

WPI Food Waste Management: Assessment and Reduction

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ABSTRACT

The goal of this IQP was to assess WPI's food waste management system and to provide a foundation for future food waste reduction with recommendations. We investigated food waste and interviewed people involved with food waste at WPI and other universities. Then we mapped the waste streams at WPI's food locations from source to destination. We found significant gaps in WPI's food waste management system and provided recommendations for improving the Campus Center system and filling the remaining gaps.

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We would also like to thank our interviewees for taking their time to contribute their answers to our questions, as well as their perspective on the issue. We would like to thank Elizabeth Tomaszewski for her interest in our project and its implementation. Also, a huge thank you to Joseph Kraskouskas, for introducing us to WPI's food waste management process. We would like to thank the student body: Claire Barrameda, the WPI Green Team Execs, Marc Printz: Lambda Chi Alpha-Pi Zeta Chapter, Worcester Polytechnic Institute, for providing their time to give us their input and solutions they believe is the best for the school. We'd like to thank James Bello, Campus Center Custodian for providing his input on the Campus Center food waste compartments. Lastly, we'd like to thank Gina Bello, Associate Director of Foisie Business School for provided her input and ideas on food waste management.

A special thank you to Steve Bandarra, Worcester State University's Sustainability Coordinator, for allowing us to tour Worcester State University and obtain more information on their food waste collection and disposal methods. We would also like to thank Jenny Isler, Clark University's Director of Sustainability, for provided her input on food waste management as well as new ideas. Lastly we would like to thank Adam Jankauskas, Co-Founder, City Compost, for providing his time to provide the school with a simple plan for composting.

EXECUTIVE SUMMARY

Did You Know?

40% of food produced in the United States today, about \$165 billion of food each year, goes uneaten (NRDC,2012).

The 2019 WPI waste audit revealed that in the Campus Center it contained nearly 100 lbs. of food waste in the trash stream.

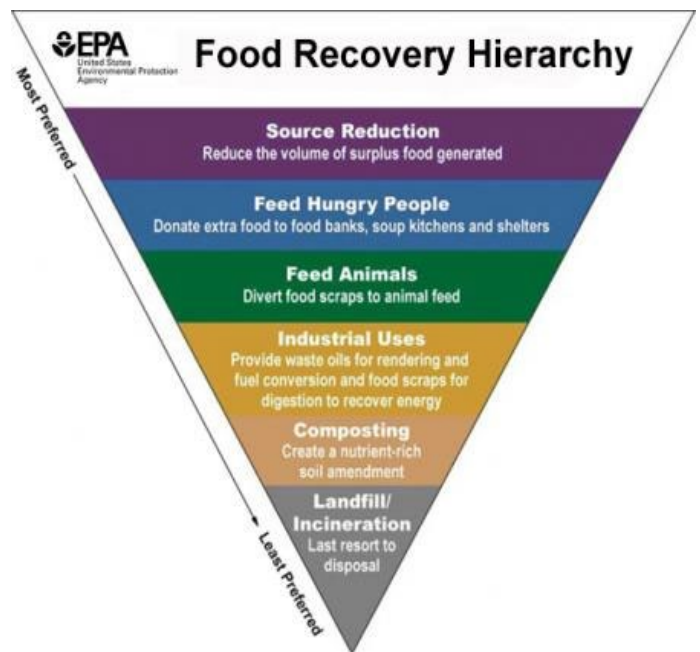
Food production accounts for 70% of all water used in the United States (Environmental Impact of Food Production and Consumption, 2009).

PURPOSE

The goal of this IQP was to assess the food waste management system at WPI and to explore and recommend potential solutions to improve WPI's food waste situation.

BACKGROUND

There are four main sources where food waste originates: production, processing, leftovers, and post-consumer. Production waste can be generated from farming, post-harvest and packing, distributing, and retailing. Processing waste occurs during the preparations of food in the kitchens, and includes such things as vegetable trimmings, chicken skin and bones, potato peels, etc. Leftover food is defined as any excess food ingredients left unused or prepared foods that are not served to consumer. Post-consumer food waste involves all the food that goes uneaten after the transaction of food to the consumer.



The EPA's Food Recovery Hierarchy (EPA, 2017)

The EPA's "Food Recovery Hierarchy" (shown above, right) is a model of food waste management systems and provides a good description of each tier. The six levels of the Food Recovery Hierarchy are:

1. Source Reduction
2. Feed Hungry People
3. Feed Animals

4. Industrial Uses
5. Composting
6. Landfill/Incineration

The methods that are higher up on the hierarchy are most preferred for food waste management. Lower down on the hierarchy are the least preferred ways to divert food waste.

There are two major problems with sending food waste to landfills. Food waste decomposes in landfills and releases methane gas, which is twenty times more potent than carbon dioxide. Uneaten food in landfills accounts for 23% of methane released into the atmosphere in the United States (NRDC, 2012). The second problem with sending food waste to landfills is the sheer amount of space it takes up. It is estimated that current landfills will be filled within 5 to 10 years, leaving waste with no destinations (Hobart and William Smith Colleges, 2012). Incineration faces similar environmental drawbacks, since burning the food releases harmful gases.

OBJECTIVES

WPI's food waste management system was assessed and compared to other universities. Solutions were then identified, developed, and analyzed based on knowledge gained during the previous process. These solutions took the form of recommendations for WPI. Future work necessary was also pinpointed. In order to accomplish the goal, five objectives were developed:

1. Research and Meet with Key Stakeholders to Discuss Food Waste Impact
2. Assess WPI's Food Waste Management System
3. Assess Other Organizations Food Waste Management
4. Identify and Analyze Potential Solutions
5. Create targeted solutions and recommendations for WPI

Research

Paige Neumann, a librarian at WPI, was a great resource for research. She explained different ways to conduct research efficiently and which databases would help find useful sources and information. Some of these resources included Google Scholar and WPI's library website search. These were great tools to find reliable information and good sources. Some steps that were recommended focused on choosing a broad keyword to search, then narrowing down the search by adding more specific words.

Interviews

An effective way to gather information was by holding interviews with individuals involved with food waste management. We asked specific questions to these individuals about data, opinions, perspectives, and general background information to confirm similar or varying knowledge among

the interviewees. We conducted interviews with members of WPI and off-campus organizations and universities. The on-campus interviews were with WPI stakeholders. We interviewed Joseph Kraskouskas, Director of Chartwells, and WPI's main dining service. He was able to point us towards other individuals who worked hands-on with the food waste management system and could provide more details. We needed to know about each program specifically so we could compare them to our potential solutions. Another contact was Elizabeth Tomaszewski, the Facilities Department System Manager and Assistant Director of Sustainability, who was able to give us further information on the food waste programs at WPI. Another interviewee was the president of the WPI Green Team, Claire Barrameda. The Green Team is a student-run sustainability club at WPI that runs several sustainability programs on campus. Claire gave us their input on how considered solutions could be implemented, as well as what she believe is best for WPI.

For more information about off-campus systems, we interviewed Jenny Isler, Clark University's Director of Sustainability, in addition to Steve Bandarra, Worcester State University's Sustainability Coordinator. They assisted in identifying their current food waste management systems and explained how they have benefited their university. They also gave us advice on how to overcome obstacles when trying to implement sustainable options for food waste.

Observations and Waste Audit

Waste audits provide useful data on how effective the current waste management system is. WPI's Green Team held their annual waste audit on April 11, 2019. The focus of this waste audit was the Campus Center. A 2017 IQP, titled "Sustainability at WPI: Food Waste Management," recommended the installation of food waste bins in the Campus Center, which were implemented in 2018. To get hands-on observations of food waste in the Campus Center, we attended the waste audit. During the waste audit, there were different bins with labels to designate different disposed items: trash, recyclables, food waste, plastic bottles, and non-hazardous liquid waste. These labels helped visualize the amount of food waste thrown in the trash that was not disposed in the implemented food waste bins. The process of auditing the trash consisted of weighing the bags initially on the way in, sorting the trash accordingly, and then weighing the sorted trash bags when they got full. The data collected were compared to the previous year's findings regarding the Campus Center's trash, when the food waste collection bins were not installed, to determine their impact and functionality.

Findings

Morgan Dining Hall has the Most Effective Food Waste Management at WPI

Morgan Dining Hall has the most effective food waste management system, even though it is the largest dining hall on campus. All the food waste from this location ends up being diverted to the Tyde Brooke Pig Farm, donated, or reused (Joseph Kraskouskas, personal communication, April 8, 2019). Multiple factors were identified that contribute to the success of handling food waste in

Morgan Hall: the layout and environment, Trim Trax system, absence of to-go options, and the use of reusable plates.

Campus Center Food Waste Management System Is Underutilized

The Campus Center is the second largest dining hall on campus, but unlike Morgan Dining Hall they send more food waste to Wheelabrator, in Millbury. The Campus Center sees more processing and unserved food waste in the kitchen area. From September 2018 to April 22, 2019, the food waste audited by Trim Trax at the Campus Center totaled 20,968.50 lbs. and \$39,629. Fortunately, all this food waste goes to the Tyde Brook Pig Farm. However, post-consumer food waste mostly ends up in the trash. Students are largely unaware of the food waste sections and dump their food at the closest trash bin. In the 2019 Annual Waste Audit, 97 lbs. of food waste was dumped in the trash and not in the food waste sections.

Certain Awareness Efforts Are Often Ineffective

Findings show WPI's efforts to raise awareness and raise participation for sustainability initiatives are often not fruitful. This finding is supported by observations at the Campus Center, the 8th Annual Waste Audit at WPI, and during an interview with the Green Team president. Clark University has many similar initiatives to WPI but has had better student cooperation than at WPI. This is mostly attributed to a level of peer-to-peer engagement not found at WPI. A question directed to WSU's Sustainability Coordinator about spreading awareness also stressed peer-to-peer engagement, even recalling himself going to classrooms and giving students merchandise such as shirts and wristbands with a sustainability logo.

Significant Gaps Exist in the Overall Post-Consumer Food Waste Management System at WPI

Food waste is not diverted in any residence halls, academic buildings, recreational facilities, administrative buildings, etc. Therefore, all the food waste generated outside of the previously mentioned locations is Wheelabrator with the rest of the trash from WPI. In the fall of 2016 and spring of 2017 Lambda Chi Alpha implemented post-consumer food waste collection bins in their residence building. They began redirecting post-consumer food to the pig farm. Lambda Chi Alpha currently diverts approximately 180 lbs. of food waste each week.

A Composting Program Is a More Inclusive Food Waste Management System to Fill the Gaps than the Pig Farm

Food waste is currently not diverted in any non-Chartwells buildings despite the success of the pig farm program in other areas. A campus-wide composting program was implemented at Clark University which has proven effective. The program was slowly incorporated starting on one floor of one residence hall and eventually expanded to encompass the entire Campus. Composting programs can accept more than only food waste, such as paper and biodegradable plastic, and would be more suitable for residence halls.

RECOMMENDATIONS

Campus Center

The Campus Centers food waste management system can benefit from several manageable changes. We recommend that the recently introduced food waste collection bins can be improved by centralizing the location of the bins and by expanding the reusable plate system already present. Offering smaller serving sizes could also be an effective method of reducing post-consumer food waste.

Another recommendation is to start a food waste campaign focused on the Campus Center. This campaign would begin with the new food waste division of the Green Team and would expand as they would reach out to the Sustainability Office, the Facilities Department, Chartwells, and the rest of the student body. This campaign would aim to encourage students to reduce food waste and act as a peer-peer role model for new students. They would also be able to lead the initiatives we have recommended for the Campus Center.

Overall Food Waste Improvements

It was found that the most significant gaps in the food waste management system at WPI exist in residence halls, fraternities, and sororities. Two solutions were identified: City Compost, and the expansion of the Tyde Brook Pig Farm via Marc Printz's methods, shown in Appendix III.

City Compost can implement a low cost (\$60-120 per week in Daniels Hall) and student-run food waste diversion system in residence halls at WPI. City Compost would haul food waste to their composting facilities after cooperating with students and the Green Team to implement a waste collection and sorting system. We recommend that the Green Team pursue this partnership with the help of the Facilities Department.

Food waste is currently diverted from Morgan Dining Hall, the Campus Center, and Goat's Head to Tyde Brook Pig Farm. This system has since been expanded to the fraternities Lambda Chi Alpha and Sigma Phi Epsilon. It is manageable to expand this system further to other fraternities and sororities at WPI although we recommend an individual in sustainability or the Facilities Department to be placed in charge of the expansion.

RecyclingWorks MA is an avenue we highly recommend looking into in the future. Unfortunately, the process of working with RecyclingWorks would have taken longer than the time we had left for this IQP. However, they are an excellent resource, and have been praised and recommended not only by various case studies online, but also by WSU's Sustainability Coordinator Steve Bandarra who interviewed as part of our research (Steve Bandarra, personal communication, April 28, 2019). Their most attractive offer is they can provide no-cost technical assistance to help

WPI maximize recycling, reuse, and food waste diversion opportunities. They can help WPI with the following:

- Evaluate existing waste streams
- Identify opportunities to prevent, recover, and divert waste
- Provide employee education and training
- Create customized waste bin signage
- Conduct a cost analysis for starting or expanding a waste diversion program
- Connect with waste haulers and processors of recyclables and organics

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CHAPTER 1: INTRODUCTION

Excessive food waste is a difficult and multifaceted problem to solve. Its effects are wide-ranging and substantial. For example, a pound of beef requires 1,800 gallons of water to produce but 40% of all food is wasted in the United States (NRDC, 2012). Food production uses 70% of the potable water in the United States. This is only one example of the resources involved in food waste. At Worcester Polytechnic Institute (WPI), the food waste management system is insufficient. Food waste is managed only at a few locations, and in some cases this system is inadequate.

At WPI, minimizing food waste is an ongoing mission of the Sustainability Office, the operations working group under the Sustainability Office, the Green Team (a student run sustainability club), and dining services run by Chartwells. Currently, WPI diverts food waste from landfills and from Wheelabrator to Tyde Brook Pig Farm for feeding animals. In 2017, 58 tons of wasted food were directed to the pig farm to be used as animal feed (WPI Sustainability Report, 2017, p. 8). This is a big increase from just two years prior in 2015, when WPI reported about 38 tons of food waste being sent to the pig farm (WPI Sustainability Report, 2015, p. 16). However, WPI reported in 2016 and 2017 that the campus recycling rate (including food waste) was only 28%. The potential recycling rates were estimated to be 45%, meaning there was food and recyclable waste in the trash that could have been diverted away from Wheelabrator Millbury, the incineration facility where WPI sends its trash. These reports show that there are still gaps in the food waste management system to be filled.

The goal of this IQP was to assess the food waste management system at WPI and to explore other food waste management options so we could provide recommendations to fill the gaps. To accomplish this, we researched what food waste is and why it is a problem generally and here at WPI. This information was used to justify our goal and show the urgency of finding a solution to reduce food waste. Then, we began to learn about the current state of food waste management at WPI in order to gauge where the current system was adequate and where improvements could be made. We then explored how other institutions managed their food waste and reached out to helpful food waste management organization to determine some feasible options for WPI.

CHAPTER 2: BACKGROUND

In this chapter, relevant background information is provided. Section 2.1 discusses why food waste poses a problem for the environment and society. The scope of this project, which is focused on food waste, is defined in addition to the terminology for the sources of food waste in Section 2.2. The EPA's Food Recovery Hierarchy (Figure 1) is an important part of the criteria for categorizing and evaluating food waste policies and programs and will be explained thoroughly in Section 2.3. Some case studies pertaining to implemented food recovery programs which fall under the hierarchy are featured in Section 2.4. An annual waste audit is performed on select buildings at WPI, which is an excellent way to collect data on food waste. Section 2.5 explains what a waste audit is and what one can accomplish in more detail. Any information obtained through research and prior knowledge of WPI regarding food waste reduction and management is stated in Section 2.6. This section also includes some background on a previous IQP's recommendation plan which this project builds upon. Section 2.7 discusses food waste laws and regulations and their purposes and intents. Section 2.8 presents research about data collection practices used for this project and explains how different data collection methods can be used to acquire necessary information.

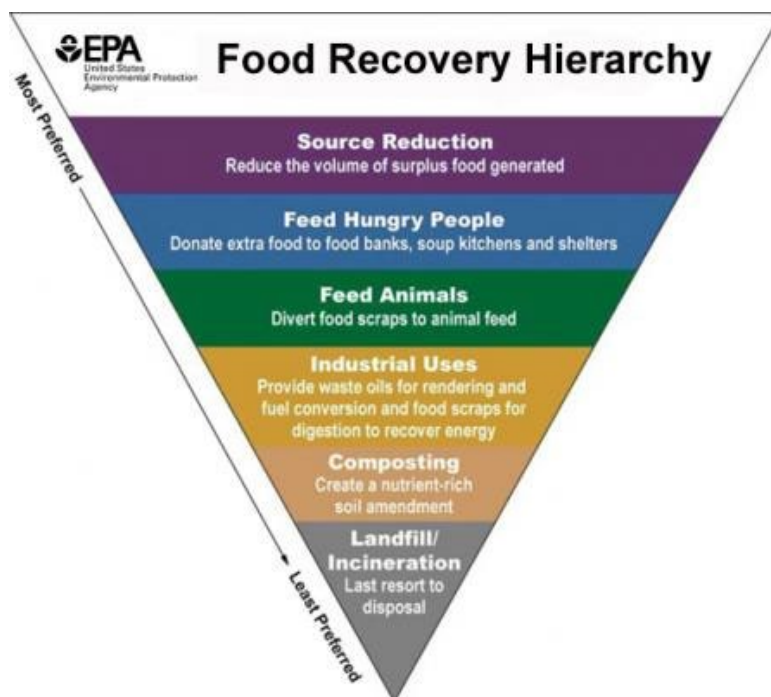


Figure 1: The EPA's Food Recovery Hierarchy (EPA, 2017)

2.1 Why is Food Waste a Problem?

Food waste represents a significant misuse of resources. The food itself is not the only resource being wasted because food requires a massive amount of resources to produce. For example, a pound of beef requires about 1,800 gallons of water to produce (Foodtank, 2016). For comparison, a pound of soybeans requires 216 gallons of water to produce (Foodtank, 2016). Food production accounts for 70% of all water used in the United States (Environmental Impact of Food Production and Consumption, 2009). This is a massive amount of water that is wasted as a result of wasting food. These are only a few of the vast amount of resources used to produce food that go to waste when food is wasted.

Food also has a significant environmental impact after consumption. Most food waste ends up in landfills or is incinerated. Only 3% of food that is lost in the entire food cycle in the United States ends up in composting (NRDC, 2012). There are two major problems with sending food waste to landfills. Food waste decomposes in landfills and releases methane gas. Methane is a greenhouse gas twenty times more potent than carbon dioxide. Uneaten food in landfills accounts for 23% of methane released into the atmosphere in the United States (NRDC, 2012). The second problem with sending food waste to landfills is the sheer amount of space it takes up. It is estimated that current landfills will be filled within 5 to 10 years, requiring new landfills to be opened and spreading the issue of landfills to more areas in the country (Hobart and William Smith Colleges, 2012). Incineration causes similar environmental drawbacks, since burning the food releases harmful gases. Food waste brings with it many harms to the environment, as now represents the single largest source of municipal solid waste reaching landfills (NRDC, 2012). There are also transportation emissions from vehicles, storage space for surplus food, packaging materials, among other environmental impacts and costs associated with the agricultural industry (Environmental Impact of Food Production and Consumption, 2009).

Aside from the environmental impacts, the fact that food is being wasted at such high rates around the world is alarming. According to the Food and Agriculture Organization, an estimated one third of food is wasted globally (Food Loss and Food Waste, n.d.). Multiple sources state that between 30-40% of food produced in the United States goes uneaten, including a report in 2012 by the Natural Resource Defense Council (NRDC) and an estimate done by the USDA's Economic Research Service (Buzby et al., 2014). Americans are throwing out the equivalent of \$165 billion each year in food (NRDC, 2012). This is especially shocking given the world hunger epidemic, and even the large amount of people with food insecurities daily. According to the Economic Research Service of the USDA, 40.0 million people in the U.S. lived in food-insecure households (USDA ERS, 2017). These societal issues shed light onto how counterproductive it is to waste food that is very much needed in the U.S. and around the world.

Although there are many negative aspects of food waste, there are also many ways that food waste can be used to benefit the environment and society. More detail is provided in Section 2.3.

Before that, to better understand what food waste is, the terminology used in this report is defined and explained.

2.2 Terminology

Types of Food Waste	Examples
Production Waste	Harvesting loss, careless handling, discarded foods due to substandard appearance
Processing Waste	Vegetable trimmings, stems, leaves, bruised/overripe fruit, animal/poultry/seafood skins, bones, burnt food, spilled/dropped foods
Unserviced/Leftovers	Unfinished pizzas, buffet trays, prepared food that was not served, ingredients that will not be used before expiration
Post-Consumer Waste	Food thrown away after purchase, excess food taken from a buffet, uneaten food resulting from large serving sizes or disfavored tastes

Table 1: Food Waste categories and examples

In this report, food waste is defined as food material that has been removed from the food cycle and gone unconsumed. This definition includes many different forms of food waste such as leftover restaurant meals which are thrown in the trash, leftover food inventory at grocery stores which is removed from retail, processing waste in the kitchen, and more. These types of food waste are distinctly different and cannot be handled the same so defining them is important. There are four main sources of food waste: production, processing, leftover food, and post-consumer.

To achieve our project goals, we can either reduce the amount of food waste being produced or engage in proper utilization and disposal of food waste which has already been created.

Production losses occur in the production of food and can be generated during farming, post-harvest and packing, distribution, and retail. These losses occur entirely before the food arrives at WPI. An important distinction to make in our project is that we can only affect the food cycle once the food arrives at WPI. This means that production, processing (packaging etc.), and distribution of food is beyond the scope of our project and will not be researched in-depth.

The next source of food waste is processing. Processing waste is generated at WPI during food preparations in the kitchens. There is substantial food waste in food preparation (see Tables 2 and 3, under KITCHEN) which cannot be ignored. Some examples of processing waste include vegetable trimmings, improper cutting of materials, chicken skins, bones, fruit cores, spoiled inventory, burnt food, etc. This type of waste is easier to collect since the kitchen is a controlled environment and staff can be trained to follow processing waste collection programs.

Food can also be wasted if it does not reach the consumer, which has been termed unserved food. Unserved food is defined as any prepared foods that were uneaten and food ingredients that were not used. This is often caused by over-preparing for the expected customer count. Proper inventory management is made more difficult by extensive menu choices as more inventory must always be available (NRDC, 2012). This type of food waste is easy to collect since prepared food can be cooled, refrigerated, and donated (see Section 2.7.3).

The final source of food waste occurs during its consumption. Post-consumer food waste involves all the food that goes uneaten after being sold to the customer. There are two big factors at this stage; how much food goes uneaten, and how the consumer decides to dispose of this food. This type of food waste is the hardest to collect since consumers are not mandated to dispose of their food waste correctly, and not everyone is well-informed on the difference between regular waste and food waste. What happens to the food waste at this stage is in the hands of the consumer. Some ways to increase food waste collection effectiveness include promoting proper disposal by introducing food waste bins, awareness campaigns, and other programs which will be discussed later.

There is also an important distinction between edible and inedible food. Edible food is suitable for human consumption while inedible food waste is not. A lot goes into this distinction including safety, health codes, contamination with bacteria, and whether anyone would want to eat the food, i.e. the condition of that food. To achieve our project goals, we can either reduce the amount of food waste being produced or engage in proper utilization and disposal of food waste which has already been created.

2.3 EPA Food Recovery Hierarchy

Food waste can be utilized so that the resources used in its production are not wasted and can even be beneficial to the environment. The Environmental Protection Agency (EPA), an agency of the United States federal government, has developed the “Food Recovery Hierarchy” for the purpose of detailing the most preferred methods of food waste management.

Most of the existing food waste in the United States is sent to landfills or incineration plants, even though much of this food is in good condition (NRDC, 2012). This food waste can be directed away from sitting in a landfill releasing methane gas or being burned and releasing more harmful gases towards initiatives that help the environment. The hierarchy designates the most preferred methods for food waste management.

The six levels of the Food Recovery Hierarchy (Fig. 1) are:

1. Source Reduction
2. Feed Hungry People
3. Feed Animals
4. Industrial Uses
5. Composting

6. Landfill/Incineration

2.3.1 Source Reduction

Source reduction, the first level and most preferred method of the Food Recovery Hierarchy (Fig. 1), entails reducing the amount of surplus food generated at the beginning of the food chain. This can be simplified to only producing what food is needed so less food and resources are wasted. For an organization, this may include making grocery lists, buying more accurate amounts of food, trayless dining at cafeterias and dining halls, keeping better track of inventory, good communication, reducing waste during preparation, and other methods to reduce the amount of food entering the waste stream. This way, the resources used for growing, preparing, and transporting the food (EPA, 2017) will never be wasted in the first place.

Source reduction is heavily reliant on consumers to be conscious of and to act sustainably. Roughly 24% of food is wasted at the consumer level (after individuals have purchased their food). This is about 60% of total food waste (NRDC, 2012). The other largest source of food waste is in retail, where roughly 10% is lost. All the remaining tiers after source reduction in the Food Recovery Hierarchy direct food waste that is generated towards more beneficial uses.

2.3.2 Feed Hungry People

Every day, businesses and institutions throw away edible food which could instead be used to feed hungry people. By donating suitable food, waste disposal costs go down and provides tax benefits. The process of food donation can be seen in Fig. 2, which shows the steps involved for the food to reach its destination. After food is brought to the market, the resources used to produce it have already been consumed; the optimal strategy for minimizing environmental impact is to use the food to serve existing needs within society. This way, resources are successfully diverted from being wasted in food waste disposal, and the food stays away from landfills.

This redirection of resources is better than the methods below it on the Food Recovery Hierarchy. For example, if a can of beans is donated to a homeless shelter and consumed, the resources used to produce and transport those beans are used to feed people. If the same can of beans is instead used for composting, the calories are completely wasted and only the nutrients continue as a soil conditioner. To promote and advertise food donation, the Harvard Food Law and Policy Clinic has prepared a fact sheet informing the companies/businesses of the tax incentives for food donation (Harvard Food Law and Policy Clinic, 2015).

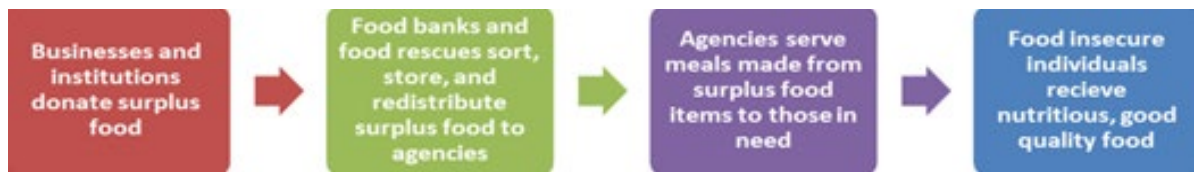


Figure 2: Process of food donation (RecyclingWorks, 2017)

Food that is redirected to feeding hungry people more effectively utilizes food which has already been produced. However, this food must be of high quality and thus only a small proportion of total food waste can be used in this way. The food must be edible and safe for consumption by humans. This means unspoiled perishables and nonperishable foods can be donated to hungry people. According to the terminology mentioned in Section 2.2, the only category of food waste which can be donated to feed hungry people is leftover food. Companies are protected under the Bill Emerson Good Samaritan Food Donation Act and must follow the guidelines for food donations. More information on the food donation laws is provided in Section 2.7.

2.3.3 Feed Animals

Food waste unfit for consumption by humans can be repurposed for consumption by animals. This way, farmers save money on food costs for their animals and businesses save money on waste disposal costs (Leftovers for Livestock, 2016). Business can also donate their excess food to feedstock producers, as opposed to donating directly to farmers. Other benefits of feeding animals are that water use, fertilizer use, and N₂O emissions (nitrous oxide, a potent greenhouse gas) would be reduced if normal feedstock were replaced with FDF (feeds derived from food waste) (Dou, Toth, & Westendorf, 2018).

The food waste that is accepted by animals is more diverse than the food waste which can be used to feed people. Animals can consume processing waste, leftover food, and post-consumer food waste. Since leftover food can be donated to people, it is preferred that only processing waste and post-consumer food waste is fed to animals. However, if there is no food donation system in place or if feeding hungry people is not an option, then animals can be fed leftover food waste as well. The fact that animals can accept more types of food waste makes collection of the food waste easier for the institution or business.

2.3.4 Industrial Uses

There is much research being done on possible industrial uses for food waste and other organic materials. One such example is the process of anaerobic digestion. Here, microorganisms are utilized to break down organic materials (food waste in our case) to produce a useful byproduct. One of the largest byproducts is biogas. This gas mostly consists of methane and carbon dioxide. The methane can be easily separated from the carbon dioxide and used as biofuel; methane is the primary component in natural gas. There is also a solid residue left behind after anaerobic digestion known as “digestate”. The digestate is high in nutrients and can be used as a soil amendment. Digestate can also be made into products such as bedding for livestock, flower pots, and fertilizers (EPA, 2017).

This method of food waste diversion can accept processing food waste, leftover food, and post-consumer food waste, which is more diverse than the types of food waste which can feed hungry people, and the same as the types which can feed animals. One added benefit is that oils and grease can be used for some industrial purposes, while it cannot be sent to feed animals or feed humans. Composting also does work with these forms of waste.

By using food waste for industrial uses, the calories from food are partially recycled to be used as energy. However, this only recovers a small portion of the total energy spent on growing the food, so it is still not ideal. More research is currently being done on methods for industrial repurposing of food waste.

2.3.5 Composting

Composting is a natural process where various waste materials are decomposed into soil conditioner. Compost is high in nutrients and can be used in gardens, agriculture, and landscaping to improve the fertility of the land. Composting can be an entirely natural process; however, it can also be accelerated tenfold by artificially creating ideal composting conditions (Moosey, 2017). Some other benefits of composting include reduction of methane produced from landfilling food waste, and the reduction in usage of chemical fertilizer.

Composting is the most diverse food waste diversion strategy from the hierarchy that benefits the environment. While anything can be dumped in a landfill or burned, these are detrimental to the environment. Along with leftover food, processing waste, and post-consumer food waste, composting can also accept any organic or biodegradable material. A slogan often used to remember what can be composted is: “If it was living, it can be composted!”

Composting is on the rise in the United States. According to the EPA, in a period of two years, the amount of composting of food waste has increased by 5.0%. During this period, it rose from 1.84 million tons of food in 2013 to 2.1 million tons in 2015. Composting can be done by businesses and organizations by sending their organic waste to composting facilities nearby. Clark University, another university in the Worcester area, sends their compost to WeCare Organics about a mile from campus and has no food waste going to landfills or incineration plants (J. Isler, personal communication, March 26, 2019). This is often the only viable composting solution for organizations in urban areas.

2.3.6 Landfill/ Incineration

Landfills and Incineration are the least desirable destination of food waste in the hierarchy. When food waste is sent for incineration, it is combusted to produce heat which can be recaptured to produce electricity using steam turbines. This process does not take advantage of any of the nutrients and few of the calories present in food waste. Furthermore, the combustion of food waste releases carbon dioxide into the atmosphere.

The alternative to incinerating food waste is dumping it in landfills. Here, food waste will release methane gas as it decomposes. There are many other negative environmental impacts caused by landfills. These include groundwater pollution, soil infertility, and taking up a lot of space which has numerous, more productive needs, such as growing trees or agriculture.

2.4 Case Studies

The EPA's Food Recovery Hierarchy can be illustrated with several examples of businesses and organizations that have been implemented in their workplace to combat food waste. In this section, we provide examples at University of Massachusetts Amherst (UMass), Whole Foods Market, Gardner Ale House, The Lenox Hotel, and Boston University.

At UMass Amherst, dining services have had a composting system for ten years and have recently sought the services of LeanPath, Inc. LeanPath provides a system which helps organizations reduce the amount of food waste at the source. In the case of UMass Amherst, the main source of their food waste is in their dining halls and kitchens. The LeanPath system shows a visual representation of what food is being wasted and tracks the weights of preparation waste. With the assistance of this data, food waste reduction programs could be developed. For example, LeanPath has assisted UMass Dining in developing uses for pineapple cores for infused water and bones for stock (RecyclingWorks MA., 2017). Their pre-consumer waste is roughly equal-parts trim, waste, and overproduction. Using a tracking system like LeanPath allows UMass to change their methods of purchasing food by analyzing what foods are being wasted the most. UMass Dining has saved approximately \$750,000 over the past three years by reducing wasted food. The amount of food that goes to waste at UMass Amherst is down to 9%, which is well below the 15% national average (RecyclingWorks MA., 2017).

Directly below source reduction on the hierarchy is feeding hungry people. Whole Foods Market in Medford, MA has been donating their leftover food waste since May of 2008. In 2014, they expanded their donation program with the assistance of Food Donation Connection (FDC). FDC is a company which helps businesses make connections to social service agencies that distribute the food to people in need (Potter, 2019). They have staff members separate the food based on its size and whether it is perishable and non-perishable. They place smaller items into 13-gallon food-safe donation bags and place larger items into unused banana boxes or 30-gallon donation bins. They place the perishable donations in a walk-in refrigerator and the nonperishable foods on shelves located near the loading dock. The company donates to approximately five or more agencies consisting of: food banks, senior centers, after school programs, homeless shelters, and low-income housing facilities (Potter, 2019).

The Gardner Ale House is a family style brew pub and restaurant located in downtown Gardner, Massachusetts. The restaurant serves an average of 1,700 meals per week. It diverts about 20 tons of barley malt annually to a local pig farmer, who uses it for feed. They have diverted approximately 15% of their food waste to feed animals and 57% for recycling, while the other 28%

of the waste is trashed. However, they are unsure how diverting the waste affected their company due to waste management logistics changing during this time (Potter, 2012).

Another example of a business donating its food to animals is MGM Resorts International. According to the EPA, they have avoided sending their food to landfills since 2007. Their food scraps from the Las Vegas Strip properties went to RC Farms. RC Farms is a pig farm with about 3,000 pigs, which are benefiting from food scraps being donated. The pig farm closed in 2016, but MGM continued their efforts by donating the food leftover food to hungry people.

Rutgers University has also contributed to donating their food waste and avoided their food scraps from going to landfills. Their dining hall has partnered with Pinter Farms, which has benefited from their food scraps. Pinter Farms collects about one ton of food scraps daily. Having their food scraps sent to Pinter Farms costs half as much as sending it to landfills, which makes being eco-friendlier more cost effective too (EPA, 2017).

The Lenox Hotel provides numerous sustainable initiatives. The Lenox Hotel runs multiple waste diversion initiatives that are used for industrial purpose. An example of one would be using oil for fueling. The staff recycle vegetable oil which is convert to fuel for a biodiesel shuttle service (RecyclingWorks MA., 2019). They also have an initiative to compost food waste. On May 2014, they implemented a program which targeted processing waste and post-consumer waste. Renewable Waste Solutions (RWS) picked up the waste and transported it to Rocky Hill Farm. RWS reported that they had been collecting 3,500 pounds of waste per week. The hotel saved \$164 per month by diverting their waste (RecyclingWorks MA., 2019).

Universities have also been using food waste for industrial purposes. Purdue University converts its food waste into renewable energy. They have partnered with the City of West Lafayette to add an anaerobic digester to generate biogas. The solid residue left over is also not wasted and is used as a soil amendment. This same process is being used by other universities, such as The University of Wisconsin Oshkosh. In fall of 2011, they used this digester which help produce energy to power 10% of the institution (EPA, 2017).

At the George Sherman Union, the food waste diversion rates began at 31% in 2008 and increased to 73% in 2011. This increase in diversion rates was due to the addition of adding a post-consumer food waste collection system. The program grew from 4 tons of organic waste composted in 2007 to over 850 tons in 2011 (Potter, 2013).

There are many initiatives to look at, with many success stories and statistics to show they are reducing food waste and negative environmental impact and even saving money in some cases. By studying these existing programs, we created a solid foundation for our understanding of food waste reduction. This enabled us to view the food waste management system at WPI with a new perspective and ask relevant questions when investigating programs that would improve the food waste management system at WPI.

2.5 WPI Waste Audit

The WPI Green Team conducts an annual waste audit of select buildings on the WPI campus. A waste audit helps reduce waste by locating the main sources of food waste. The 7th annual report in 2017, the most recent report during the early stages of this project, audited Gordon Library, Founder's Hall, and the Campus Center. The Green Team, accompanied by faculty and community volunteers, sorted through the contents of the waste in these buildings to gather information on the amounts and types of waste at WPI. They separated the waste into trash, bottles and cans, cardboard, paper, liquids, food waste, and to-go containers. This helps to reduce food waste by giving the Sustainability Office, Green Team, and any other sustainability organizations data informing the current state of waste management. These data were necessary to diagnose problems in the food waste management system so that new programs can be developed.

The waste audit team found mixed results with the audits. In Gordon Library, the location of a small cafe, they found that food waste as a proportion of total waste went down from 25.1% in 2016 to 18.6% in 2017. On the other hand, they found that food waste went up from 23.1% to 27.8% in the Campus Center, which hosts one of the main dining locations on campus. Only two buildings were audited, and the largest dining hall on campus, Morgan Dining Hall, was not included. The Waste Audit gives us a snapshot of the food waste situation on campus, but not the entire story.

The Waste Audit also does not provide any information on what the food waste consists of. This is critically important to our project. To explain, imagine that all the food waste in a garbage bin consisted of only banana peels, apple cores, egg shells, and chicken bones. Next, imagine that the same waste consists of uneaten burritos, sandwiches, milk, eggs, and other edible foods. The two scenarios would be reported identically by the Waste Audit despite their important differences. Edible foods can be donated to people or animals, while in the first scenario the foods can only be composted or sent to a landfill.

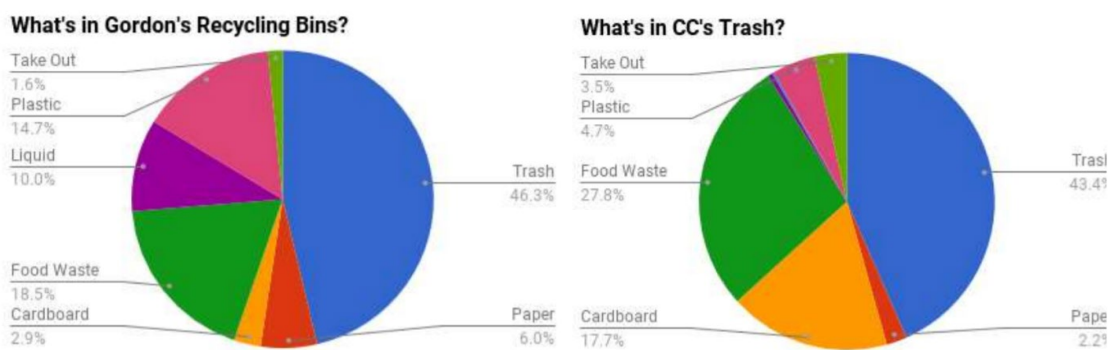


Figure 3 (left): Gordon Library Waste Audit (Waste Audit Report, 2017)

Figure 4 (right): Campus Center Waste Audit (Waste Audit Report, 2017)

2.6 Food Waste Programs at WPI

At WPI, there are several current food waste programs. These are roughly ordered by preferability according to the EPA's Food Recovery Hierarchy (Figure 1).

Perhaps the most successful program in recent years has been the introduction of trayless dining in 2006 which reduced the food thrown in trash bins by 40% (Cammarata et al., 2017). Morgan Dining Hall is a buffet style dining hall, so students are responsible for serving themselves. The removal of trays meant that students were less likely to over-serve and more likely to finish the smaller amount of food on their plate. Of course, students can still get up for second servings. This is an example of source reduction because its goal is to make sure people do not take more than they will eat. This reduces the amount of post-consumer waste which is the most difficult type of waste to collect

Another program is Project Clean Plate, which is done once a week during A-term in Morgan Dining Hall. Students are awarded with a raffle ticket for returning clean plates and not wasting food. This is meant to incentivize proper serving sizes and make people conscious of how much food they are taking.

Trim Trax, another program, is a back-of-house food reduction method implemented by Chartwells, WPI's food services provider. Back-of-house is a dining term meaning all things before the food reaches the consumer, which deals with processing waste. By keeping processing waste in clear buckets and collecting data on the amounts, the kitchen staff can remain aware of the amount of food being wasted during preparations and work to minimize preparation waste. The amounts of waste collected is recorded in a program called Waste Not, which keeps track of the amount and cost (estimate) of food being wasted.

Trayless dining, Trim Trax, and Project Clean Plate are all examples of the first tier in the Food Recovery Hierarchy: source reduction. Each of these programs work to reduce the amount of food being wasted in the first place by reducing how much food is taken by consumers and prioritizing conservatism with ingredients in the kitchen.

An example a program to feed hungry people at WPI is the Food Recovery Network. This is a group of students who focus on feeding hungry people with unserved food at WPI. Safe, unserved food from Morgan Dining Hall and the Campus Center Food Court are collected in aluminum pans and donated to charitable organizations in Worcester, such as Friendly House (Cammarata et al., 2017). The Food Recovery Network was established in 2011 at the University of Maryland and has since expanded into a national network of schools with their own chapters, WPI included. It is entirely student run and Chartwells at WPI supports their efforts. (Cammarata et al., 2017)

At WPI, feeding animals is the most utilized food waste reduction program present. WPI currently donates around 58 tons of food waste annually to the Tyde Brook Pig Farm in Holden,

Massachusetts. For comparison, WPI produces approximately 718 tons of total waste (WPI Sustainability Report, 2017). About 400 lbs. from Morgan Dining Hall and 150 lbs. from other locations per day accumulate and are picked up by the pig farmer 2-3 times per week (Cammarata et al., 2017). Diverting food waste for animal feeding simultaneously addresses waste management (landfilling), food security, and resource and environmental challenges. In this case, livestock function as bioprocessors for turning food that is otherwise inedible or unwanted by humans into meat, milk, and eggs. This also saves food grains which would otherwise be used on the animals.

The remaining tiers are industrial uses, composting, and landfill/incineration. WPI does not currently use any of their food waste for composting or industrial uses. The WPI Facilities Department has avoided composting in residence halls and other locations on campus due to apprehension over complaints they would receive (E. Tomaszewski, March 19, 2019). Ms. Tomaszewski cited complaints of excessive smell and bugs surrounding food waste collection systems at other universities as reasoning for why the WPI Facilities Department has avoided residential composting.

2.6.1 Composting IQP: Food Waste Collection in the Campus Center

A lot of work has been done to improve the food waste situation at WPI. One of these was a previous IQP titled “Sustainability at WPI: Food Waste Management” which investigated the food waste management system at WPI. The background information in this report provided a good starting point for the rest of the research in the current project.

This IQP focused their analysis and recommendations on composting, which they believed would improve WPI’s food waste management. They eventually made a final recommendation for a Campus Center compost pilot program. The goal of this program was to evaluate the successfulness of food waste collection to support their goal for implementing composting. They explained that determining this would require setting up food waste collection bins in the Campus Center and having them audited to determine if people were utilizing them for their food waste, or a mix of garbage. This program was eventually implemented in 2017 with the cooperation of the Facilities Department, the Green Team, and the Sustainability Office (Joe Kraskouskas, April 8, 2019) and there are currently four food waste collection bins in the Campus Center. However, these bins are not currently audited by the Facilities Department as recommended in the pilot program. Additionally, the bins have been integrated into the larger pig farm system instead of composting. Their effectiveness was not measured until WPI’s 8th Annual Waste Audit.

2.7 Relevant Regulations

The amount of organizations and businesses that have been contributing to food waste has been increasing over the years. This may be due to the fact of new laws emerging. As they begin diverting their food waste there regulations that must be followed, even for food donations. To better understand the difference in laws, we compared it to two other states: New Hampshire and California.

2.7.1 Massachusetts State Laws

The amount of environmental regulations has been steadily increasing in the United States for the last 20 years (Ferris et al., 2017). This section will focus on regulations for food waste. It is important to understand the legal landscape surrounding food waste to provide feasible and legal recommendations.

The Massachusetts Department of Environmental Protection (MassDEP) acted against food waste on October 1, 2014 with the “Commercial Food Material Disposal Ban”. Organizations and businesses in Massachusetts are now prohibited from disposing more than one ton of organic material per week. The waste ban was instituted to redirect food waste from landfills to composting, conversion, recycling, or reuse. It is part of MassDEP initiative to divert at least 35% of food waste by 2020. As shown in Figure 4, some states ban a certain amount of organic materials such as wasted food (yellow) from going to landfills while other states only have a ban on yard debris (green). Even though there are states with the same organic waste ban (yellow), they each have their own regulations and interpretations of the law, as shown in Figure 3. Comparing these states’ laws to Massachusetts’ can reveal if certain regulations are effective for reducing food waste. There are many states without these organic waste disposal laws. Taking a broad look at how they handle food waste will give some insight into the effectiveness of laws for reducing food waste, and whether they are a good motivator for businesses and institutions.

State Organic Waste Bans & Recycling Laws Currently in Effect

	Connecticut CONN. GEN. STAT. ANN. § 22a-226e	Vermont VT. STAT. ANN. TIT. 10, § 6605k	Massachusetts 310 MASS. CODE REGS. 19.017	Rhode Island R.I. GEN. LAWS ANN. § 23-18.9-17	California CAL. PUB. RES. CODE § 42649.81
Food Waste Generators Covered	Commercial food wholesaler or distributor, industrial food manufacturer or processor, supermarket, resort or conference center.	Any individual, partnership, company, corporation, association, unincorporated association, joint venture, trust, municipality, the State of Vermont or any agency, department, or subdivision of the State, federal agency, or any other legal or commercial entity.	Any individual, partnership, association, firm, company, corporation, department, agency, group, public body (including a city, town, district, county, authority, state, federal, or other governmental unit).	Commercial food wholesaler or distributor, industrial food manufacturer or processor, supermarket, resort or conference center, banquet hall, restaurant, religious institution, military installation, prison, corporation, hospital or other medical care institution, casino, and covered educational facility.	Any business, meaning a commercial or public entity such as a firm, partnership, corporation, or association organized as a for-profit or non-profit entity. Multifamily residential dwellings are exempted.
Waste Production Threshold to be Covered	2014: 104 tons/year 2020: 52 tons/year	2014: 104 tons/year 2015: 52 tons/year 2016: 26 tons/years 2017: 18 tons/year 2020: Food scraps banned from landfill completely	1 ton/week* *Generators are covered only for weeks during which they meet the threshold	2016: 104 tons/year 2018: 52 tons/year for covered educational facilities	2016: 8 cubic yards per week 2017: 4 cubic yards per week 2020: 2 cubic yards per week IF statewide organic waste disposal has not been reduced to 50% of the level in 2014.

Table 2: State Organic Waste Bans & Recycling Laws Currently in Effect (Leib, Rice, Balkus, & Mahoney, 2016)

The Massachusetts Department of Environmental Protection (MassDEP) regulates the organic waste ban, which prohibits the disposal of commercial organic waste from institutions or businesses. They are affected by this ban if they dispose of one ton or more of organic waste material per week. (Commonwealth of Massachusetts, 2019). Since institutions are not able to dispose of their organic waste in landfills, they must divert this organic material from the waste stream to comply with the ban. As a result, businesses and institutions have seen an increased utilization of the other 5 levels of the Food Recovery Hierarchy (Figure 1). In a study performed by ICF International Inc., it was noted that the organic waste ban benefited the states in three significant ways: creating well-paying jobs, increasing the gross state product by about \$77 million, and by generating more than \$5 million in state and local tax revenue. There have been many positive impacts from the organic waste ban for Massachusetts, but other states have also benefited. California has the same ban but has different regulations in place.

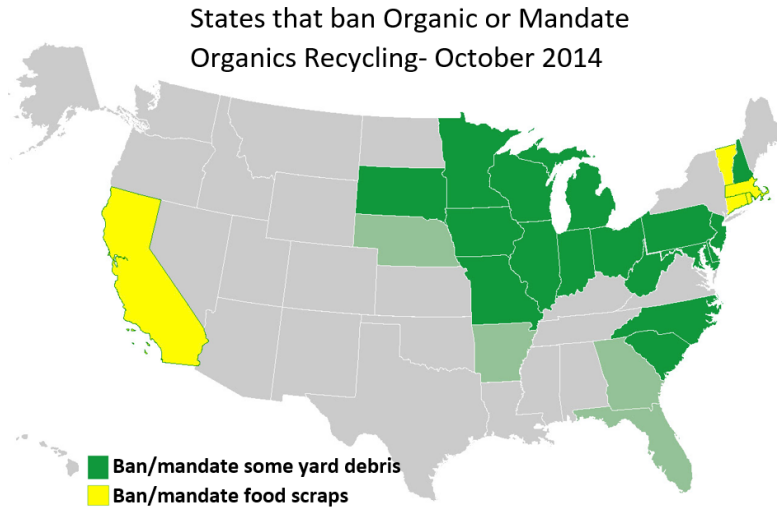


Figure 5: States that Ban Organic or Mandate Organics Recycling- October 2014

2.7.2 Other States' Organic Waste Laws

California's compliance with the organic materials ban can provide context for other states in the country under this law, proving that Massachusetts is not an isolated case. As shown in Figure 3, California is also part of the organic waste ban, even though they began this initiative in April of 2016. The difference is that the Massachusetts ban includes only institutions, but the ban in California includes public entities and multifamily complexes of five units or greater (City of Malibu Environmental Sustainability Department, 2016). These businesses and buildings began recycling as of April 1, 2016. Figure 5 shows the plan involving decreasing the maximum threshold of food waste generated each year. California plans to include buildings that produce 2 or more cubic yards of solid waste per week by January 1, 2020, which will increase the number of buildings affected by the ban. This law requires businesses to divert organic waste from landfill, such as food waste, green waste, landscape waste, non-hazardous waste, and food-soiled paper (City of Malibu Environmental Sustainability Department, 2016). Along with this law, local jurisdictions were required to implement an organic waste recycling program. This program was supposed to provide organic recycling options, educate businesses and multifamily houses about their local organic recycling options (City of Malibu Environmental Sustainability Department, 2016).

April 1, 2016 – generators of 8 or more cubic yards of organic waste per week;
January 1, 2017 – generators of 4 or more cubic yards of organic waste per week;
January 1, 2019 – generators of 4 or more cubic yards of solid waste per week;
***January 1, 2020 – generators of 2 or more cubic yards of solid waste per week, if statewide disposal of organic waste is not decreased by half.**

Figure 6: Recycling Guidelines for the ban (City of Malibu Environmental Sustainability Department, 2016)

New Hampshire does not have organics disposal bans in place as of April 2019. However, food waste reduction initiatives are present at institutions such as University of New Hampshire (Sustainable Efforts, 2017). UNH has undergone extensive efforts in reducing its food waste and its negative environmental impact. They use a pulper and compost their food and use oils from cooking for biofuels (Sustainable Efforts, 2017). These sustainability initiatives were not in compliance with any food waste bans. There are simply many more benefits to reducing food waste than not, such as taking pride in sustainable practices, protecting the environment, standing at the edge of innovation, and even saving money. Looking to states without organic waste laws shows that there are ways to get institutions such as WPI to reduce food waste regardless of compliance with laws.

2.7.3 Massachusetts Food Donation Laws

Massachusetts has two liability protection laws for food donations. The first is with the Emerson Act. This act states that if companies have not acted with intentional misconduct, they are not responsible for damages incurred by donated foods (Public Law 104–210, 1996). This legislation covers individuals, businesses, non-profit organizations, and the officers of businesses and non-profit organizations. From this law, states are enabled to create laws following the regulations of the Emerson Good Samaritan Act. The second law Massachusetts created was the Good Samaritan Law (Harvard Food Law and Policy Clinic, 2015). This law protects donors by allowing them to donate food past their expiration date if they comply with two requirements. The first requirement states the donated food cannot be misbranded or adulterated and must have been manufactured, processed, prepared, handled or stored in compliance with the public health regulations. This means that donated food must comply with the Massachusetts laws on date labeling to receive liability protection. The second requirement is that any injury resulting from such donation cannot be the result of gross or negligible food. Like the Emerson Act, it does not provide regulations to what gross or negligible food may constitute (Harvard Food Law and Policy Clinic, 2015).

If food was heated, it cannot be donated for further use at food shelters or similar facilities unless it is handled properly after the food is refrigerated. While the food is still hot, it is recommended by the Food Recovery Committee (FRC) under the Conference of Food Protection (CEP) that the food be cooled from 135 to 70 degrees Fahrenheit (57.2 to 21.1 degrees Celsius) over

a period of two hours, and generally must be cooled from 135 to 41 degrees Fahrenheit (57.5 to 5 degrees Celsius) over a six hour period after serving (Comprehensive Resource for Food Recovery Programs, Food Recovery Committee, 2016).

2.8 Field Research

The development of potential solutions to food waste issues require a number of research techniques to collect and analyze data. There are many different types and methods of data collection since it is such a useful tool in all disciplines. Observations and qualitative interviews are two important methods for data collection that are commonly used.

Observations are used to obtain relevant data necessary to change or improve a system within a limited timeframe. Observations can be qualitative or quantitative in nature. Qualitative observations use the five human senses to observe results: sight, smell, touch, taste, and hearing. Quantitative observations are made with instruments such as rulers, scales, and thermometers. The results from quantitative observations are measurable. Observational data includes raw materials that an observer collects from observations, interviews, and materials that others have created, such as reports. There are several ways in which data can be recorded, including written notes, recordings, and photographs. One way to record observations made are field notes. Field notes are derived from data collected during observations and interviews. They are generally written as soon as possible after the observation or interview. Field notes consist of two parts: descriptive and reflective. Descriptive field notes are used when the observer tries to capture the scene in words including setting, actions, and conversations that took place. Reflective field notes record the observer's thoughts and questions based on the observations or interviews. Field notes are used add thoughts to initial observations while the experience is still fresh, organize data collected, and draw connections from what was learned such as thematic ties (9 Field Notes Examples & Samples, n.d.).

A qualitative interview is a type of field research method used in this project which generates information and data by asking interviewees questions directly. There are three main types of qualitative interviews: informal, conversational; semi-structured; standardized, and open-ended (Field Research, n.d.).

Informal, conversational interviews occur frequently during observations when a researcher begins conversing with nearby people. Questions can be formulated during the conversation about any topic of interest discussed. These informal, conversational interviews allow the researcher to be more responsive to the individual but may lead to less systematic data. This type of interview was used often for this report since most of the food waste management system involved people with little information about specific data, but a necessary perspective on the issues for the project.

Semi-structured interviews involve formally requesting a meeting with a person to conduct an interview. A few questions and or probes, also known as interview guides, are drafted before the interview to guide the conversation (Field Research, n.d.). The questions are often open-ended to

allow for more information and details to surface. These types of interviews were important to this project since a lot of information known beforehand needed to be verified, and there were many facts not made aware until the interview.

Standard, open-ended interviews are more structured than the others. These interviews address all interviewees with the same open-ended questions in the same set order to capture each interviewee's individual differences on the topic. This type of interview enables comparability across interviews but does not offer flexibility for learning information about new topics that unfolded during the interviews (Field Research, n.d.). Standard, open-ended interviews were not used in this report since the positions and institutions of the different interviewees were not similar enough to need compatibility across interviews.

CHAPTER 3: METHODOLOGY

The goal of this IQP was to assess the food waste management system at WPI and to explore other food waste management options so we could provide recommendations which directly address this issue. Different solutions have been analyzed in order to refine and inform our recommendations for WPI. We have conducted preliminary research followed by interviews on campus, as well as off-campus interviews, observations, tours, and a waste audit. The goal has been broken down into smaller, achievable objectives which were used as guidelines for our project. These objectives are:

1. Research and meet with key stakeholders to discuss food waste at WPI
2. Assess WPI's food waste management system
3. Assess other organizations' food waste management
4. Identify and Analyze potential solutions
5. Create Targeted Solutions and Recommendations for WPI

3.1 Data Collection

The definition of food waste and understanding how to target food waste problems required the establishment of any research to begin approaching our project's goal. In order to obtain substantial information about food waste globally, at WPI, and other universities, different types of research were conducted. This research included literature review, observational methods, and interviews.

3.1.1 Literature Review

An initial meeting on March 18, 2019 with Paige Neumann, a research librarian at the Gordon Library, helped clarify different methods of internet research. Some of these methods included Google Scholar, WPI's online library, and general Internet guidelines. Figure 7 displays WPI's online library, with a red box outlining the three main different search engines she provided. With advanced search, it was able to search for specific words which were needed to be included in the sources. This also enabled specific works of literature to be looked for, such as articles, book, media, or even different types of work from students.



Figure 7: WPI Library Research Portal for access to databases

While using the Internet for research, there were steps to follow to locate sites which were credible enough to use in this report. A main overview of how to narrow down the search of this project was to first use search engines with specific search terms which focused on the main topic. Later, further examination of the sources was made to assure the site had limited bias and avoided misleading information (Best Schools, 2017). Finally, this research needed to provide enough support of information in the background for the goal of the project.

3.1.2 Interviews

Prior to any interviews that were conducted, the first step was obtaining WPI's Institutional Review Board (IRB) approval. In order to conform to the IRB standards, interviewees were given a description of the project, how the research will be purposed, and any risks undertaken by participating. They also were asked for their consent to participate in the interview. This process is known as informed consent (Allen, 2017).

The most effective way to gather information was found through holding interviews with individuals involved in food waste. In this way, specific targeted questions were asked to these individuals about data, opinions, perspectives, and general background knowledge. Due to the large number of potential interviews in different locations, the interviews had to be conducted as quickly and efficiently as possible. Nearly all the interviews were conducted in person, but some had to be done over the phone. Prior to each interview, the primary purpose of the interview was identified. Using this purpose, preliminary questions were developed, which were then sent to the interviewees so that they were to be able to think about them and acquire any resources that may be necessary to answer them. To initiate the interviews, a small and quick conversation was started by one of the team members, followed by the questions in our email. While the interview was held, one or more of the team members took notes on the material being covered during the interview; this provided information that was able to be looked back on. After the interviews were complete, the team wrote up some field notes using the data collected from the interview. The answers to the questions were then consolidated into a formal write up. The write up and summary of each interview were completed within 24 hours of the respective interview. Each of these summaries are included in Appendix I. Interviews represent a substantial portion of how the objectives were to be accomplished. They were primarily used to gather data which helped in achieving the main objectives.

3.1.3 Observations and Waste Audit

In some cases, interviews and research could not provide adequate information. Here, direct observations were made.

To get hands-on observations with food waste in the Campus Center, we attended the annual WPI Waste Audit on April 11, 2019. This waste audit first began with a safety meeting, held on Monday, April 8 at 5:00 P.M. The safety meeting was mainly to inform of any risks or how injuries should be handled, as well as the proper garments to wear. The picture shown below was the proper safety garments to wear over clothing. Participants were provided with the disposable Tyvek suits, as well as disposable and washable, puncture-resistant gloves. Blue nitrile gloves were to be worn first with the washable gloves worn over them.



Figure 9: Waste Audit at WPI (April 15, 2019)

The event itself was sponsored and organized by the Green Team and was held from 9:00 A.M. to 1:00 P.M. outside Harrington Auditorium. All the waste and recycling, except for the food waste from the bins in the food court, from the Campus Center bins were collected before the event on March 10th. The waste was sorted into liquid food waste, solid food waste, trash, or recycling.

The process itself consisted of weighing the recycling and waste bags (white and green bags, respectively) on the way in, and then weighing it again on the way out, including food waste (Fig. 9), after it had been sorted. The audit began with white bags, which was trash only. These bags were weighed and then sorted into trash, recyclables, food waste, plastic bottles, and liquid waste. Once these containers were full, they were bagged and weighed. After all the white trash bags had been sorted, the team moved on to the green recycling bags. The system was very easy to understand and

accessible to anyone. Students walking by the gym could help. In this way, the participants could determine the contents of WPI's trash.

One week before the waste audit, observations were made of the food waste bins in the Campus Center Food Court. This was done on April 10, 2019, from 1:00 P.M. to 3:00 P.M. These are peak hours in the Campus Center. The project members spread out and each observed one food waste bin and student tendencies in the food court. Notes were taken about how often students placed their food waste in the proper bins, which bins were most common, and other behavioral observations which are described in the findings section.

3.1.4 Tours

Along with interviews, tours were utilized to gather data. Tours granted access to the kitchens and waste management areas for more in-depth observations and allowed for additional questions to be asked like an informal interview. There were two tours performed during this project, one at WPI's main dining hall and one at WSU's main dining hall.

In order to develop a better understanding of WPI's food waste management system, a tour of WPI's main dining hall was scheduled for April 15, 2019. Charles Hill, a member of the dining services team at Morgan Dining Hall, led the tour through the kitchens and food waste management area. The goal of this tour was to make detailed observations of the kitchen practices and to investigate previous knowledge about food waste management practices. He also answered questions that were brought up considering the tour and provided data for their food waste management system.

After an interview with WSU's Sustainability Coordinator Steve Bandarra, there was a tour of the main dining hall at WSU and related facilities. The goal of this tour was to learn more about the homegrown lettuce from WSU and to make detailed observations of their food waste management system and kitchen practices. First Mr. Bandarra explained the process for WSU's Freight Farm, a Chartwells initiative to grow fresh lettuce in a freight container. Then he introduced the kitchen staff and the system for food waste collection which dealt with both preparation waste and post-consumer waste. Lastly, he displayed the dehydrator at WSU, an integral part of their food waste management system.

3.2 Objectives

This section discusses each of the specific objectives in detail. First, the information necessary to complete each objective was determined. Then, the specific research and methods necessary to acquire this information is detailed.

Most of the background information was collected through informal, semi-organized discussions and interviews. This section establishes how our interviews have supplemented our objectives. There is also information about interview methods and the questions we will be asking

each interviewee. Further detail on each interview is provided in Section 3.2, and the write-ups of each interview are available in Appendix I.

The remainder of our research was done through various internet sources, the WPI Gordon Library, the waste audit, direct observations, and tours. The waste audit, observation, and tours were especially helpful in analyzing solutions.

3.2.1 Objective 1: Research and Meet with Key Stakeholders to Discuss Food Waste Impact

To begin the project, background research of the global impact of food waste was conducted. This was done to get a sense of the areas which excessive food waste impacts and to inform the rest of the project as we narrowed down the scale to WPI. We then met with key individuals managing and affected by the WPI food waste management system. We used the ideas we had from researching the global impacts of food waste to develop the questions we asked these individuals. Additionally, the background research could be used as justification towards our goal of reducing food waste at WPI.

Individuals were targeted based on their perceived ability to help us understand the impacts food waste. According to WPI's Sustainability Plan, one of the institute's three guiding principles towards sustainability is that of Ecological Stewardship. Ecological Stewardship "embodies the principle that human activities must respect the need to preserve the natural world" (WPI Sustainability Plan, 2017). Given that food waste impacts the natural world, as our background research would eventually show, we determined that the Sustainability office could help us understand the impacts of food waste at WPI. We held an interview with Elizabeth Tomaszewski, Associate Director of Sustainability, on March 19, 2019. Ms. Tomaszewski is also WPI's Facilities Systems Manager, so she could also provide some information on how the Facilities Department operates and how they handle food waste.

Ms. Tomaszewski was also chosen to help describe how the food waste problem has manifested at WPI. In any difficult problem, there are several key obstacles which must be overcome to develop an effective solution. It was determined that an understanding of these obstacles was necessary from the beginning to inform the rest of the project. We brought this up with Ms. Tomaszewski because, as a prominent individual in Sustainability, she has been involved with food waste for extended period and has a good understanding of the inherent difficulties.

It was also important to research the financial side of food waste. It was determined that Chartwells would be most capable of describing this aspect of food waste given that they purchase the raw food materials. This was one of the reasons Joseph Kraskouskas, Director of Dining Services, was interviewed. This interview took place on April 8, 2019.

3.2.2 Objective 2: Assess WPI's Food Waste Management System

It was critically important to gain a full understanding of the current food waste management system at WPI. Before anything could be improved, an assessment of the current system was necessary. This involves where food waste is going, how it gets there, where it is produced, which programs are in place, how effective these programs are, and the reasons for their effectiveness.

This objective was achieved throughout the course of the project. Initially, food waste programs throughout campus were identified primarily through the interview with Elizabeth Tomaszewski, through background research on the 2017 IQP (Section 2.6.1), and through internet sources. This is where important programs such as the Tyde Brook Pig Farm donations, Trim Trax, the Food Recovery Network, and Project Clean Plate were first identified.

It was determined that more detailed information was necessary on the programs after the first round of research. For this reason, Green Team president Claire Barrameda was interviewed on March 31, 2019 and Director of Dining Services Joseph Kraskouskas was interviewed on April 8, 2019. The Green Team was contacted for spreadsheets, statistics, and other specific information on Project Clean Plate and any other initiatives because they are the organization which originally implemented the program. Mr. Kraskouskas was contacted for statistics on Trim Trax, the Food Recovery Network, and the Tyde Brook Pig Farm system, and for an explanation of how each of these solutions works. All three of these solutions take place in Chartwells kitchens, so Chartwells employees were deemed capable of discussing them.

Mr. Kraskouskas directed us to Charles Hill, Morgan Dining Hall Kitchen Supervisor, after we discussed the need for an understanding of the Chartwells kitchens, Trim Trax statistics, and of the general food waste atmosphere in the kitchen. An understanding of how the employees work together in the kitchens, the atmosphere there, pace of work, and other factors are important for developing kitchen-based solutions. Mr. Hill gave this tour on April 15, 2019.

To gain an understanding of fraternities and sororities, Marc Printz was interviewed on April 24, 2019. Mr. Printz currently administers a food waste collection system in Lambda Chi Alpha which he implemented as a student in 2016. He was recommended to us by Gina Betti, Associate Director of Foisie Business School, with whom we had a conversation about food waste solutions.

Some information could not be adequately received through interviews alone, so direct observations, tours, and a waste audit were conducted. Little information existed on the food waste situation at WPI's second largest dining hall; the Campus Center. Particularly with the food waste bin system developed following the 2017 IQP. Although the report recommended they be audited, this has not been done. Therefore, the food waste bins in the Campus Center food court were observed for 2 hours on April 10, 2019, from 1:00 P.M. to 3:00 P.M. These are peak traffic hours in the Campus Center. The project members spread out and each observed one food waste bin and students' tendencies in the food court. Additionally, the custodians responsible for emptying the bins were contacted and asked about their thoughts on the food waste bins effectiveness. We considered the

custodians valuable sources of information in this area because they could make empirical observations which would not be reflected in hard data. Finally, the project group attended the annual WPI Waste Audit to get hands on information about the contents of the Campus Center's waste. The data from this event were published, however by attending we could gather empirical evidence specific to our project that is not reflected in that data.

The purpose of all this information is to provide a better understanding of food waste at WPI. It becomes easy to determine which areas on campus are satisfactory and which need improvement with a comprehensive and detailed view. This makes it possible to explore new ways to reduce food waste which can be brought to campus from other schools and facilities and implemented in weak areas.

3.2.3 Objective 3: Assess Other Organizations Food Waste Management

To properly assess WPI's food waste management system, we wanted to compare it to the same system at other organization. Through this comparison, we could then identify the areas in food waste management where WPI is lacking and possibly implement those solutions.

One university of interest is Clark University. Clark donates four times as much food waste as WPI despite producing less total waste (AASHE, 2017). Clark donates 12.64 tons annually while WPI donates only 3.00 tons. The AASHE STARS program uses a statistic they call "Weighted Campus Users" to determine how many people are using the campus facilities which can be used to compare the waste numbers across universities. This number is 4,146 for WPI and 3,038 for Clark, which means that Clark should have less food donated, although this is not true. This background research helped to identify Clark as a leader in food waste management and a valuable subject for further research. This research was conducted through an interview with Jenny Isler, the Director of Sustainability at Clark. Additionally, Clark uses a different dining services provider than WPI called Sodexo. We identified this difference as a possible source of alternate solutions not currently in place in Chartwells.

At Worcester State University (WSU), and interview with Sustainability Coordinator Steve Bandarra was conducted to identify their programs in place for food waste. Worcester State University was chosen due to its proximity and accomplishments in sustainability. WSU are the winners of the EPA's 2014 Food Recovery Challenge. This is an annual challenge by the EPA where organizations "pledge to improve their sustainable food management practices" (EPA, 2019). Furthermore, Worcester State also employs Chartwells for their dining services. Therefore, any programs implemented there are presumably easier to implement with WPI Chartwells.

Massachusetts universities have been primarily selected for investigation due to their proximity to campus. The number of locations has been prioritized over the variety of locations so that as much information relevant to the Worcester area can be gathered. Universities which are closest to WPI facilitate our needs. Furthermore, Massachusetts Universities are subject to all the

same laws and regulations as WPI. Universities which exist in similar environments as WPI, that is, urban college towns have also been prioritized.

3.2.4 Objective 4: Identify and Analyze Potential Solutions

Eventually, specific solutions for WPI locations had to be identified. This was done once an understanding of WPI and other universities' food waste management systems was developed. We analyzed and compared these waste management systems. The differences were used to explain why some solutions worked well at one location but not at another, and what similar traits worked well. Thus, we could establish what factors result in an effective food waste management system and apply that knowledge to WPI.

One reason the interview was conducted with the Green Team President was to help implement a solution once it had enough basis. The Green Team is a student-run organization which often implements original ideas and sustainability initiatives on campus. This is exactly what a potential product of this project could have looked like, so Claire Barrameda's advice on this subject was important. Additionally, the Green Team is established on campus and could be the ones to take our recommendations and implement them, so it was important to establish communication with the club.

3.2.5 Objective 5: Create Targeted Solutions and Recommendations for WPI

Once we produced our potential solutions, we focused on the area we had the most knowledge viable solutions on. This was determined through the ease of implementing solutions, effectiveness of those solutions, amount of support for these solutions, and the food waste situation in that area.

Additionally, we developed some broad recommendations for WPI. A few areas which need significant improvements to their food waste management on campus were identified and provided recommendations. These areas were considered out of the scope of this project but were still important to the topic of food waste at WPI. The recommendations focused on consulting various organizations which we deemed have potential for future success.

3.3 Summary

Many different forms of research were undertaken in order to advance towards the goal of reducing and redirecting food waste. Interviews were conducted through the process to gain background information, ask targeted questions to important individuals, and discuss potential solutions. Observations and other forms of field research were undertaken to develop a personal understanding of the food waste situation at WPI and other locations. Finally, recommendations were developed through comparisons and analysis. Some organizations were also contacted to provide consulting on food waste issues.

CHAPTER 4: FINDINGS

The research resulted in a greater understanding of the WPI food waste management system, as per Objective 2. During our investigations, we uncovered what policies and programs were in place, and how they affect the flow of food waste through WPI. For greater visualization, we developed a food waste map (Fig. 10) involving the four main sources of food waste laid out in Section 2.3 and six locations, five of which are managed by Chartwells.

Several findings were drawn from a comparison of the dining locations at WPI as well as at a few other locations, including Clark University and Worcester State University. These are each laid out with the supporting results and analysis in this chapter.

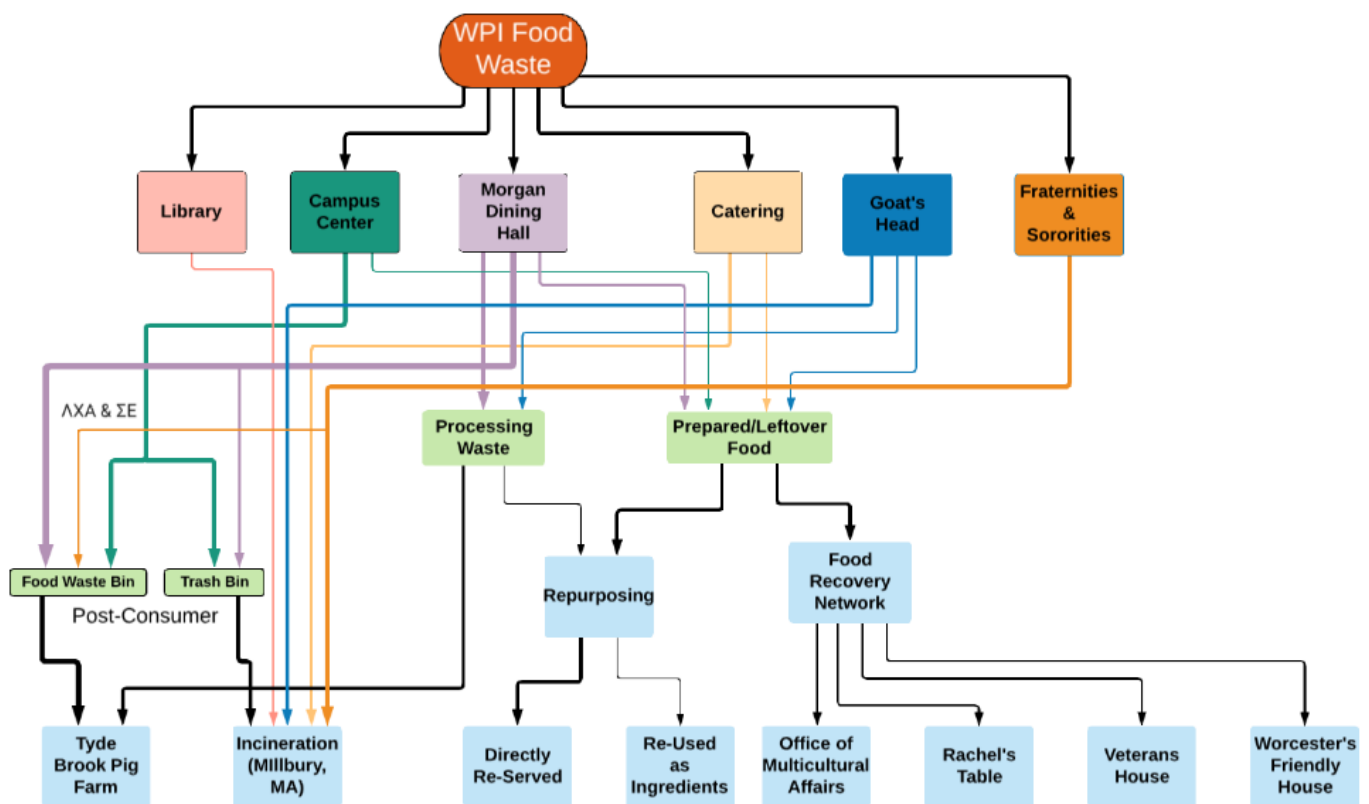


Figure 10: WPI food waste map

The food waste map shows the flow of food waste from the point that it arrives at WPI to where it eventually ends up, represented in blue. The thickness of the arrows roughly corresponds to the amount of food waste flowing for purposes of illustration and is not to scale. The map shows six substantial sources of food waste. Some notable exceptions were made due to a lack of data, including Dunkin' Donuts, Residence Halls, and Planet Smoothie/Auntie Anne's. The green boxes represent each food waste source as discussed in the terminology (Section 2.2).

4.1 Morgan Dining Hall has the Most Effective Food Waste Management System at WPI

Morgan Dining Hall, with 2,317 meals served on March 20th, 2019, is the largest dining location at WPI, which consequently means that it generates the greatest amount of food waste on campus (Charles Hill, personal communication, April 25, 2019). However, it was also found that Morgan had the most effective food waste management system when compared to the other Chartwells dining locations. According to Joe Kraskouskas, virtually all the food waste from this location should theoretically end up being diverted to the pig farm, donated, or reused (Joseph Kraskouskas, personal communication, April 8, 2019). Multiple factors were identified to contribute to the success of handling food waste Morgan when compared to other locations. These factors include the Trim Trax system, in the layout and environment, types of food served, and the use of reusable plates.

By the end of the food waste management process in Morgan, 400 lbs. per day of food waste are sent to Tyde Brook Pig Farms in Holden, Massachusetts. This represents the third tier of the EPA's Food Recovery Hierarchy: feeding animals. The Dining Hall contributes to processing waste, unserved food waste, and post-consumer waste. Charles Hill detailed this entire system as part of a tour of Morgan Dining Hall and its kitchen on April 15, 2019. Processing waste and unserved food waste are both dealt with by Chartwells, while post-consumer waste is mostly dealt with by the Facilities Department

, although certain Chartwells programs do help to mitigate it.

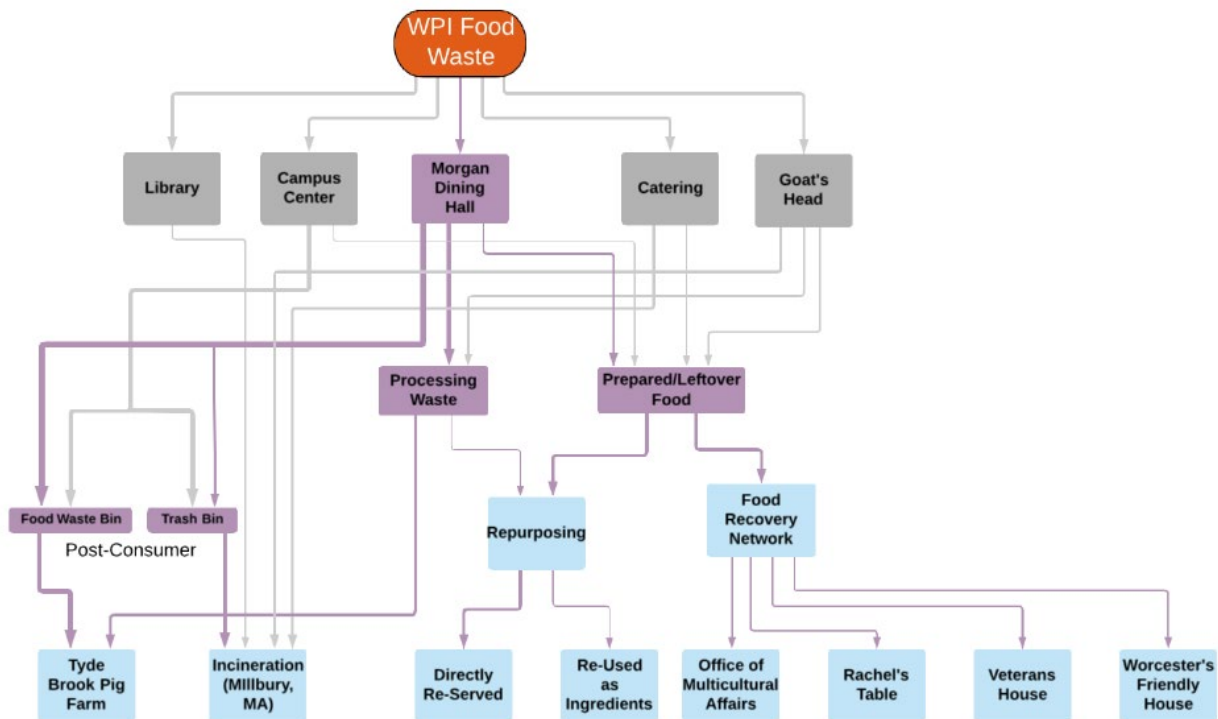


Figure 11: Morgan Dining Hall Food Waste Map

Processing waste and unserved food waste both occur in the kitchen. In Morgan, Chartwells uses a food waste tracking and auditing system called Trim Trax. Chartwells employees also refer to this program as the Waste-Not program. In this system, all the processing waste is audited by placing it in clear white bins which also serve to remind the kitchen workers of exactly how much food they are wasting (Table 3, Fig. 12). Any vegetable trimmings, chicken bones, onion shavings, broccoli heads, and other processing waste items are placed into these bins by the kitchen staff. Although the data on Trim Trax does not go back to before it was implemented, there is a similar system in place at Clark University. Clarks dining services provider Sodexo contracted LeanPath, and independent company, to implement a food waste auditing system in their kitchens. Clark University saw a 63% reduction in processing waste in the first year (Jenny Isler, personal communication, March 26, 2019).



Figure 12: Trim Trax container used in Morgan Dining Hall

Chartwells categorizes their kitchen waste into three main categories as part of the Trim Trax auditing system. These are “Production Waste”, “Over Production Waste”, and “Unused/Out of Date Inventory” (Fig. 14). Production Waste and Unused/Out of Date Inventory are both processing wastes while Over Production Waste is unserved food waste. Over Production Waste is food waste resulting from food that has been prepared but not eaten and is not suitable for repurposing, reusing, or donation. Unused/Out of Date Inventory is food in the kitchen which is no longer fit for consumption. These three sources are collected and measured daily by Charles Hill from each station of the Dining Hall (Charles Hill, personal communication, April 15, 2019). The food waste from these sources is either repurposed or placed in 55-gallon drums (Fig. 13) by the kitchen staff and then collected by the farmer from Tyde Brook 2-3 times per week.

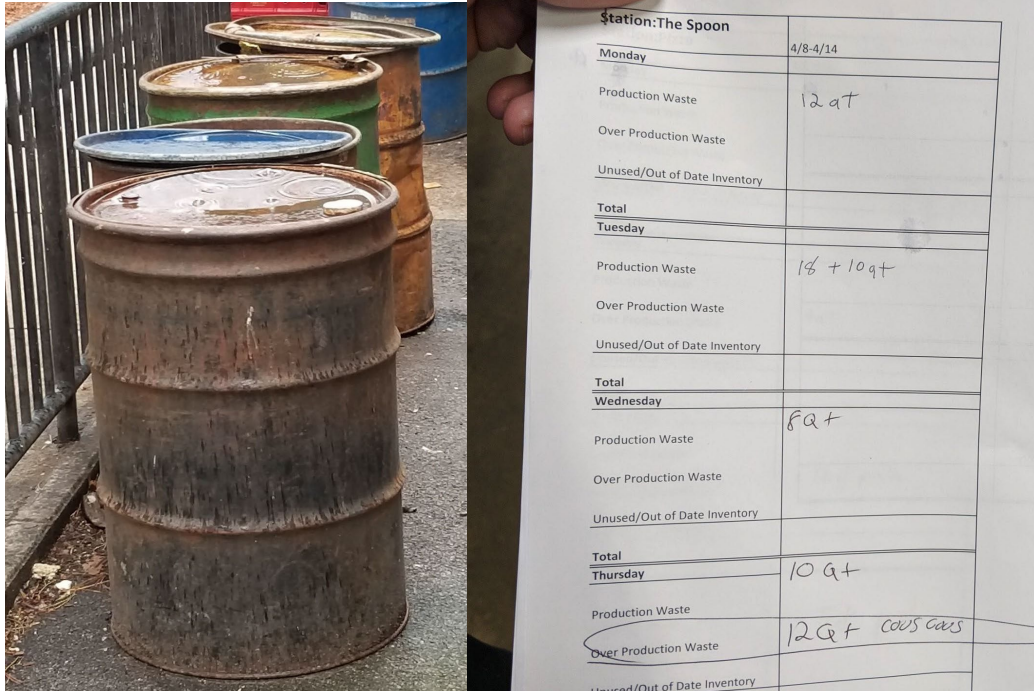


Figure 13 (left): 55-gallon food waste collection drums behind Morgan Dining Hall sent to the Pig Farm

Figure 14 (right): Charles Hill's Trim Trax note sheet

The figures Mr. Hill collects daily on his note sheet (Fig. 14) are entered into a software developed by Compass Group, the company which owns Chartwells. The software keeps track of the overall food waste and calculates a cost estimate of that food waste. The chart itself is confidential according to Mr. Hill's superior, but a small part of the data from Morgan can be found below (Table 3). The key for Chartwells Waste-Not terminology can be found in Appendix VI.

Month	March		February	
Year	2019		2019	
Station	Waste (lbs.)	Waste Cost	Waste (lbs.)	Waste Cost
Total	2,947.36	\$5,570.81	3,286.40	\$6,211.30
ACTION	544.96	\$1,029.97	470.08	\$888.45
BACK	2,005.12	\$3,789.68	2,227.60	\$4,304.66
DELI	39.52	\$74.69	99.84	\$188.70
KITCHEN	212.16	\$400.98	280.80	\$530.71
PIZZA	145.60	\$275.18	158.08	\$298.77

Table 3: Data from Chartwells Trim-Trax program at Morgan Dining Hall

From September 2018-April 22, 2019, about 7 months, the food waste audited by Trim Trax totals 20,398.56 lbs., or \$38,553.28 worth of food waste. Unfortunately, a substantial proportion of food waste in the kitchen haphazardly makes it past Trim Trax accounting and into the normal waste stream and is sent to the Wheelabrator waste-to-energy site Millbury (Charles Hill, personal communication, April 15, 2019). Mr. Hill estimated that the amount of food waste that gets past Trim Trax to the Wheelabrator site is around 10%. He cited the significant employee turnover and their insufficient training in improper disposal practices.

Some items do not need to be entered into the Trim Trax system and labelled as food waste because they can be reused or repurposed. Blast chillers are present at Morgan Dining Hall and the Campus Center Food Court which can quickly refreeze food which is unused (Fig. 15) (Joseph Kraskouskas, personal communication, April 8, 2019). Chartwells will reuse this food in the next day's meals. They will also repurpose chicken bones, vegetable trimmings, and other processing waste or unserved food for stews, stir fry selections, and at the salad bar.



Figure 15: An example of food chilled to be reused for the next day

Unserved or leftover food is also donated to several locations to feed people in Worcester. This is an example of the second tier of the Food Recovery Hierarchy. The WPI chapter of the Food Recovery Network has been donating food since the spring of 2016 under the guidelines the Food Recovery Committee sets forth. This is done using the food left over from Morgan Dining Hall and the Campus Center. Since the establishment of the chapter, WPI has donated a total of 5,044.7 lbs. of food under the food Recovery Network's supervision and has currently donated 766 lbs. for the 2019 spring season (Food Recovery Network Annual Report, 2019). According to Chartwells, the FRN donates roughly 20-30 pounds of food per day (Table 4). The Food Recovery Network generally uses WPI sponsored SNAP shuttles to donate their food to Worcester's Friendly House or Veteran's Inc., two local services that provide food to those suffering from food insecurity. If this is not an option for any reason, workers from Rachel's Table, an organization which donates food to shelters, will come to WPI to pick up the food (Joseph Kraskouskas, personal communication, April 8, 2019).

Date	Location	Weight (lbs.)	Items
1/15/19	Chartwells	38.5	Muffins, hot dogs, pizza, sweet potatoes, mushrooms and potato, salami
1/18/19	WPI dining Hall	41	Croissants, desserts, BBQ seitan, rice, meatloaf with eggs, Spanish rice, rice with carrots
1/23/19	WPI	37	Grilled cheese, quinoa, brown rice, roast beef and beans
1/25/19	WPI	45	Sweet potatoes, pinto beans, mashed potatoes, rice & beans, grilled cheese
1/28/19	Morgan Dining Hall	38.8	N/A
2/4/19	Morgan Hall Kitchen	42	Rice, beans, beef, sweet potato hash, mushroom gravy
2/5/19	Morgan POD	45.5	N/A
2/5/19	Morgan POD	52	Lentil hummus, seitan tempeh, corn on the cob, cheese, rice and okra
2/6/19	WPI Dining Services	55	Tomato okra, baked potato, hummus, turnips, beans
2/11/19	WPI Dining Hall	55.95	Ratatouille, orange tofu, potatoes, American chop suey, stuffed peppers, chickpeas

Table 4: 2019 Food Recovery Network Deliveries

The final source of food waste in Morgan Dining Hall is post-consumer. Students are responsible for scraping their leftover food into marked bins (Fig. 16) as they leave the dining hall. Otherwise their food waste is sent to Wheelabrator. The bins are located close to the exit of the dining hall, so students are required to walk past them. Fortunately, it seems that most students properly dispose of their food waste and that the Morgan Dining Hall system is quite effective (Joseph Kraskouskas, personal communication, April 8, 2019). It was found that only 0.13 lbs. of post-consumer waste were produced per meal as part of Project Clean Plate in a term of 2017 (Table 5). This is a remarkable improvement from 0.55 lbs. wasted per meal a few years ago (Cammarata et al., 2017).

Date		Total Food Waste (lbs.)	Number of Students	Pounds of Person
9/6/2017		89	725	0.123
9/20/2017		105	750	0.140
9/27/2017		100	802	0.125
10/4/2017		89	814	0.109
11/1/2017		56.8	546	0.104
11/8/2017		85	655	0.130
	Totals:	524.8	4292	
	Averages:	87.47	715.3	0.121

Table 5: Project Clean Plate data from Morgan Dining Hall

On the consumer side of things, it makes sense why the situation in Morgan Dining is positive. This is for two principle reasons. First, food is not allowed to leave the dining hall and there is only one exit, so the students must either finish all of their food or dispose of it somewhere before they leave the dining hall. The proper disposal bins are located along the sole exit (Fig. 16), so it is natural for students to dispose of their food waste in the proper location. Secondly, the plates are reusable and must be returned at the end of a student's meal, so it makes sense for them to scrape the food off beforehand. Additionally, there is substantial signage promoting proper food waste disposal surrounding the exit, dish return, and waste bins in the exit to the dining hall (Fig. 17, 18). This signage serves as a reminder to students about food waste.

The food waste that makes it into the proper bins is collected in the 55-gallon drums (Fig. 13) and sent to the pig farm along with the Trim Trax food waste (Charles Hill, personal communication, April 15, 2019).

There is not much realistic room for improvement in Morgan Dining Hall. It is currently the model for sustainable food waste management at WPI. Most of the food waste is either sent to the pig farm, reused, or donated, which compromises the second and third tiers of the Food Recovery Hierarchy.



Figure 16: Waste bins located near the exit of Morgan Dining Hall, denoted by “Non-Food Waste Items” and “Food Waste Here”



Figure 17: Signage above the dish return in Morgan Dining Hall promoting proper food waste disposal

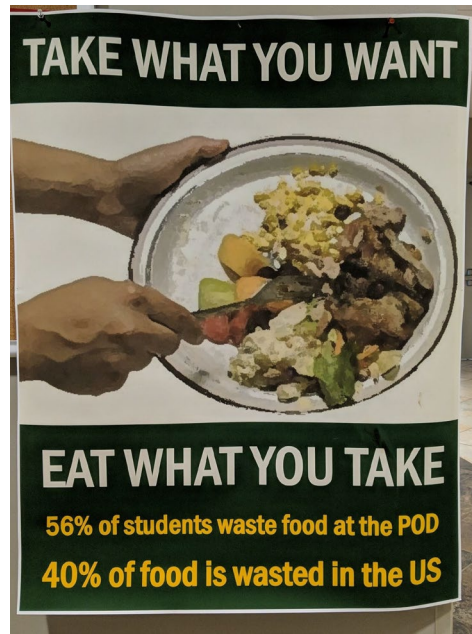


Figure 18 (Left): Another example of the signage promoting proper food waste disposal in Morgan Dining Hall near waste disposal area

4.2 Campus Center Food Waste Management System Is Underutilized

The Campus Center Food Court is the second largest dining location at WPI. The food waste management system here is less effective than in Morgan Dining Hall even though many of the same programs are present. Through a comparison with Morgan, several factors were determined which decrease the effectiveness of the system, particularly in post-consumer waste, in the Campus Center.

The Campus Center kitchen employees participate in the same Trim Trax system in Morgan described in section 4.1. However, despite being a smaller dining location, the Campus Center sees more processing and unserved food waste in the kitchen area. From September 2018 to April 22, 2019, the food waste audited by Trim Trax at the Campus Center totaled 20,968.50 lbs. Valued at \$39,629. This is slightly more than the same figures of 20,398.56 lbs. and \$38,553.28 at Morgan Dining Hall. Fortunately, all this food waste goes to the Tyde Brook Pig Farm.

Month	March			February		
Year	2019			2019		
Station	Waste (lbs.)	Waste (qts.)	Waste Cost	Waste (lbs.)	Waste (qts.)	Waste Cost
Total	5,921.76	2,847.00	\$11,192.13	3,997.76	1,922.00	\$7,555.77
DELI	854.88	411.00	\$1,615.72	440.96	212.00	\$833.41
DISH	1,187.68	571.00	\$2,244.72	752.96	362.00	\$1,423.09
KITCHEN	875.68	421.00	\$1,655.04	780.00	375.00	\$1,474.20
PIZZA	700.96	337.00	\$1,324.81	436.80	210.00	\$825.55
SALAD	1,183.52	569.00	\$2,236.85	832.00	400.00	\$1,572.48
TEX	1,119.04	538.00	\$2,114.99	755.04	363.00	\$1,427.03

Table 6: 2019 Trim Trax data, displaying March and February food waste weights and costs by location

The post-consumer food waste management at the Campus Center needs significant work. During the 8th annual Waste Audit it was found that 97.4 lbs. of food waste had been thrown in the trash of the Campus Center (Table 7) (Fig. 16). This food waste was separated from 477.2 lbs. of total trash. Therefore, 20.4% of the total trash in the Campus Center was improperly disposed food waste. On this day, the food waste was redirected to Tyde Brook Pig Farm, but normally it would be sent to Wheelabrator along with the rest of the trash. The audit was conducted on April 11, 2019 which was a normal week day with no significant events occurring in the Campus Center which might have resulted in increased food waste. Several factors were determined as the primary causes for the excessive food waste in the trash. One significant factor is the design of the food waste collection system in place.

Unsorted		Notes
Trash (lbs)	477.2	
Recycling (lbs)	62.6	
Cardboard (lbs)	51	
Total waste (lbs)	590.8	
Recycling rate	19.23%	* Includes cardboard
Sorted		
Trash (lbs)	328.8	
Recyclables (lbs)	61.8	* Includes only paper, bottles, and plastic/glass/cans
Cardboard (lbs)	51.6	
Food waste (lbs)	97.4	
Liquid waste (lbs)	49	
Paper (breakdown) (lbs)	17.2	
Bottles (breakdown) (lbs)	19.6	
Plastic/Glass/Cans (breakdown) (lbs)	25	
Total waste (lbs)	588.6	
Recycling Rate (potential) (lbs)	19.27%	* Includes cardboard

Table 7: Data from the 8th annual waste audit, conducted at the Campus Center (8th Annual Waste Audit, 2019)

The food waste collection system was implemented in 2017 following the previous IQP (Section 2.6.1). This includes four food waste bins (Fig. 20, 21) placed throughout the food court next to the trash and recycling. The food waste collected from these bins is placed in 55-gallon drums in a system like those in Morgan Dining Hall. The food waste in these drums is also picked up by the Tyde Brook pig farmer.

The food waste bins are emptied roughly twice a day, once during peak hours (12:00 P.M.-2:00 P.M.) and once during the night shift after dinner. Each bin was observed by an individual team member on April 10, 2019, from 1:00 P.M. to 3:00 P.M. Each bin sees different levels of traffic, which seems to depend on their proximity to the registers according to observations. The two bins closest to the registers (Profiles in Good Taste, Fig. 21) see the most usage with the other two seeing significantly less usage.



Figure 19: One example of food waste sorted out from the trash of the Campus Center



Figure 20: Campus Center food waste bin in the TV viewing area

Several student tendencies were revealed in the observations which could explain why the bins are underused. First, students were likely to dispose of their waste in the nearest bin to their seat, regardless of whether it had a food waste compartment. If the bin did not have a food waste compartment, any food waste would be thrown in the trash.

Students were also observed to be rushed and unwilling to spend the time to separate their waste into trash, recycling, and food waste. This could explain some findings from the waste audit,

where a high portion of the food waste encountered was inside of disposable containers. The amount of these containers was likely so high in the first place because they take precedence when food is ordered at the Campus Center; reusable plates are presented only upon request, which may contribute to their seldom use. The connection between reusable plating and food waste is further supported by the success in Morgan Dining Hall, where no disposable containers are available.

A conversation with James Bello, the day shift custodian at the Campus Center who empties the bins, also revealed that students are often not mindful of where they place their waste (James Bello, personal communication, April 10, 2019). Students often reach over from the other side of the bins to toss their trash without paying attention to where their waste goes. In fact, the custodians believe that somewhere around 50% of the items in the food waste bin are recycling or normal trash.

The layout and environment of the Campus Center may also play a role in the underutilization of the food waste bins. In Morgan Dining, students must walk past the food waste bins on their way out which makes it very likely for them to dispose of their waste (Joseph Kraskouskas, personal communication, April 8, 2019). However, in the Campus Center, the food waste bins are spread out and not as apparent to customers (Fig. 21). Customers are less likely to dispose of their food waste properly.

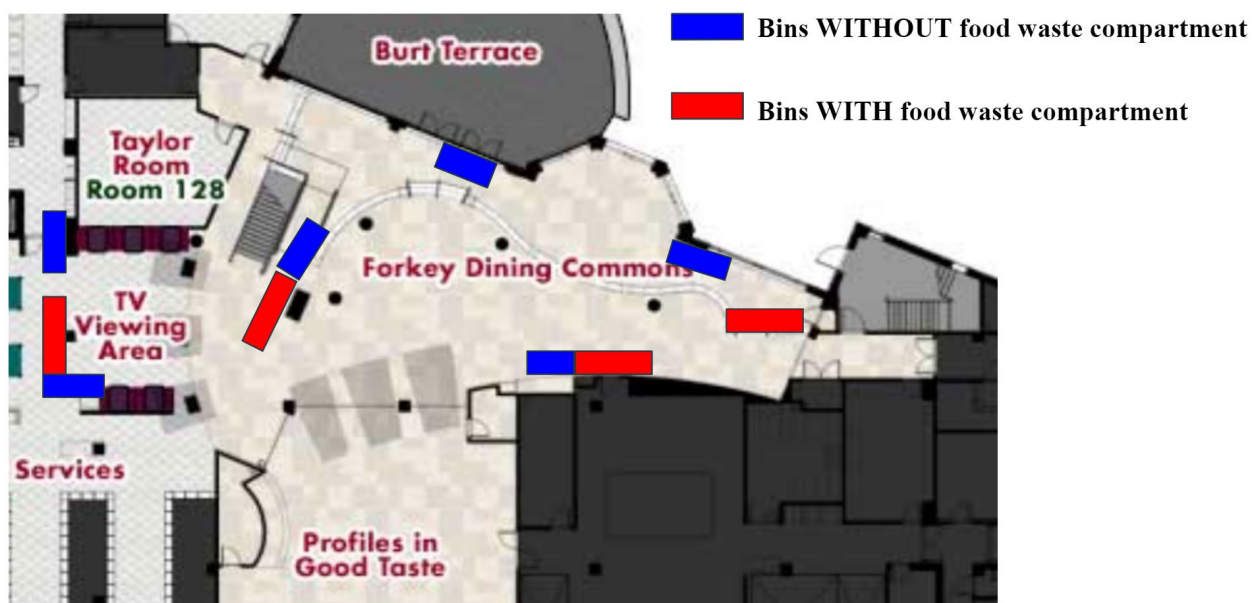


Figure 21: Campus Center floor plan and waste bin locations

From the observations gathered from the waste audit, it was noted that most of the food waste collected originated from the Chef's Table and Chick-n'-Grill brands at the Campus Center. It was also observed that the amount of food waste from the sandwich serving station, Mondo Subs was substantially less than that of Chef's Table and Chick-n'-Grill. This difference in contribution could possibly best be attributed to the portion sizing of each option given. Since Mondo Subs allows for 6- or 12-inch options for sandwiches, clients are given the potential to choose an option more

proportional to their appetites when compared to Chef's Table and Chick-n'-Grill, which serve a singular size option in disposable paper containers (Fig. 22).

All American Sub 6" <small>Ham, roast beef, & turkey with American cheese</small>	480 cal
All American Sub 12"	960 cal
Cajun Turkey Sub 6" <small>Turkey, Jack cheese, bell pepper, red onion, lettuce, tomato, & Cajun mayo</small>	425 cal
Cajun Turkey Sub 12"	850 cal
Roast Beef Sub 6" <small>Roast beef, red onion, cheese, lettuce, tomato & mayo</small>	470 cal
Roast Beef Sub 12"	960 cal
Chicken Salad Sub 6" <small>Chicken, Dijon, mayo with red onion and celery</small>	480 cal
Chicken Salad Sub 12"	960 cal

Figure 22: Mondo Subs Menu Selection Featuring Small Serving Sizes

4.3 Certain Awareness Efforts Are Often Ineffective

Low student awareness of sustainability initiatives at WPI has been a recurrent issue. There has been much done to improve awareness, but many of these efforts have been ineffective. The lack of student awareness and cooperation is not just a problem at WPI, but at both Clark University and WSU. Messages either do not get to people due to information overload, or people do not get properly engaged.

One solution that was proposed by Clark University was to get students to cooperate, but to avoid triggering, affronting, or excluding them in the process (Jenny Isler, personal communication, March 26, 2019). Ms. Isler stated that sustainability initiatives, especially food waste, needs to be an inclusive and supportive community. At Clark University, peer-to-peer and word of mouth between students, as well as students encouraging each other has been most effective towards improving awareness. Eco-reps used to create posters, but eventually stopped about four years ago. They realized that posters were completely overused and students did not pay attention to them due to information overload. Ms. Isler stated how human connection can unite people under a cause like this. This human connection was proven to be effective during Clark's annual Clean Plate Challenge, where they had student athletes cheer students at their main dining hall (Jenny Isler, personal communication, March 26, 2019).

Since 2015, waste volume has dropped significantly from the fall semesters to the spring semesters at Clark University. Jenny Isler attributes this to education of the incoming freshman in the dining halls resulting in a reduction in food waste. When freshmen first arrive, they are mostly unaware of the impacts of food waste at Clark and their food waste initiatives. However, by the end of their first semester, programs like the Clean Plate Challenge educate and motivate them to reduce

food waste. The Clean Plate Challenge incorporates students from athletics to cheer participants on and spread the message around campus. This was found to be effective due to the peer-to-peer engagement involved.

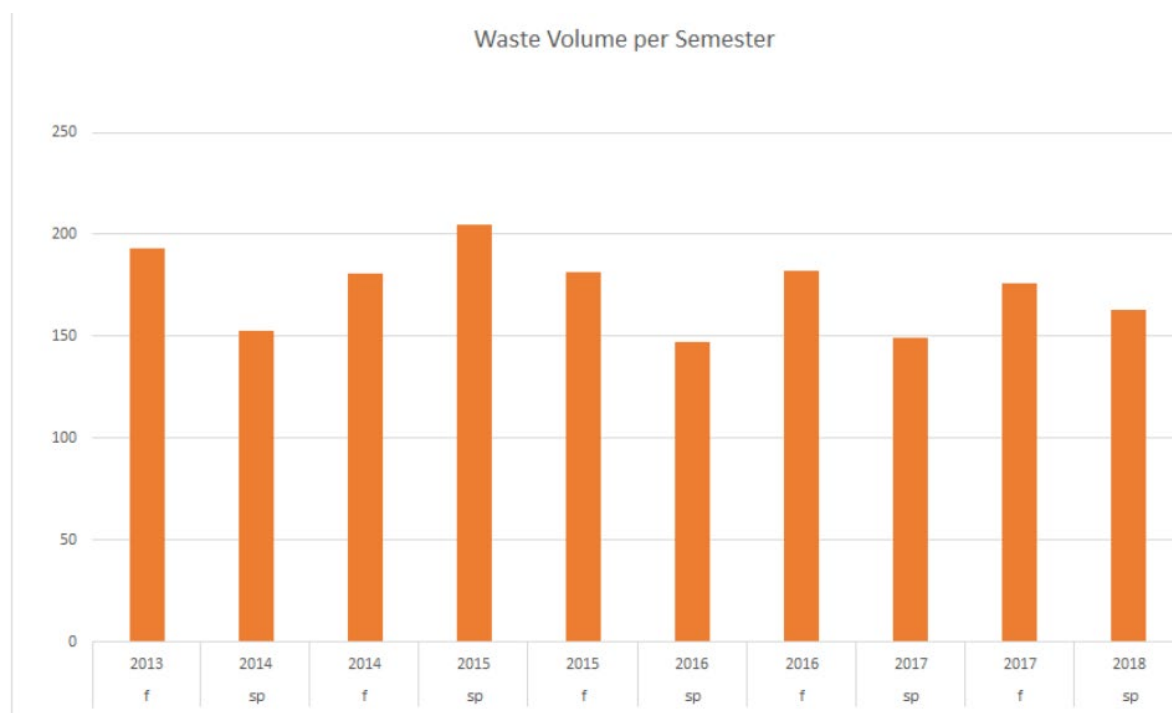


Table 8: Waste Audit data by semester at Clark University (Jenny Isler, April 5, 2019)

The lack of awareness of students at WPI was noticeable during this year's Waste Audit held by The Green Team. As spoken about in Section 4.2, about 100 lbs. of post-consumer food waste was found in one day's worth of Campus Center trash. This food waste could have been diverted to the pig farm if it was scraped or thrown into the newly added food waste compartments. According to James Bello, a day-shift custodian at the Campus Center, the food waste containers are rarely used and end up being half full with items that are not food waste (James Bello, personal communications, April 10, 2019). The custodians believe that customers are often careless and reach over the bins to place their waste without an awareness of which bin their trash ends up. This could be due to the fact that customers were never educated about the waste compartments when they were added, they do not care enough to throw their food in the compartments, or they are in a rush and throw in the bin closest to them. These behaviors were observed on April 10, 2019, when each team member watched over each waste station with food waste compartments. One observation made was that consumers would not look at the signs that were present on the trash bins. During this observation period, it was also noted that most consumers used the compartment if they had been served their food on reusable plates. Reusable plates were also noted to be successful at Morgan Dining Hall and WSU's main dining hall, where customers are made aware of food waste diversion using signs and the structured system.

Clark University is notable for its efforts to combat food waste when compared to WSU and WPI by extending its outreach in its residence halls and events. The student body is instrumental in the success of these initiatives to reduce food waste, and the use of the compost bins in residence halls is entirely up to the residents. Students and faculty also take initiative when proposing zero-waste events on campus, as the information to successfully hold these events are provided by the Clark University Office of Sustainability.

Typical awareness efforts are mostly ineffective. These include posters, Email campaigns, signage, and other common programs. Instead, peer-to-peer engagement and a more encouraging and inclusive atmosphere are most effective towards improving awareness.

4.4 Significant Gaps Exist in the Overall Post-Consumer Food Waste Management System at WPI

The only buildings which divert post-consumer food waste at WPI are the Campus Center, Morgan Dining Hall, and two fraternity houses: Lambda Chi Alpha and Sigma Phi Epsilon. Food waste is not diverted in any residence halls, academic buildings, recreational facilities, administrative buildings, etc. Therefore, all the food waste generated outside of the previously mentioned locations is incinerated with the rest of the trash from WPI. Notably, processing waste and unserved food waste are diverted at the Goat's Head through Trim Trax and sent to the pig farm, although there is no post-consumer food waste collection (Table 9).

Month	November		
Year	2019		
Station	Waste (lbs.)	Waste (qts.)	Waste Cost
Total	569.92	274.00	\$1,077.15
ACTION	120.64	58.00	\$228.01
BACK	336.96	162.00	\$636.85
GRILL	41.60	20.00	\$78.62
PIZZA	29.12	14.00	\$55.04
SALAD	41.60	20.00	\$78.62

Table 9: Trim Trax data for Goat's Head

Lambda Chi Alpha currently diverts approximately one-third of a 55-gallon drum of food waste per week; roughly 180 lbs., of post-consumer food waste per week to Tyde Brook Pig Farms

(Marc Printz, personal communication, April 24, 2019). This is produced from two meals a day served for about 55 students on the fraternity's meal plan. The food waste consists of leftover food from plates during meals, spoiled food from the fridges, and any other food waste members of the fraternity throw out. There is a 5-gallon bin inside the house where anyone is welcome to dispose of their food waste. This bin is emptied every day into the 55-gallon drum outside, which is then picked up by the pig farmer 2 to 3 times per week.

The system at Lambda Chi Alpha began in the 2016-2017 WPI academic year by Marc Printz. Printz implemented the system after learning of the pig farm system through Chartwells. Joe Kraskouskas then put him into contact with the pig farmer. Printz eventually proposed the system to the officers at Sigma Phi Epsilon, which they later implemented into their chapter. Expanding the pig farm system is a relatively simple process, according to Printz; Sigma Phi Epsilon only had to borrow a drum and educate their population on the new receptacle. These are the only two fraternities currently engaged with the pig farm system, though sororities Alpha Gamma Delta and Alpha Xi Delta have expressed interest in adopting this system.

There are eleven other fraternities and six sororities at WPI. 34% of undergraduate students join a fraternity or sorority, many of whom belong to meal plans in their houses (Office of Institutional Research, WPI, 2018). Lambda Chi Alpha produces at least 180 lbs. of food waste per week, which indicates that the rest of Greek life combined generates a considerable amount of food waste. All this food waste is sent to Wheelabrator along with the rest of the waste that is thrown in the trash (Marc Printz, personal communication, April 24, 2019).

Like most of Greek life, no residence halls officially divert any of their food waste (Elizabeth Tomaszewski, March 19, 2019). Additionally, there is very little data on the waste coming from residence halls, which makes the problem difficult to investigate. One piece of data is the 6th Annual Waste Audit, conducted in the 2016-2017 academic year. This waste audit found that 8% of the trash and recycling in Daniels Hall, a freshman residence, was food waste (Fig. 23). Unfortunately, the waste audit report does not contain data on the total weight of the waste and a few Green Team members contacted could not locate this information.

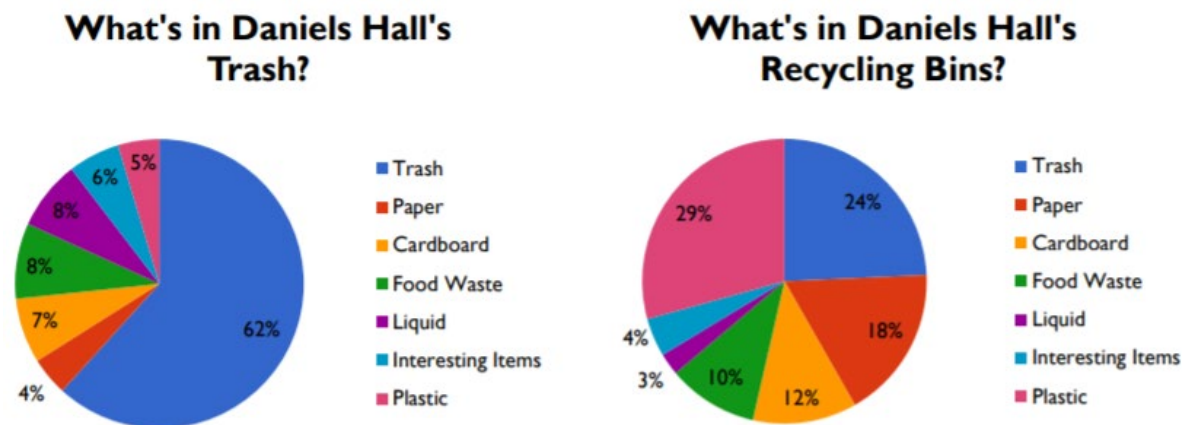


Figure 23: 6th Annual Waste Audit data (Waste Audit Report, 2016)

Daniels Hall likely produces less food waste than some other residence halls at WPI. The rooms in Daniels Hall do not have kitchens, so students cannot cook meals and are more likely to eat outside of their rooms. Other major residence halls, such as Faraday and East Halls, feature suite-style kitchens in every dorm room, which could mean they produce more food waste; more investigation is necessary.

Data are missing for the administrative, recreational, and academic buildings at WPI. While there are no specific dining locations in these buildings, food waste can still occur. For example, there are several small kitchenettes throughout WPI where faculty and staff can prepare food (Figure 24).



Figure 24: Kitchenette found on the 2nd floor of Washburn Shops

4.5 A Composting Program Should be Explored at WPI

Clark University and Worcester State University compost their food waste. Clark University features an encompassing composting system campus-wide, while Worcester State composts post-consumer food waste in their main dining hall.

WSU implements composting at their main dining hall, Sheehan Hall Pulse on Dining. While the proper disposal of food waste in WPI's Morgan Dining Hall relies on students to properly place their food waste into the designated receptacle in the hall before dropping off serving plates to the

kitchen, this entire process is delegated to Chartwells staff at WSU's Sheehan Hall. When students are finished eating, they place their dishes with any leftover food on a conveyor belt. The kitchen staff scrape the food off the plates and into a setup of a shredder and pulper; this also includes the wastewater produced from rinsing the food waste from the plates. The resulting food waste is then transferred to the garbage room, where it is run through the dehydrator. This machine heats the food waste at very high temperatures to kill bacteria and drain any moisture from the food. The resulting product looks like dirt, is dry food waste with a 90% reduced volume, and has little to no smell which makes the waste much easier to handle (Steve Bandarra, personal communication, March 27, 2019). The product is then placed into 35-gallon totes to be collected by composting facilities.



Figure 25: compostable product of the Worcester State University food dehydrator

While WSU uses a dehydrator for composting supervised by Chartwells, implementing this system at WPI may be more complicated than the current system in place. Some complications may include the funding to buy the dehydrator. If this system was to be initiated at WPI it would reduce the weight of the food waste and will not take as much space. While composting is inclusive to using paper products, they would need to be removed if the food waste would still be sent to a pig farm. The dried food waste can be composted and may have potential as animal feed (Cal Recycle, 2019).

Clark University has found success with composting in residence halls. Residence hall kitchens feature small compost, trash, and recycling bins, which are then emptied into larger bins on the floor. (Jenny Isler, personal communication, March 26, 2019). Ms. Isler spoke about how Clark implemented their composting system by having the sustainability office partner with the custodial and residence hall staff. The staff was told to include the compost bins in their biweekly checks. The bins are often empty as students either take it upon themselves to dispose of the waste properly or they do not produce waste in the kitchens. The custodial and residence hall staff first introduced the

pilot program on one floor in one building. They talked to students, responded to complaints, and asked them to be part of the solution. Later, they expanded the program to the rest of the floors, then to other buildings, and finally to all the residence halls on campus. The final elite suite hall had to earn composting by writing a proposal with a plan for implementing composting in their building. Clark University composts 100% of the food waste in their normal waste stream (Jenny Isler, personal communication, March 26, 2019). They send their food waste to an organization called WeCare Organics about a mile from Clark's campus to be composted. Therefore, Clark University has methods to avoid placing any food waste in the normal waste stream in both residence and dining halls.

While Clark University can divert a greater proportion of food waste when compared to WPI, composting food waste is less preferable than using the available resources for feeding animals, as presented by the Food Recovery Hierarchy. However, composting seems to be significantly more accessible and easier to manage on a consistent basis. While composting can accept any organic material, such as paper and biodegradable plastics, only food waste can be given to animals for consumption. The state at which the food waste is given to animals must also be considered; food in an advanced state of decomposition is not acceptable for eating and can contaminate a full supply of edible food waste.

CHAPTER 5: RECOMMENDATIONS

In this chapter, we discuss the recommendations WPI should pursue to improve the food waste management system. These recommendations are supported by our findings through research, interviews, and observations. We also provide a basis for future work that that we feel should be pursued which was outside the scope of our project.

5.1 Campus Center Improvements

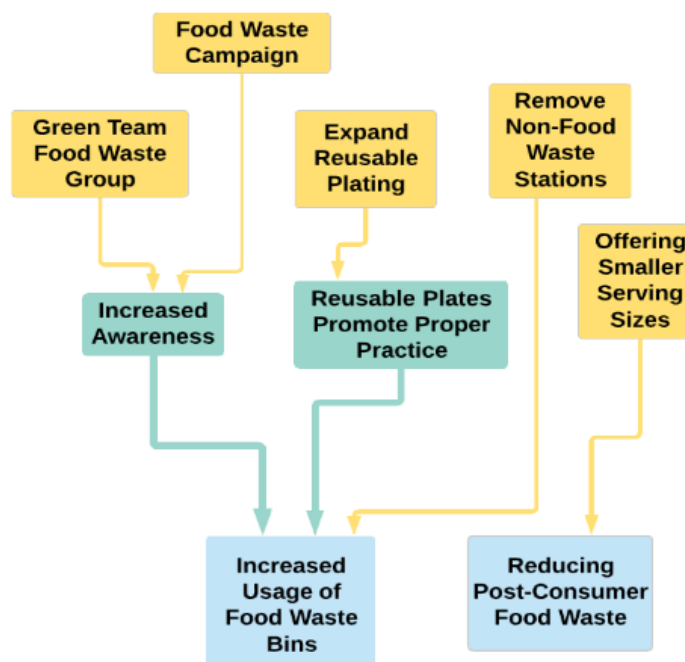


Figure 25: Campus Center Food Waste Recommendations Flowchart

The Campus Center post-consumer food waste management system was found to be underdeveloped and could benefit from a few manageable improvements. Our observations revealed an excessive amount of food waste in the Campus Center trash despite the recent introduction of food waste collection bins. Nearly three tons of food waste per month is improperly disposed of in the trash. Ideally, all the post-consumer food waste should be placed in food waste bins, collected, and sent to Tyde Brook Pig Farms. Our main recommendations are focused on improving this system and the overall food waste situation in the Campus Center.

5.1.1 Expand Reusable Plating

We found that the food waste management system at Morgan Dining Hall is the most effective on campus. We determined the most contributing factors to be the layout of the waste system, the

absence of to-go options, and the exclusive use of reusable plates. In the Campus Center, disposable packaging takes precedence over reusable plating; reusable plates are not provided unless explicitly asked for, which may contribute to the scarcity of their use. Additionally, our observations during WPI's 8th Annual Waste Audit revealed that customers often threw out their food waste in these disposable packages. At Morgan, plates are freely available to be taken at every food station. We recommend that Chartwells expands the reusable plate system in the Campus Center to be similar to the one in Morgan.

5.1.2 Improve Placement of the Waste Stations

Our observations of the food waste system in the Campus Center revealed that the layout of waste stations is non-ideal. Unlike in Morgan, where the food receptacles are localized, the receptacles in the Campus Center are dispersed. Most customers were found to dispose of their waste in the nearest waste station regardless of the presence of a food waste bin out of convenience. As a result, people tend to throw their food waste in the non-food waste stations. We recommend that the Facilities Department and Chartwells either remove the non-food waste stations, add additional food waste bins to the existing stations, or localize the food waste stations.

5.1.3 Offer Smaller Serving Sizes at Select Locations

Additional observations during the Waste Audit indicated that food from certain vendors is more frequently wasted than others. Sandwiches from Mondo Subs were found to be less frequently wasted than food from locations including Chick-n-Grill and the Chef's Table. Mondo Subs offer customers the choice between 6-inch and 12-inch sandwiches. Meanwhile, Chick-n-Grill and the Chef's Table offer only one large size. We recommend that all vendors in the Campus Center offer portion sizes more accurately sized to their customers appetites.

5.1.4 Improve Awareness of Food Waste Bins

Despite the presence of food waste collection bins equipped with instructional signs, students continue to throw their food waste, totaling nearly 100 lbs. in one day, into the trash (8th Waste Audit, 2019). According to James Bello, a custodian at the Campus Center, the contents of the food waste bins are nearly 50% trash. Poor awareness of proper food waste disposal was apparent during our observations of the Campus Center. Mr. Bello also cited a lack of awareness among students for the misuse of the food waste bins. We recommend that a food waste campaign be created to increase awareness and promote proper use of the Campus Center food waste bins.

The Green Team is a student organization at WPI which focuses on sustainability issues. According to the Green Team president Claire Barrameda, they aim to create a food waste division within the Green Team (Barrameda, personal communication, March 29, 2019). This team of students could raise awareness among first-year students at the Activities Fair held at WPI which advertises all the clubs on campus. They could also communicate with New Student Orientation (NSO) to promote the use of the food waste bins and other food waste initiatives to first year students. The food

waste division of the Green Team would also wear shirts to promote the use of the food waste bins. An example of a possible design for the shirts is shown in Figure 23. The shirts give the movement a sense of identity and can foster the Green Team as role models for food waste diversion among other sustainability efforts. Another way to increase awareness is by performing table sittings in or near the Campus Center, which would promote using the food waste bins. The table sittings could also inquire students about their views on food waste diversion through surveys or offer incentives to promote sustainability and their mission to reduce food waste beginning at the Campus Center. The food waste division can also reach out to the Facilities Department and Chartwells to setup signs near the bins and try advertising the food waste bins through word of mouth.



Figure 26: Example of a T-shirt promoting awareness of food waste disposal

CHAPTER 6: CONCLUSIONS

The Campus Center post-consumer food waste management system was found to be underdeveloped and could benefit from a few manageable improvements. We recommended a number of solutions for this area. We recommend that the reusable plating system be expanded, that smaller serving sizes be offered, the bins placement be improved, and that a food waste awareness campaign be developed.

Our findings indicated the most significant gaps in the post-consumer food waste management system to be present in residence halls, fraternities, and sororities. Not only that, but there is a severe lack of data about the food waste situation in residence halls. Three promising solutions which were explored during this IQP could help rectify these situations if pursued further: City Compost, expansion of Marc Printz's food waste system, and RecyclingWorks. Other small solutions were also explored.

6.2.1 City Compost

Adam Jankauskas, Co-Founder of City Compost, stated in a phone interview that his organization could conduct a waste audit for various residence halls and perhaps even Greek life housing to assess costs of the program. Once this was done, a custom solution would be developed to implement a pilot food waste collection system in one residence hall. This solution would be student-run at a cost of 25 to 50 cents per student per week (Appendix I: Adam Jankauskas, Appendix II). With a capacity of ~220 students, Daniels Hall could be run at a cost of \$60-120 per week. City Compost may also willing to facilitate the expansion of the Tyde Brook Pig Farm system to residence halls.

Composting is also a more accessible option for some locations where food waste makes up a smaller proportion of the trash. In Daniels Hall, only 8% of the trash was food waste (6th Annual Waste Audit, 2016). Composting can accept any organic material, such as paper and biodegradable plastics, while food waste can only be given to animals for consumption. The state at which the food waste is given to animals must also be considered; food in an advanced state of decomposition is not acceptable for eating and can contaminate a full supply of edible food waste.

We recommend that a partnership with City Compost should be explored further. Mr. Jankauskas said that the Green Team would be an ideal partner as they have experience implementing programs on campus and City Compost has worked with students in the past.

6.2.2 Expansion of Pig Farm System to Greek Life

Current food waste management is inadequate at most fraternities and sororities at WPI. With the exceptions of two fraternities, all Greek life housing post-consumer food waste is incinerated via Waste Management. At Lambda Chi Alpha (LCA), 180 lbs. of post-consumer food waste per week are diverted to Tyde Brook Pig Farm as part of a system facilitated by Marc Printz. Implementation

of this system at other fraternities and sororities is a simple process at a cost of only \$20 to \$40 and has already occurred at Sigma Phi Epsilon. Printz has developed a document to facilitate expansion into other Greek life (Appendix III).

We recommend that this system be expanded to more fraternities and sororities. The pig farmer picks up barrels from LCA and Sigma Epsilon two times per week. The timings are currently coordinated by Marc Printz and a “Pig Chair” position at Sigma Phi Epsilon. If the system were expanded, it would be necessary for an individual in the Facilities Department or elsewhere to be placed in charge of coordinating and scheduling with the pig farmer and to oversee the expansion.

6.2.3 RecyclingWorks

After reaching out to RecyclingWorks MA, we recommend a future team work with them to evaluate and improve WPI’s food waste management system. RecyclingWorks in Massachusetts is a recycling assistance program designed to help businesses and institutions maximize recycling, reuse, and composting opportunities. Their website contains plenty of useful information which we cited throughout this IQP, including case studies of other food waste management systems, food donation guidance, and more.

RecyclingWorks has worked with WPI in the past, providing technical assistance focused on addressing the recycling program. There is currently a serious food waste issue at WPI that needs to be addressed, as well as a need for a more encompassing collection system for post-consumer food waste. They can provide options for organic haulers who collect the food waste to bring to an offsite composting facility. Some universities have even considered an on-site anaerobic digester.

The most attractive offer is that RecyclingWorks can provide no-cost technical assistance to help businesses and institutions maximize recycling, reuse, and food waste diversion opportunities. They can help WPI the following:

- Evaluate existing waste streams
- Identify opportunities to prevent, recover, and divert waste
- Provide employee education and training.
- Create customized waste bin signage
- Conduct a cost analysis for starting or expanding a waste diversion program
- Connect with waste haulers and processors of recyclables and organics

Unfortunately, the process of working with RecyclingWorks would take longer than the timeframe of this IQP. However, they are an excellent resource, and have been praised and recommended not only by various case studies online, but also by WSU’s Sustainability Coordinator Steve Bandarra who we asked in a personal interview ourselves (Steve Bandarra, personal communication, April 28, 2019). This is an avenue we highly recommend looking into in the future.

6.2.4 Other Recommendations

Taste samples could further reduce Morgan Dining Hall food waste. Having taste samples will enable students to taste foods that look delicious before they eat. Once they taste the food, they can determine the amount of food they want and decide whether they will completely eat it. The taste sampling can utilize small dishes already located at Morgan Dining Hall. This idea also received positive feedback from Joe Kraskouskas, who was receptive to the idea (Joe Kraskouskas, personal communication, April 8, 2019).

Lastly, we recommend that more research be done on the food waste management employed by Dunkin' Donuts at WPI. According to several informal conversations with stakeholders, Dunkin' Donuts at WPI does very little to divert their food waste from the waste stream. This could be an area of research and investigation which yields good results but could be a big task which our IQP did not have enough time to explore.

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Appendices

Appendix I: Interview Summaries

Jenny Isler: Director of Sustainability- Clark University

Participants: Augustus Moseley, Jenny Penaloza, Junaid Rathore, Steven Trvalik

Location: Clark University Office of Sustainability

Date: 03/26/2019, 3:30 P.M.

Intention for Interviewing: Explore the role of sustainability in food waste at a university that has a similar location and student population to WPI, as well as exploring the initiatives and actions taken to reduce food waste that may be comparable to those made at WPI.

Q: Are there any statistics available for how much food is wasted at Clark University?

A: Ms. Isler stated she would send an email later with this information.

Q: Are there any steps being taken to reduce food waste at Clark that we should know about?

A: Back-of-house food waste reduction can be impacted greatly with behavior change strategies:

1. They are reusing their potato peels, carrot peels, chicken skin, bones, etc. (defined as incidental food waste by Ms. Isler) to make lunch for the next day, such as soups, stocks, sauces, and gravies by boiling them down. This reduces the weight and size because it is boiling out the moisture and flavoring and is simultaneously used to feed people, which is at the top of the EPA food waste hierarchy
2. Knife skill training for the kitchen staff ensures efficiency in material usage, minimization of skins or rinds wasted, and better overall practice. They take pride in the way they process food. They have been given the knife skills, they are being watched and are rewarded for their minimal wastage by peers.
3. The Leanpath system enabled their kitchen to cut food waste by 63% in the first year and about 20% to 30% every year thereafter. After the cooks prepare the ingredients, they take the waste to their supervisor and weigh how many pounds are being wasted in preparations. This leads to friendly competition among cooks and kitchen staff to reduce the amount of food wasted in prep. It also sparks creative ideas for new ways to reduce food waste. For example, some knives bruise the outside leaves of lettuce, so they use different knives. Previous wheels of mozzarella cheese they would purchase ended up having edges that were wasted, so they changed which form they purchased.
4. Human monitoring is the key. They [kitchen staff] keep an eye on the compost based on what is being sent back to the kitchen. One example was when a staff member noticed a lot

of the baked potatoes being wasted. They were delicious and looked good served whole, but they realized the potatoes were too big. They could be up to 2 serving sizes for some people, so the cooks cut the potatoes into fourths before serving them. Another example is pizza, where a lot of pizza crust was being thrown away, so they now offer crustless pizza.

5. Ms. Isler is quite certain that the efforts of the kitchen staff to keep track and make these adjustments are sparked by her intervention; it's a cooperation, a partnership. These partnerships are a strength because you can use their resources and manpower and avoid having to create a whole new system from scratch.

Front of house food waste can be reduced through systematic changes:

6. One main principle is doing just as most moms do at home: wrapping up leftovers and saving them in the fridge.
7. They take leftovers and they reuse them for future meals. For example, if they have fried chicken thighs, tomorrow they will make chicken stew, if this does not get eaten then they will make chicken soup. Their menus are not preset, so it is easier to change the meals. For salads, they recover the lettuce and pick it out for seven days.
8. For freshmen's first semester, audits show high numbers of food wasted. As the year goes on, the numbers begin to decrease as students learn to waste less and begin to settle in to the Clark system.
9. Clean Plate Challenge: This was effective, but the program was run by the athletes for a single year. This seemed to engage the student more, with motivation and cheering from the athletes. Athletes communicated with fellow students to stop wasting food. This was coming from people who are usually well known for eating right, and for eating a lot, so athletes pose as great role models. Don't treat this as a shaming exercise but encouraging students and cheering them on is a great way to build on a community's values.
10. Partnership with Rachel's Table to donate approximately 1200 lbs./yr.; staff consists of older employees which take unused food from single walk in refrigerator (packaged food, sandwiches, dairy). Rachel's Table does not allow open air or heated food; the food must remain in packaging but can be used before donation.

Q: The AASHE STARS program states that Clark donated or re-sold 12 tons of materials in 2017. WPI donated or re-sold only 3 tons. What does that 12-ton figure constitute? How much of those materials was food? What programs and partnerships were used to donate these materials/foods?

A: This is for clothes donation, typically left from students upon graduation (Clark community thrift store.) In the residence halls, they take collections and donations. Once students graduate, they leave things behind.

Q: How are food audits conducted?

A: Waste audits are conducted bi-annually to notice what the change is within the year. Food waste is separated into food waste that is considered incidental and the food waste that people took and did not eat. They weigh this separately, since the incidental food waste is deemed to be an inevitability.

Q: Based on a look at your sustainability page, it seems that composting is your main destination for food waste. Is this true? Are there any other destinations for your food waste such as landfills, and how much of the food waste from Clark ends up there?

A: 1,200 lbs. a year (all the food waste they have left to donate) is sent to Rachel's Table. This includes all packaged, unheated, unopened food (yogurt, dairy, expired food). Everything that is opened or prepared (heated, cooked), is either eaten or composted.

Q: Composting seems to work well on your campus, could you give us some detail about how your composting system works?

A: First, a pilot program was held in one kitchen in one hall. Then it was moved into the other floors in that hall. They changed some issues they had, and they continued the program. They partnered with the custodial and the residence hall staff. They trained the custodians and moved into other upperclassmen halls. The last elite suite hall had to earn compost by writing a proposal with a plan for the composting. Residence hall kitchens feature small compost, trash, and recycle bins which are emptied into larger bins in the hallway when they are filled. The crew works to empty dorm kitchen bins throughout campus twice a week; staff occasionally found bins empty because some take it upon themselves to dispose waste properly. It is great to know people are out there who will take initiative. The commercial compost facility partnered with Clark University, WeCare Organics, allows certain amount of plastic in compost.

Q: Were there issues with the composting system (smell, space, and insects) or extra maintenance costs to deal with such as hiring maintenance?

A: "Bugs are bugs. There are bugs everywhere...there are bugs on your eyelashes." The composting systems in the residence halls have gotten zero complaints about bugs. However, there were a couple of complaints of smell in the 36 compost infrastructures. If there were serious issues, the program was pulled back and given time to be sorted out. When people complained, they were talked to directly and had their problems addressed to be part of the solution. Additional maintenance staff was not needed; they each had overlapping individual jobs to take care of. The only additional bins that were provided were for holding compost. Sometimes the resident assistants or the students took the initiative to empty the composting bins. The cost of the composting was covered fully by the student sustainability fund, which stems from student fees. A rough estimate was about \$3 per student out of the tuition. The budget allowed about \$20,000 to work with a year.

Q: Are Zero Waste Events successful? Students might take the initiative in stride, but are guests willing to bring their own utensils, etc.?

A: Students bring their own utensils or use shareware that can be loaned out at no charge on campus. Each club can decide whether they want an event to be a zero-waste event. If students are using paper plates, they are recyclable, and plastic utensils are recyclable. If you don't have Styrofoam cups and plates, you can do a zero-waste event because nothing will go in the landfill. Most catered events are zero-waste because Sodexo buys all compostable plastic utensils and cups and reuses the china and silverware. Spree-day, commencement, or orientation are pre-screened before the event. On Spree-day, the food vendors are told they can come if everything they provide can be composted or recycled. At conferences Ms. Isler used to attend about 20 years ago at Slow Food, people would bring their own plates and mugs, which turned into people showing off their china and cool mugs. It was like show-and-tell. They began to bring their own plates to "show off" the designs their plates have, but silverware was not often brought, likely because there is no reason to show people silverware.

Q: How effective are labeling and signs on disposal bins? Do they spread awareness or does that initiative need to be instilled in students another way?

A: It does not seem to help much more than it already has. Peer-to-peer pressure and word of mouth is very important. Awareness seems to already be there, so now the question is how to inspire action among the people. Getting people to care about the issues can be accomplished through peer-to-peer engagement, such as friends who eat together and encourage each other to waste less, and peer-to-peer in the sense of following someone you admire. Love and admiration are great motivators.

Q: Are there food waste awareness programs at Clark? Do they show success?

A: The athletics team at Clark University oversaw scraping off food from plates during the Clean Plate Challenge. This was successful because it motivated the students to leave a clean plate, and they got a sticker if they returned a clean plate. The athletics students also cheered for students and rang a bell for students who succeeded. This also encouraged peer-to-peer pressure, giving each other advice on not taking a lot of food at once.

Q: Have students been cooperative with sustainability initiatives? Are there any tips and tricks for getting students to cooperate?

A: To try and get students to cooperate, do not to trigger, affront, or exclude them in the process. You recognize there are people out there with serious food issues. It is a sensitive issue and should be handled with care. It must be a place that welcomes, not scolds. The slogan Clark has adopted, approved through Student Leadership and Programming, is "Take what you want, eat what you take". Ms. Isler stated: "If your food insecurity issue is such that you need to load your plate up, then by all means, take what you want, eat what you take."

Q: Has anything been done to improve student awareness of food waste? What has been most successful?

A: The eco-reps used to create posters, and cycled through themes around water, energy, food, transportation, etc. It was unsure if this would engage students and motivate them to act. They stopped doing this about four years ago. Nobody was doing more than looking at the poster, or very few people were convinced to change their habits, so the eco-reps stopped doing the posters. It is peer-to-peer and word of mouth between people you care about which can move people. There is a flood of information out there, both false and true. Even social media is a never-ending stream of information. People know or will know about the problems of the world one way or another, but it is how to get people to act that is the key. They had incentives, like the sticker, but they were also motivated by cheering. It is human connection which can unite people under a cause like this. Food waste is a monster to tackle, but it can be done through working together as people and cooperating with other organizations.

Steve Bandarra: Sustainability Coordinator, Worcester State University

Participants: Augustus Moseley, Jenny Penaloza, Junaid Rathore

Location: Worcester State University Sustainability Office

Date: 03/29/2019, 1:40 P.M.

Intention for Interviewing: Explore the role of sustainability in food waste at a university that has a similar location and student population to WPI, as well as exploring the initiatives and actions taken to reduce food waste that may be comparable to those made at WPI.

Q: WSU seems to have a great system for food waste. Are you working on any new programs or future initiatives?

A: The Sustainability Office is working on composting for the WSU community garden, while also considering the Wellness Center as another possible option. Lower campus retailers do not have compost options and may be a potential target in the future. School-wide farm shares could also be expanded, which involves giving local farmers on community supported agriculture (CSA) farms funds for supplies, which then allows a monthly selection of produce over the summer. For example, a local CSA provides 22 weeks of food for \$365; the Sustainability Office is considering purchasing 10 shares for the WSU campus.

Q: In your opinion, are there things WPI does well, or things WPI could stand to improve on regarding food waste?

A: WPI has the contract with the pig farmer. That system was found too unreliable for WSU, since a reliable schedule could not be made to collect food waste. That is why the program was switched to composting.

Q: How did your changes to WSU's food waste system line up with the Massachusetts law changes regarding the Food Waste Ban?

A: WSU does not produce enough that would have made them to trigger the ban. They began these initiatives before the 2014 ban based on the interests of the Sustainability Center.

Q: Have the programs at WSU been successful? Should other schools take after this system or are there better systems to strive towards?

A: The system has been successful. There have been some issues with getting Chartwells to cooperate with the use of the dehydrator. At times it will stop working, but Mr. Bandarra stated that he usually will not hear about it until he checks himself. It seems like Chartwells staff only do what is in their job description.

Q: How would you rate your experience with RecycleWorks MA? Have they done a lot to help with the transition? Would you recommend WPI work with them as well?

A: It is beneficial and fantastic to work with them; they came in and calculated and assessed everything first. Then they helped organize the way they would set the program. They help with

signage, calculations, ideas, and finding vendors. Partnership is integral to help engage these programs.

Q: We are impressed by the dehydrator, composting, and Freight Farms. Are there any other food waste reduction efforts at WSU you can tell us about?

A: There are not many new initiatives, probably because of low student participation.

Q: Has Chartwells been cooperative with the changes?

A: They were cooperative with implementation, but the system is not perfect.

Q: What are ways to begin a program for food waste that could be successful?

A: Start small and let it succeed and go well, instead of starting big and having it tumble down. They put liners on the barrels, when the truck dumped the compost the liner would fall out. They would put elastic on the plastic bag as people dumped the bags were falling in. Then, WSU coordinated with the truck drivers to remove the elastics. The drivers would drop food once the bags stick to the barrels on the floors and would not clean up. Communicating with dish workers what was compostable and what was not was difficult at first. Most workers English was their second language so visual posters were provided.

Q: Does a dehydrator make the process of composting/disposal easier?

A: It compresses all the water out and it reduces the volume of the waste by 90%. It also eliminates the bad odor. It makes it easier to handle.

Q: Is a dehydrator feasible for other schools, like WPI? What are its specifications?

A: It is. The machine is not too costly, and setup is done by the proprietary company. The use of the machine is very simple and easy to learn, and not too time consuming. There are also haulers that will take the organic waste produced. The dehydrator requires 220-240 watts to operate and a place to drain the water from dehydration process. WSU could be more sustainable if a use was found for the wastewater, but it is currently drained through a floor drain.

Q: Does Chartwells make decisions regarding the Freight Farm?

A: It does; it is a Chartwells program. They have about two people in charge of the farm.

Q: What was required to start the Freight Farm? What were some initial costs and challenges?

A: There needed to be a tar top and some diversion of power and water from a main building nearby. Besides the construction, the freight was put on and the lines were hooked up. The rest was not too difficult.

Q: Would A Freight Farm be feasible for WPI? Is there a way we could gauge this?

A: It is very feasible. Even people in busy cities can grow lettuce in a freight. If there is a place near a building for a freight, like the ones 18-wheelers carry, then there is room for a freight farm.

Q: The Freight Farm seems successful, though the information about it online is limited; what benefits has it brought to the food waste situation?

A: Having homegrown lettuce reduces purchasing costs and transportation resources wasted; the WSU Freight Farm unit produces about a one-acre equivalent of lettuce when compared to a conventional farm. The system is hydroponic, sending nutrients through water that drips down from each fixture to a catch basin for reuse. Approximately 25% of the lettuce crop is harvested at a time, and each full rotation takes about four weeks to complete.

Q: Have students been cooperative with food waste reduction on the front-of-house end?

A: They are not entirely responsible for it, since they simply put the plates of food including waste on a conveyor belt. This brings the plates to the kitchen where the kitchen staff take care of the food waste. Only the main dining hall has the composting and the food waste initiatives. The other coffee shops and places around WSU do their own thing.

Q: Has there been a noticeable shift in attitude since you began these initiatives?

A: No, since it does not touch on students. The Sustainability Office does not ask them to do anything. Their plates go on to the dishwasher, so the workers sort the food out. They have done the Project Clean Plate so once they see it, the food waste goes down.

Q: Low turn-out to sustainability events seems to be a common issue at other universities. Is the situation similar here?

A: This is happening everywhere. The message is not getting to people, part of the problem is that people in Washington actively work against the environment. There is so much misinformation. Everybody knows about it, people just need to care, and be willing to do something about it.

Q: Are there any tips for increasing awareness and cooperation with sustainability efforts?

A: Making people feel comfortable and invited. Having a good atmosphere and making sustainability accessible can help spread the message to people's personal lives.

Claire Barrameda: WPI Green Team President

Participants: Augustus Moseley, Jenny Penaloza, Junaid Rathore, Steven Trvalik

Location: WPI, Gordon Library

Date: 03/31/2019, 2:00 P.M.

Intention for interviewing: Attain insight on how the student-run Green Team brings about sustainability initiatives throughout WPI campus, in addition to the possible actions the Green Team have taken to try and reduce food waste.

Q: Can you give us a brief summary/mission statement of what the purpose or goal of the Green Team here at WPI is?

A: The Green Teams wants to focus on showing people the little things, that even one plastic bag people throw away is a problem.

Q: What is the process of implementing a program on campus? Who do you have to go through? Does Ms. Tomaszewski help?

A: Many of the changes regarding sustainability involve contacting higher authority for student involvement (top-down), which is more difficult than conventional student outreach methods (bottom-up); most success in these endeavors is through contacting Tomaszewski.

Q: Is there any possibility of the Green Team expanding to increase involvement in more programs?

A: The Green Team tried getting Chartwells to change things like getting rid of plastic bags and plastic utensils. In addition, they are trying to introduce food samples in attempt to reduce food waste on the Chartwells side.

Q: How receptive have organizations and individuals been to collaborating with the Green Team?

A: The Green Team has tried to reach out to other organizations, but they are usually unsure of how to proceed, or if they want to do participate in a sustainability event.

Q: What solutions for food waste reduction have worked best for you in the past? Are there any themes in what works best here at WPI? Any tips for making a successful food waste program?

A: Even with some of the behaviors the Green Team have asked Chartwells to stop, such as putting plastic bags up front or leaving plastic utensils for last resort use and having people use silverware. They just revert to their old ways after a few weeks and make an excuse such as not being able to keep up with the dishes.

Q: What is your opinion of whether Project Clean Plate was successful?

A: It was not well managed or advertised. It does not seem to get much attention, possibly due to the award. There is also very little advertisement about wanting people to not waste food.

Q: How do you recommend we collect data on food waste here at WPI? Specifically, in the dorm rooms/Dunkin' Donuts/other non-Chartwells areas?

A: The group would need to talk to the Facilities Department. Possibly the most significant data can be derived by conducting an independent waste audit for areas outside the Campus Center.

Q: Are there any ideas you are considering in the future?

A: Green Revolving Fund, besides the club funds, could help jumpstart initiatives. The Office of Sustainability needs to be more organized; even the adults such as Liz and Matt (Facilities) do not get along. There needs to be a more focused directive. IQP teams could communicate and finish each other's projects, or even work together. Global labs in Foisie. People want to set up tables where they can talk about ongoing sustainability projects. Reducing the serving sizes in Campus Center could help, such as the large burritos. Move inventory around stores in Campus Center to dissuade people from taking certain items unless requested, such as plastic bags or utensils near the dining area.

Q: Is there anything you think we should have asked you that we did not? Are there any resources you think would be useful for our project?

A: Disassociation with the problems. For example, going on IQP you try to solve problems halfway across the world, but they go home and think that it is their problem. But it is their problem as well. Don't guilt people or they will disassociate even more. Can't be too hard on yourself. Allow for exceptions, in the means of improvement. Sustainability is a mess, and a lot of people going at it from different angles, there are so many IQPs, but there is no coordination to make changes. People push the problem away, there are many atrocities hidden in the current system, but people find the system convenient and are complacent so they just focus on what's in front of them, which might look good. The process and the system. Big companies tell people to go green, but there are people who would try making small changes if taught how. Teach how to do small changes. Most importantly, do not lose hope due to imperfection. Just because not everyone is doing it, do not think there is no hope. Even small change matters like on the individual level. There is some psychology research that will be sent over. These are helpful to understand how to get people to care about food waste, and how to persuade people.

Joseph Kraskouskas: Head of Chartwells Dining Services

Participants: Augustus Moseley, Junaid Rathore, Steven Trvalik

Location: WPI Campus Center

Date: 04/08/2019, 1:00 P.M.

Intention for interviewing: Gather information regarding Chartwells' relations with the Food Recovery Network, Trim Trax, separate food service companies on campus (Dunkin' Donuts, Auntie Anne's, Planet Smoothie), and the Tyde Brook pig farm.

Q: Do you know how much total food waste there is at WPI?

A: Mr. Kraskouskas said that he doesn't know about total figures, although he referenced the 400 lbs. at Morgan/ 100 lbs. At the Campus Center/ 50 lbs. At the Goat's Head that is sent to the pig farm, further reinforcing this information originally acquired from Ms. Tomaszewski.

Q: Where is the Food Waste sent? Incinerators? Landfills? Holden Pig Farms? Can we determine the percentages of where food waste is sent?

A: Most of the food from Morgan Dining Hall is sent to the pig farm. He is very confident in the effectiveness of the solution in Morgan. Absolute statistics for the true proportion of food diversion location are currently unknown.

Q: At Clark University, Jenny Isler said that Sodexo's Leanpath, which is like Trim Trax, has resulted in a 63% reduction in food waste in the kitchen. Has Trim Trax seen similar results? Do you have any statistics on Trim Trax?

A: Mr. Kraskouskas referred us to Charles Hill. Charles gave us a tour of the entire Morgan kitchen and supplied us with statistics on the Trim Trax system. Mr. Kraskouskas was very surprised at the 63% figure supplied by Jenny, prompting the group to contact Jenny about the Leanpath program.

Q: Could you elaborate on Chartwells' relationship with Mondo Subs/Auntie Anne's/other chains on campus? Do you have jurisdiction over their kitchen procedures and menus?

A: There is control over all the menus on campus other than a select few. For example, Mondo's is entirely a Chartwells brand, so they have control over the subs/sandwiches there. Chartwells does not have control over Auntie Anne's, Planet Smoothie, and Chick-n-Grill other than the preliminary menus that were mandated to exclude allergen-prone nuts. These locations are either chains or brands so Chartwells must go to the owners before they can change the menus. When Planet Smoothie first came to Campus, Chartwells vetted the menus to remove peanut butter from anything on the menu. Joe took down our idea of offering smaller sizes for burritos at Chick-n-Grill and told us he would contact the parent company.

Q: What are the benefits of wasting less food from your perspective as the director of dining services?

A: The main benefit of wasting less food from Chartwells perspective is that this means students

serve themselves less food, so their costs go down. He was not entirely sure if this would reduce WPI student meal plans, but he did say that it could increase WPI profits from meal plans as Chartwells' costs would go down.

Q: When was trayless dining implemented? Who was responsible for this idea?

A: Mr. Kraskouskas later responded in an Email that it was started in 2006, but he was not sure who was initially responsible.

Q: Could you elaborate on the process of getting a new program implemented in WPI dining halls? Are student ideas welcome?

A: Students (such as members from the Green Team) often come to him with ideas and are more than welcome. One idea that they have been thinking of is making a food waste and plate collection area in the Campus Center just like in Morgan. This would reduce waste and improve the efficiency of the system. However, space concerns in the Campus Center may make this program implausible.

Q: Could you elaborate on how Chartwells reuses food for the next day of meals?

A: Only certain food is suitable for reuse the next day. It is Chartwells personal rule was that food can be reheated once. After this point, the food is either thrown out or donated through the Food Recovery Network. Chartwells uses blast chillers, which rapidly chill food for reuse, at both the Campus Center and at Morgan Dining Hall.

Q: What are your thoughts about letting people take leftover food home in a reusable container?

A: Chartwells is going to start a program in the coming years where students can meal swipe and then have 15 minutes to fill up a container of food from Morgan Dining Hall. He said that this program would mostly be implemented to free up space in the dining hall because an extra 585 students per class are planned in the next 6 years.

Q: What are your thoughts on using people to serve students? Could this reduce serving sizes in a buffet style setting?

A: Chartwells had used servers in the past but when they removed them, they saw food waste go down. He believes that students can serve themselves more accurately than staff could.

Q: What are your thoughts on offering taste samples?

A: Mr. Kraskouskas was very open to the idea of offering taste samples. He was unsure of how exactly they could implement it. We discussed using the small plates in Morgan for students to use for taste sampling.

Q: Can you tell us about your partnership with the Food Recovery Network?

A: Mr. Kraskouskas was not too sure about the Food Recovery Network. He referred us to a chef in Morgan Dining.

Q: What is the feasibility of a dehydrator (like WSU's) at WPI?

A: Mr. Kraskouskas was familiar with the dehydrator at WSU. He said that the program would not make much sense here as we send our food waste to the pig farm, and that WPI does not have an existing compost system.

Q: Is there anything you think we should have asked you that we did not? Do you have any more advice for how we can reduce food waste?

A: Mr. Kraskouskas referred us to multiple people to help with the project. He said we should talk to Bill Spratt, of the Facilities Department, about the food waste collection operation. He also set up a tour of the Morgan Kitchen with Charles Hill. Other useful sources he referred to include the custodians in the Campus Center, Michael Rena, coordinator of the Campus Center food court, and Nikki, a chef at Morgan who could give us more information on the Food Recovery Network. Joe said food waste initiatives cannot be done too often or else students get burned out and start to feel ashamed of their food waste. The food ordering software that Chartwells uses often leads to food waste because it does not combine like items. For example, diced onions and sautéed onions are treated as different materials which leads to excessive onion ordering. The Office of Multicultural Affairs also receives food that has been put on the line. Although the Food Finder email alias is no longer in use, students descend upon catering locations and little of the food from those locations is wasted. Chartwells uses Rachel's Table when they do not have the Food Recovery Network to donate their food. Rachel's table will send their own vehicles to pick up food waste. Finally, there is an idea to turn Salisbury Estates into a "Whole-Foods-esque" food court because the university will be expanded soon.

James Bello: Campus Center Custodian

Participants: Junaid Rathore, Steven Trvalik

Location: WPI Campus Center

Date: 04/10/2019, 3:00 P.M.

Intention for interviewing: Gauge student usage of waste bins, particularly in reference to the newly featured food waste bins in the Campus Center.

James is a custodian working the day shift at the Campus Center food court. He personally empties the food waste collection bins every day.

Q: In your estimation, how much are the food waste bins in the Campus Center used?

A: Mr. Bello told us that most of the food waste bins are rarely used at all. He said that the one closest to the registers is about half full (the containers are roughly 3 gallons each) when he empties it around 3:00 P.M. each day. Meanwhile the others are used much less. He is not the night shift custodian, but he said that the bins are emptied once more later at night by the other custodians.

Q: How well do you think students utilize the bins?

A: Mr. Bello said that the students are often unaware of where they are putting their food waste. He said that for the waste bin near the stairs, people often reach over it from the other side and pay no attention to which bin their waste goes into. He commonly finds non-food waste items in the bins.

Q: Do you have any specific figures on how much food waste is emptied from the bins per day? Are the bins audited at all?

A: Mr. Bello replied that there is no weighing or auditing done, but that in his opinion the bins are used much less than possible.

Adam Jankauskas: Co-Founder, City Compost

Participants: Augustus Moseley, Junaid Rathore, Steven Trvalik

Location: Phone interview

Date: 04/24/2019, 3:15 P.M.

Intention for interviewing: Assess the viability of introducing a composting system to WPI residence halls; estimate the funding and logistics of a composting system at WPI.

Q: Do you offer composting solutions for residence halls, the Campus Center, or fraternities/sororities?

A: City Compost offers services for any type of organization upon request.

Q: Has City Compost provided services to a university setting before?

A: City Compost worked with a university in Waltham, MA for back-of-house (i.e. kitchen staff food waste) compost in five separate dining locations.

Q: How can a composting system be introduced to a residence hall?

A: While most universities pay by weight, City Compost pays by volume, since food is one of the heaviest items that can be thrown away in a residential setting. The cost would be 25-50 cents per student per week. Containers would be switched out weekly to isolate smell. They can work directly with the students from the Green Team to set up awareness programs and get students running the program in the residence halls.

Q: How does composting compare to the existing method to divert waste to Tyde Brook pig farm from WPI?

A: Mr. Jankauskas believes there is a greater ecological contribution from food waste through compost than the amount of pork out of feeding a pig.

Q: What kinds of organic waste collection does City Compost support?

A: The system supports paper towels. Maybe something in the bathroom for hand towels, small waste basket for personal hygiene purposes they can also do hair from brushes, any compostable items can be placed in the compost bins. Coffee grounds from the Campus Center Dunkin' Donuts and much of their waste has the potential to be used for composting.

Q: How do you intend to expand the program?

A: They can start in any area on campus and assisted through partnership with the Green Team for product promotion.

Q: How do you undertake the estimate of waste in new locations?

A: They do a waste audit at one location and extrapolate it to provide an estimate of generated

waste across campus. They then provide all scales of containers for users based on the amount analyzed from the audit.

Marc Printz: Lambda Chi Alpha-Pi Zeta Chapter, Worcester Polytechnic Institute

Participants: Augustus Moseley, Jenny Penaloza, Junaid Rathore, Steven Trvalik

Location: WPI, Foisie Innovation Studio, FI200A POD

Date: 04/24/2019, 12:20 P.M.

Intention for interviewing: Gain insight in food waste retrieval process in a fraternity setting, as well as discussing the relationship between Lambda Chi Alpha and the Tyde Brook pig farmer, who also gathers food waste from Chartwells at WPI.

Q: How did you introduce food waste disposal in your fraternity?

A: During Printz's sophomore year (3 years ago, 2016-2017), food waste recycling system introduced by sending it to the pig farm in drums. Before this, all the food waste was put in the large waste management dumpster at the house and eventually incinerated. About a year before Lambda chi Alpha (LCA) adopted this system, Theta Chi initiated it, but they stopped because whoever was overseeing its operations stopped or graduated. This system is currently in place at LCA and Sigma Phi Epsilon (Sig Ep) fraternities. These were brought upon by the knowledge that Chartwells was doing was some food waste diversion; they talked to Joe K., then he put him in contact with pig farmer. LCA Bought three 55-gallon drums and 2 were purchased for Sig Ep; one of Sig Ep's went missing, so LCA gave one of its drums to them. LCA has one chef and houses about 45 people. People not living in the house also in the meal plan, so there are about 55 people served daily. People also come in with their own food as well, especially on weekends when the chef is absent. Sig Ep has a similar demographic. There is a 5-gallon tub inside where anyone is free to place their food waste, the contents of which are emptied into the drums daily. About a third of the 55-gallon drum is filled each week. This is generally a simple process, as there is a singular system for only one house.

Q: What are the responsibilities the fraternity takes on when implementing this system?

A: Following the academic calendar based on when the pig farmer picks up the drums. When the chef prepares food correlates with food waste that will be generated. Eventually, brothers must clear out the fridges once per week which will be emptied out into the drums. The drums themselves also need to be accessible; removing of snow or anything that may be obstructive is a top priority. Making sure people are aware of how to send their food is also very important; some people are not properly informed of what can be disposed, such as bones or other questionable organics. Currently, LCA is working on making signs for what can be put in there, as well as making the 5-gallon bucket more accessible to prevent spillage. This process could be made easier if a universal system is implemented throughout the fraternities at WPI. The Alpha Gamma Delta and Alpha Xi Delta sororities are interested in this system as well.

Q: Do you have direct contact with the pig farmer?

A: Yes, there is good communication present. The pig farmer comes Tuesday and Saturday, and

probably goes four days a week as well throughout WPI. The pig farmer does not take the drums in the summer, as there is a drastically smaller amount of food waste being made with a smaller population. Because of this, a drum was discarded as a result of decomposing food from the summer.

Q: How much food does the chef prepare?

A: Two meals are prepared per weekday (lunch and dinner), in addition to a continental breakfast. Unused food is placed into Tupperware containers and refrigerated and are typically dumped out if left unused on weekends.

Q: Is there any possibility of a position where one person oversees this system?

A: In LCA, they had a “pig chair”, which later evolved into a sustainability chair. Recently, the sustainability chair went through the house and redid the signage regarding food waste.

Q: Were there any difficulties with health risks or facilities? Were there any logistical problems?

A: The big drums have rings so animals can’t get into it. There must not be a buildup of decomposing food when the food is sent to the pig farm; the 5-gallon bucket is rinsed daily, and the drums are washed out by the pig farmer before he returns them. There was a health inspection this year, and there was no issue with the food waste system.

Q: Do you have any advice on how to expand this system?

A: Making a position in the Facilities Department or Sustainability Office who deals with the schedule for all of the frats and logistics with pig farmer such as pick up times and speaking with them to setup such a system at their fraternity. The schedule could also be the same for all the fraternities. Neither IFC nor Panhellenic have a sustainability individual who can help manage these systems. If there was a chair for each organization, they could collaborate on something.

Q: What is the pig farmer’s schedule?

A: He comes on Tuesdays and Saturdays, 10 A.M. in the morning. He rolls the barrel to his truck and then must lift it up into his truck. If there were more fraternities participating, he will probably need a bigger truck (he currently uses a pickup). Making schedules to make the system as beneficial for him as possible helps to keep him interested.

Appendix II: City Compost Plan



City Compost can provide, 32, 48, and 64 gallon rolling carts that would be emptied with every service. These containers would need to be lined with bags.



Preferably, WPI would be set up with 20 gallon or 28 gallon totes with two-sided snap lids. These containers are more secure than hinged-lid systems and can be filled to 100% capacity then carted out for service. They easily stack three (20g) or two (28g) high in order to save space. These containers are exchanged each service and no bags are required. This would save the school on costs associated with container cleaning.





Dormitory Service

Opt-in of 2 gallon personal containers for eco-minded students. We often hear from many students they wish their dorm room had options. We could have local drop points at the dumpsters or exchange these out.



Cafe Service

5 gallon bucket or 10 gallon barrel service for the larger generating cafes not currently composting.



Post Meal Service

23 Gallon Square containers allow for students to utilize current 3 bay set up in dining areas. 23 gallon rectangular is also a viable option for narrower areas without existing stations. These containers would be bagged and emptied into 64 gallon rolling carts.



Office Service

Many meals are often eaten at the desk or in small conference rooms where a larger container would be too large.. This is perfect for the 7 gallon container.

Other : Additional Customizable Solutions Possible

Container Size (gallon)	Base Price per Location	Additional Containers
2G	\$2.50	\$1.75
5G (100% Capacity/No Bags)	\$5.00	\$2.50
7G (At Container Service)	\$6.00	\$3.50 (same floor)
10G (100% Capacity/No Bags)	\$7.00	\$4.25
20G (100% Capacity/No Bags)	\$10.00	\$7.50
28G (100% Capacity/No Bags)	\$13.50	\$10.00
32G	\$18.00	\$13.00
48G	\$22.00	\$17.00
64G	\$28.00	\$23.00

Table i: City Compost container pricing, based on capacity and location



Collection Containers



4 Gal



8 Gal



13 Gal



24 Gal



13 Gal



24 Gal



23 Gal



23 Gal



7 Gal



10-20-32 Gal



23G Cover
(above)



1.3 Gal



2 Gal



5 Gal



Home Compost Collection Service



Support Local Food

Create a new square foot of growing space for food each week



Protect the Environment

Keep over 250lbs worth of CO2 out of the atmosphere each year



Community Health

Healthy soil grows healthy food and improves peoples lives

All Foods Including



Cooked & Raw



Meat & Dairy



Sauces & Dressings

Service Features



Receive Compost



Fresh Bucket Weekly



Year Round Service

Service starts at \$5 per week or \$7 every other week

(978) 378-3048 ~ www.citycompost.com



All Foods Items from Plant & Animal plus Other Compostables are Accepted
Cooked & Raw ~ Expired, Moldy & Fresh ~ With or Without Sauce

PLANT BASED FOOD ITEMS	ANIMAL BASED FOOD ITEMS
Rice, Beans, Quinoa & Grains	Hard & Soft Cheese
Stems, Peels, Cores & Skins of Fruits & Veggies	Curdled Milk & Moldy Cottage Cheese
Shells - Pistachio, Walnut, Peanut & Coconut	Shells – Clam, Shrimp & Lobster
Pits – Peach, Nectarine, & Avocado	Fish, Turkey, Chicken & Beef
Pizza Crusts & Moldy Bread	Trimming, Fat & Bones
Any Food that Comes from Plants	Any Food that Comes from Animal
OTHER FOOD RELATED ITEMS	
Spoiled Sauces and Soups	Sweets and Treats
Old Spices, Flour, Baking Goods	Fats, Butters, Dressings & Oil
Napkins & Paper Towels used with Food or Water	Dirty Paper/Compostable Take-Out Containers
Coffee Grounds & Filter	Tea Bags without the Staple & Tag
OTHER NON-FOOD ITEMS	
House Plants & Flowers	Plain Paper with No Color Ink (Heavy Metals)
Toothpicks, Popsicle Sticks, Chopsticks	Potting Soil, Plant Trimmings, Twigs, Flowers
Untreated Pet & Human Hair	Dry and Wet Pet Food
Yard Material (Upon Approval)	Vegetarian Pet Bedding (i.e. Hamsters & Rabbits)
NOT ALLOWED	
Paper Used with Chemicals	Thick Cardboard & Pizza Boxes
Fruit Stickers & Plastic Bags	Large Quantities of Oil/Grease
Color Ink Newsprint / Paper	Glossy Paper / Magazines
Styrofoam & Plastic Wrap	Plastic, Glass, or Metal
Diapers & Dog, Cat, or Bird Droppings	Personal Hygiene Products incl. Used Tissues
Grass Clippings from Unapproved Lawns	Dryer Lint or Vacuum Bag Content

Compost Collection Day _____

Please place container out the night before service and remember to recycle too!!

Have a question about something not listed? Please reach out and we will add it on!!

www.citycompost.com | 978-378-3048 | info@citycompost.com

Table ii: Materials that can be composted through City Compost service

Appendix III: Marc Printz Pig Farm Expansion Document

Tide Brook Farm Food-Waste Recycling

What: free food-waste pickup

Why: helps reduce the environmental impact of the chapter house and reduce waste-related expenses

Who: George (774-364-4521) from Tide Brook Farm

Contact Marc Printz (978-408-6602) with any questions or would like to see the set up at LCA

When: pickup twice per week during the school year

Cost: \$20-40 total, one time for the barrels

George currently does food-waste pickup from LCA, Sig Ep, Morgan Dining Hall, the Campus Center and Goats Head. The food-waste is used to feed pigs at his farm, off-setting the cost of having to purchase pig feed.

Food-waste is collected in 55-gallon drums that have locking lids; one or two will be needed (so that he can swap the empty one with the filled one when he comes. The locking lids are so that animals cannot climb into it. They can be purchased from Carl (508-868-9907; 29 Lyon St., Worcester 01604) for ~\$20 per.

George needs the barrel to be easily accessible from the street during the winter when it snows. That might require shoveling a path to it/around it.

Appendix IV: Supplementary Charts/Figures

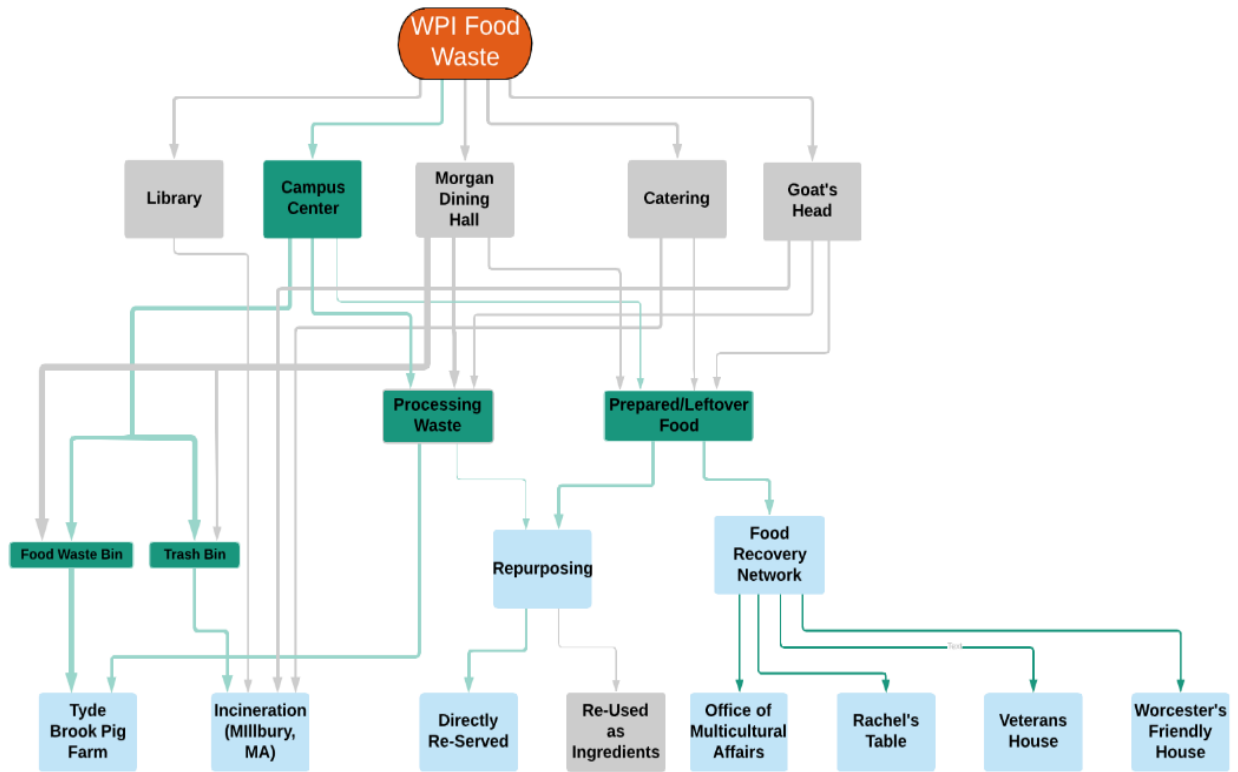


Chart i: Food Waste Map, Focused on Campus Center

Appendix V: Photographs from Tours

Worcester State University

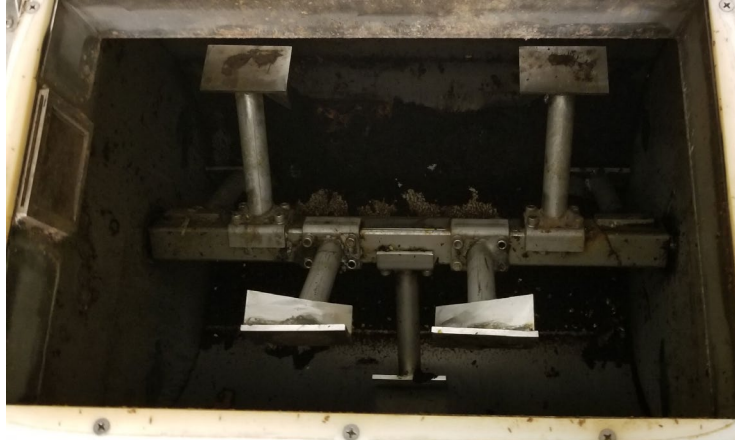


Figure i: interior view of the Worcester State University food dehydrator, displaying its pulping mechanism [Personal photograph taken at WSU]. (2019, March 29).



Figure ii: Freight Farm control panel [Personal photograph taken at WSU]. (2019, March 29).



Figure iii: Hydroponic nutrients and accoutrements for Freight Farm lettuce plants [Personal photograph taken at WSU]. (2019, March 29).



Figure iv: Freight Farm lettuce seedlings [Personal photograph taken at WSU]. (2019, March 29).

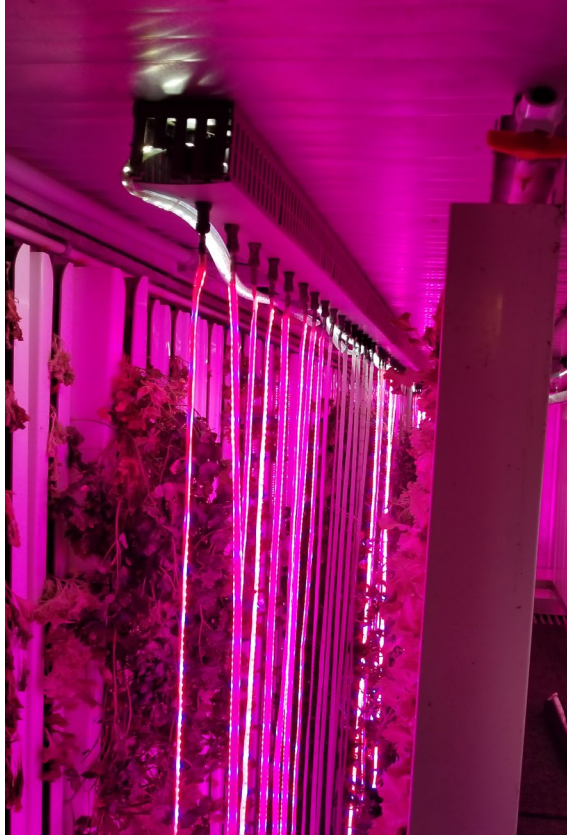


Figure v: Interior view of the Freight Farm displaying the vertical planting orientation for the lettuce crops [Personal photograph taken at WSU]. (2019, March 29).



Figure vi: Picture of the main kitchen at Morgan Dining Hall. [Personal photograph taken at WPI] (April 19, 2019)



Figure vii: Vegetable ingredients at the Morgan Dining Hall Kitchen. [Personal photograph taken at WPI] (April 19, 2019)



Figure viii: Vegetable trimmings in Morgan Dining Hall Kitchen. [Personal photograph taken at WPI] (April 19, 2019)

Chartwells
where hungry minds grow

MenuWorks Week At A Glance Report

Report Run By: EDD SAARINEN
Run Date: Apr 08, 2019
NPR (2074)

CHE 19 Spring Morgan Hall 2074

Sunday (04/14/2019)	Monday (04/15/2019)	Tuesday (04/16/2019)	Wednesday (04/17/2019)	Thursday (04/18/2019)	Friday (04/19/2019)	Saturday (04/20/2019)
Bean and Tomato Chili	Baked Marinated Tofu	Vegetable Pasta	Lunch: Vegan Sofan Vegan Pepper "Steak"	Vegan Chicken Free Nuggets	Curried Tofu	Cilantro Pesto Tofu
Basmati Rice	Vegetable Pad Thai	Garlic Thyme Garbanzo Beans	Basmati Rice with Peas	Herbed Quinoa	Roasted Red Potatoes	Spicy Green Beans
	<i>Vegetarian Mac & Cheese</i>			Carrot Couscous	Steamed Broccoli	Roasted Sweet Potatoes
Chimichuri Salmon	Tofu Marabò	Vegetarian Stuffed Bell Pepper	Dinner: Vegan Juggernaut Veggie "Steak"	Jerk Tofu Steak with Mango Salsa	Tampah Provincial	Portobello and White Bean Ragout
Herb Roasted Potato Wedges	Garlic & Herb Olive Oil Roasted Potatoes	Red Beans and Rice	<i>Vegan Soft Fries</i> Cilantro Lime Brown Rice	Spanish Rice	Rosemary Roasted Mushroom	Grits
Spicy "Green Beans"	Fresh Braised Greens	Steamed Cauliflower	Roasted Corn	Spicy Black Beans	Fresh Steamed Carrots	Steamed Green Beans

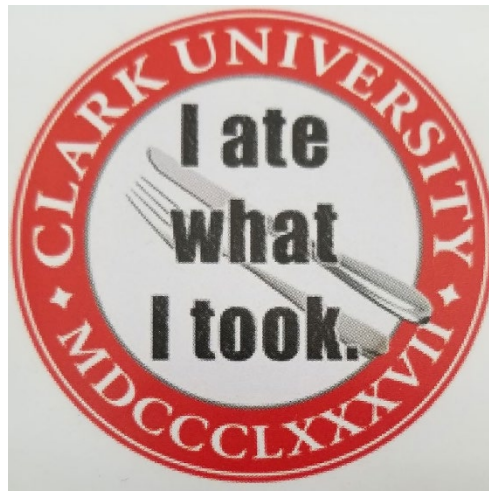
Broccoli

Bold indicates menu item displays on dining websites
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Page 1 of 1

Figure ix: Chartwells binder displaying the vegan options in a weekly menu for Morgan Dining Hall. [Personal photograph taken at WPI] (April 19, 2019)

Clark University



*Figure xiv: Clark University Clean Plate Challenge Incentive Sticker [Personal photograph taken at Clark University].
(2019, March 26).*

Appendix VI: Chartwells Waste-Not Terminology

Each name corresponds to a specific Chartwells location. Some names can refer to multiple locations. For example, there is a pizza station in both the Campus Center (Campus Center) and Morgan Dining Hall.

ACTION	Spoon Around the World
BACK	Back-of-house/Kitchen waste in Morgan
DELI	Deli station
KITCHEN	Back-of-house/Kitchen waste in Campus Center
PIZZA	Pizza Station
DISH	Chef's Table
GRILL	Mondo Grill
SALAD	Salad Bar
TEX	Chick-n-Grill (Campus Center)

Table ii: Chartwells Trim Trax terminology based on location