaning and decontaminating work.

7.3. Decontaminate and disinfect all work surfaces in the Chemotherapy Administration Area (e.g., chairs, side tables, stretchers, counter tops and supply carts) daily.

7.4. Decontaminate and disinfect floors in the Chemotherapy Administration Area daily.

7.4.1. Do not use floor mops used in the Chemotherapy Administration Area in any other areas of the institution; keep in a utility room in or adjacent to the unit.

7.5. Regularly launder any porous surfaces in the administration area to minimize contamination of the area.

Note: If at all possible, use all non-porous surfaces in the Chemotherapy Administration area.

7.6. Empty storage shelving of all supplies, clean and disinfect at least once monthly.

7.7. Decontaminate and disinfect refrigerators, freezers, shelves, and other areas where pharmacy-prepared sterile products are stored at least once monthly.

7.8. Collect waste generated throughout the cleaning or decontamination procedures in red plastic bags (labeled as cytotoxic waste), and remove according to procedure # 5 – Cytotoxic Waste Disposal.

8. **Cytotoxic Spills**

Equipment

Spill Kit including (but may not be limited to):

- 2 pairs disposable non-latex chemotherapy gloves- large size
- Low permeability disposable gown and shoe covers
- Safety glasses, splash goggles or face shield
- N95 Respirator mask (unless included in face shield)
- Absorbent plastic backed pads (sufficient to absorb a spill of up to 1000mL)
- Disposable towels for absorbing and cleaning liquid spills
- 2 red plastic cytotoxic waste bags
- Cleaning solution for cleaning and decontamination of area
- Instructions on the management of a cytotoxic chemotherapy spill.
- Warning signs to alert other staff to the hazard and isolate the area of the spill.

8.1. Alert other employees in the area of the potential hazard; limit access to the area while a spill kit is obtained and place the warning sign (from the kit) in a prominent position.

8.2. Remove the contents from the spill kit. Don personal protective equipment in the following order:

8.2.1. mask,
8.2.2. Goggles/ face shield,
8.2.3. one pair of non-latex gloves,
8.2.4. gown,
8.2.5. shoe covers,
8.2.6. then second pair of non-latex gloves.

8.3. For a liquid spill, carefully place an absorbent pad over the spilled liquid. Absorb as much liquid as possible into the pad.

8.4. If the spill involves a powder, carefully place a damp disposable pad over the powder and carefully pat the spill area to adsorb as much powder as possible.

8.5. If there is broken glass in the spill, carefully pick up the glass pieces using a disposable scoop and place all glass in a puncture-proof container.

8.6. Gather up the contaminated pads. Discard all waste into the cytotoxic waste container or bag.

8.7. Repeat steps until the entire spill has been cleared.

8.8. Use the cleaning solution to wash the area of the spill thoroughly, discarding all waste generated into the waste container.

8.9. Rinse the area well with clean water.

8.10. Dry the area completely to prevent accidental slippage on the wet floor.

8.11. Discard all used items including personal protective equipment into the cytotoxic waste container or bag. Remove protective apparel in the following sequence:

8.11.1. top pair of gloves,
8.11.2. goggles,
8.11.3. mask,
8.11.4. shoe covers,
8.11.5. gown.

8.12. Wearing a second pair of gloves, double bag with the aid of a second employee and dispose of these gloves.

8.13. Arrange for collection of waste.

8.14. Wash hands thoroughly with soap and water.

8.15. Arrange for housekeeping to re-clean the area.

8.16. Arrange for a replacement spill kit to be obtained.

8.17. Notify the Health Services Manager or Charge Nurse and complete a 'Patient Safety Report'.

9. Contamination with a Cytotoxic Agent

9.1. If an employee or patient/family member is contaminated with a cytotoxic agent, remove all overtly contaminated personal protective equipment and place in the cytotoxic waste container.

9.2. Remove all contaminated personal clothing and, if heavily contaminated, discard the clothing into the cytotoxic waste container.

9.3. Arrange for clothing with a minimal amount of contamination to be laundered separately and rinsed well.

9.4. Use an emergency shower or equivalent (e.g. hand-held spray device) if appropriate. Wash the contaminated area of the skin with soap and rinse with large amounts of water.

9.5. If the eyes have been exposed to a cytotoxic agent:

9.5.1. Thoroughly irrigate with water or isotonic eyewash for as long as possible (e.g. up to 15 minutes).

9.5.2. Remove contact lenses, if not flushed from the eye, as soon as possible and discard.

9.5.3. Use an eyewash station, if available, or water splashed by hand into the eye from a faucet.

9.5.4. Do not irrigate the eye directly with running water from a faucet due to the potential for water pressure damage to the eye.

9.5.5. In all cases where the eye is contaminated by a cytotoxic agent, seek ophthalmologic advice as soon as possible.

9.6. If the skin is broken or there is a needle-stick injury, express blood from the wound and irrigate the affected area with plenty of water.

9.7. Seek medical attention as soon as practical.

9.8. Health care providers exposed during spill management report the exposure to occupational health by contacting SAFE.

10. Patient and Family Education

10.1. Inform patients and family members of safe handling practices and why these practices are implemented.

10.2. Include in teaching for patients and families:

10.2.1. How long to maintain precautions

10.2.2. What is considered cytotoxic – drugs, body fluid / excreta

10.2.3. How to protect others and the environment:

- Store all cytotoxic drugs in a leak proof container out of reach of children
- Flush all that is flushable
- Use a condom during sexual activity
- Caregivers wear gloves when handling cytotoxic drugs, waste or soiled items.

10.3. Provide the following patient brochures::

10.3.1. Cytotoxic Precautions At Home: A Guide for Cancer Patients and Families

REFERENCES

Blecher,C.S., Glynn-Tucker, E.M., McDiarmid, M., & Newton, S.A. (2003). *Safe handling of hazardous drugs*. Pittsburgh, PA: Oncology Nursing Society.

BC Cancer Agency, Systemic Therapy Policy V-10: Cytotoxic agents - Safe handling standards. Vancouver, British Columbia. August 2000.

BC Cancer Agency. Systemic Therapy Policy V-30: Spill management of cytotoxic drugs. Vancouver, British Columbia: BC Cancer Agency; April 2009.

National Institute for Occupational Safety and Health (NIOSH). Preventing occupational exposures to antineoplastic and other hazardous drugs in healthcare settings. Cincinnati, Ohio: NIOSH - Publications Dissemination; 25 March 2004.

Nixon, S. & Schulmeister, L. (2009) Safe Handling of Hazardous drugs: Are you protected? Clinical Journal of Oncology Nursing 13 (4).

Polvich, M. (2010) Cancer Chemotherapy Guidelines and Recommendations for Practice. (3rd ed) Pittsburgh, Pennsylvania.

RELATED DOCUMENTS

Policies

MM 15-015 Independent Double Check
MM 40-005 Administration of Cancer Chemotherapy
MM 50-010 High Alert Medication
CH 90-017 Biomedical Waste Management

Brochures

Cytotoxic Precautions At Home: A Guide for Cancer Patients and Families
Available from Cancer Care Nova Scotia:
http://www.cancercare.ns.ca/site-cc/media/cancercare/Cytotoxins.pdf

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Appendix D: Case Study Photos

Figure D. 1 Polystyrene collection from the QE II Camp Hill Site

Figure D. 2 Collection collection from the Darmouth General

Figure D. 3 Polystyrene collection from the QE II VG Site

Figure D. 4 Polystyrene collection in a polywoven bag

Figure D. 5 Second run of collection from the QE II VG Site

Figure D. 6 Polystyrene transportation

Figure D. 7 Colchester Material Recovery Facility Densifier M-C200

Figure D. 8 M-C200 air vent

Figure D. 9 Polystyrene collected in totes prior to being densified

Figure D. 10 Amount of polystyrene densified into a single ingot

Appendix E: Densifier Specification Sheet

QUOTATION

VERSION: 20190611

INTCO RECYCLING
3F, BUILDING 9, NO.188 XINJUN RING RD., SHANGHAI 201114, CHINA
TEL: +86 21 3497 8818 FAX: +86 21 3497 8808
WWW.INTCORECYCLING.COM

Date:	2019/06/20
From:	Daniel Wang
Currency:	USD

TO

Company: ____________ Country: ____________

Address: ____________ Zip/Postal Code: ____________

Phone: ____________ Fax: ____________ Contact Name: Jamil Sinno

ITEM	Unit	Unit Price	Quantity	Amount
GREENMAX M-C100	SET	35,000	1	35,000.00
GREENMAX M-C200	SET	42,000	1	42,000.00
GREENMAX Z-C100	SET	32,000	1	32,000.00
GREENMAX Z-C200	SET	40,000	1	40,000.00

TERMS & REMARKS

Voltage: 3 Phase, Any Voltage
Applicable Material: EPS & XPS & PSP & EPP
Guarantee: 1 YEAR
Delivery Terms: FOB SHANGHAI
Time of Delivery: 30 DAYS
Offer Validity : 30 DAYS
Payment Terms: 50% ADVANCE, 50% BALANCE BEFORE SHIPPMENT.
Remarks :

TECHNICAL DATA

GREENMAX M-C200E	
Motor Power	41.7 kw / 55.9 hp
Production Capacity	200 kg per hour / 440 lbs per hour
Compressed Foam Density	600-800 kg/m3 / 1320-1750 lbs/cubic yard
Feed Hopper Dimension	960*532 (l/w) mm / 37.8*20.9 (l/w) in.
Dimensions	2980*1400*2195 (l/w/h) mm / 117.3*55.1*86.4 (l/w/h) in
Shipping Dimensions	3080*1500*2445 (l/w/h) mm / 121.3*59.1*96.3 (l/w/h) in.
Weight	2,600 kg / 5,720 lbs

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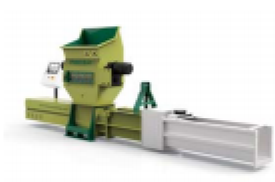
QUOTATION

INTCO RECYCLING
3F, BUILDING 9, NO.188 XINJUN RING RD., SHANGHAI 201114, CHINA
TEL: +86 21 3497 8818   FAX: +86 21 3497 8808
WWW.INTCORECYCLING.COM

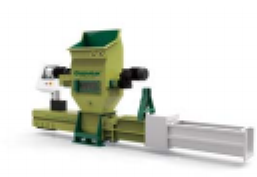
GREENMAX M-C100

Motor Power	22.9 kw / 30.6 hp
Production Capacity	100 kg per hour / 220 lbs per hour
Compressed Foam Density	600-800 kg/m3 / 1320-1750 lbs/cubic yard
Feed Hopper Dimension	800*555 (l/w) mm / 32*22 (l/w) in.
Dimensions	2030*1500*2030 (l/w/h) mm / 80*59*80 (l/w/h) in.
Shipping Dimensions	2130*1600*2280 (l/w/h) mm / 84*63*90 (l/w/h) in.
Weight	1,500 kg / 3300 lbs



GREENMAX Z-C200

Total Power Consumption	33.65 kw / 45.12 hp
Crusher Power Consumption	2*4 kw / 2*5.36 hp
Production Capacity	200 kg per hour / 440 lbs per hour
Compression Ratio	50:1
Compressed Foam Density	200-400 kg/m3 / 570-1140 lbs/cubic yard
Foam Block Dimensions	380*380 (w/h) mm / 15*15 (w/h) in.
Feed Hopper Dimension	1000*650 (l/w) mm / 39*25 (l/w) in.
Dimensions	5445*750*2080 (l/w/h) mm / 214*30*82 (l/w/h) in.
Shipping Dimensions	Main part: 3950*950*2350 (l/w/h) mm / 156*37*93 (l/w/h) in. Output chute: 1650*620*720 (l/w/h) mm / 65*24*30 (l/w/h) in.
Weight	2,000 kg / 4,400 lbs



GREENMAX Z-C100

Total Power Consumption	20.45 kw / 27.42 hp
Crusher Power Consumption	2*2.2 kw / 2*2.95 hp
Production Capacity	100 kg per hour / 220 lbs per hour
Compression Ratio	50:1
Compressed Foam Density	200-400 kg/m3 / 570-1140 lbs/cubic yard
Foam Block Dimensions	380*380 (w/h) mm / 15*15 (w/h) in.
Feed Hopper Dimension	1000*650 (l/w) mm / 39*25 (l/w) in.
Dimensions	5445*750*2080 (l/w/h) mm / 214*30*82 (l/w/h) in.
Shipping Dimensions	Main part: 3950*950*2350 (l/w/h) mm / 156*37*93 (l/w/h) in. Output chute: 1650*620*720 (l/w/h) mm / 65*24*30 (l/w/h) in.
Weight	2,000 kg / 4,400 lbs