AN INVETIGATION INTO ORGANIC WASTE BIN LINERS

Karl Kong, Pei Wen Lei, Yabo Li, Rain Yuan Rain Tian

University of British Columbia

APSC 262

April 10, 2014

Disclaimer: "UBC SEEDS provides students with the opportunity to share the findings of their studies, as well as their opinions, conclusions and recommendations with the UBC community. The reader should bear in mind that this is a student project/report and is not an official document of UBC. Furthermore readers should bear in mind that these reports may not reflect the current status of activities at UBC. We urge you to contact the research persons mentioned in a report or the SEEDS Coordinator about the current status of the subject matter of a project/report".

AN INVETIGATION INTO ORGANIC WASTE BIN LINERS

SUSTAINABILITY PROJECT REPORT

Yabo Li

Karl Kong

Rain Tian

Pei Wen Lei

Date of Submission: April 10, 2014

Course Number and Name: APSC 262 Technology and Society II

Instructor Name: Paul Winkelman

ABSTRACT

Green carts that are currently used to collect food scraps at UBC are cleaned at the Composting Facility located at the south campus, which lead to extra cost on transportation of the carts, and operating and maintaining cleaning facilities. Therefore, the purpose of this report is to investigate available compostable bin liners or bags on the market and recommend possible solutions that can keep the carts clean without being cleaned at the composting facility.

Investigation was performed by interviewing UBC work staffs, studying resources in the UBC libraries and researching on the internet. As a result of the investigation, two solutions are proposed: designing a mechanical pipe minimizing leakage of food scraps due to shape difference between available liners and the carts, and designing customized paper bags that can perfectly fit into the carts.

Both solutions are assessed utilizing the triple bottom line which includes social, environmental and economic concerns. Based on the assessment, the recommended solutions are proved to solve the problem at a low cost without creating additional social and environmental alerts. The focus of this report is to provide general recommendations on solving the problem; thus, the solutions are limited to preliminary designs. Further evaluations on feasibility assessment of the solutions are recommended.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

GLOSSARY

Triple Bottom Line	Triple bottom line (TBL) accounting expands the traditional reporting framework to take into account social and environmental performance in addition to financial performance. (“Triple Bottom Line,” 2014, para. 6)

LIST OF ABBREVIATIONS

TBL	Triple Bottom Line

1.0. INTRODUCTION

UBC is currently running a Compost Project which is dedicated to reduce waste on campus. As a result, an In-Vessel Composting Facility was built on the south campus to process organic waste which is collected from designated sites around campus.

Pails and carts are currently used to collect organic waste such as food scraps. Food scrap pails are mostly used in places such as offices, lunch rooms, and other small work spaces. Green carts are used to collect food scraps emptied from the pails or directly disposed by users; the green carts are mostly seen in the hallways or atriums of various buildings such as Irving K Barber library and Macleod.

In order to control the odors and flies, both pails and carts need to be cleaned frequently. Most pails used in small work spaces are kept clean by UBC staff; the green carts are emptied and cleaned by UBC Municipal Operation personnel.

Another easy way to keep the pails and carts clean is to use liners or bags. The composting system of UBC does not accept any non-compostable plastic bags. Therefore, the main task of this project is to investigate on current available compostable liners and recommend solutions that can make use of the available liner products.

2.0. INVESTIGATION

2.1. FOOD SCRAP PAILS

The main problem with the food scrap pails is the shape difference between the pail and currently available paper bags. The Rubbermaid 2957 Wastebasket 39 litre bin shown below is a proposed solution for collecting moderate volume of food waste.

FIGURE 1 RUBBERMAID 2957 WASTEBASKET 39 LITRE BIN

SOURCE: BUD FRASER

However, the inside of the bin is shaped as an upside down trapezoid (side view). The available Bag-to-Earth large paper bag liners as shown in the figure below do not fit into the 39-litre bins.

FIGURE 2 BAG-TO-EARTH LARGE PAPER BAG LINER

SOURCE: BUD FRASER

A mechanical design which can hold the bag open at the top of the bin is proposed by mechanical engineering students at UBC. The design will presumably resolve inconvenience caused by the shape difference between the bin and the liner, and effectively avoid food leakage. Although the design is still in progress, the concept of it is straightforward and the price range of the solution is acceptable.

2.2. GREEN CARTS

So far there has not been a good solution of using compostable paper bags to keep green carts clean. Below it is a Schaefer USD 35 green cart that is used in UBC. The Schaefer USD 35 can contain approximately 140 Litres of food waste. Current available compostable paper bags or liners are not big enough to fit into this type of carts. As mentioned earlier, the UBC composting system does not accept non-compostable plastic bags. As a result, these green carts are emptied and cleaned in the Composting Facility on the south campus.

FIGURE 3 SCHAEFER USD 35 GREEN CART

SOURCE: BUD FRASER

2.3. GREEN CARTS CLEANING

The Composting Facility is located on the south campus. The carts are transported to and cleaned at the facility several times a week.

FIGURE 4 DOCKING STATION AT THE COMPOSTING FACILITY

The lifting machine shown below empties the carts that are full of food scraps.

FIGURE 5 THE LIFTING MACHINE

After the carts are emptied, they are cleaned by high pressure water in the cleaning facility shown in the figure below.

FIGURE 6 THE CLEANING ROOM

The process of emptying and cleaning of the green carts takes time and costs extra money. Every time after being cleaned, the carts have to be transported back to the main campus. Maintenance costs of the lifting and cleaning facilities have to be included in the budget. In

addition, since the food scraps are not contained in bags or liners at the Composting Facility, work staffs at the facility are exposed to terrible odors caused by the food waste.

Thus, to find a solution that can avoid cleaning the green carts at the Composting Facility is the main focus of this research project.

3.0. RECOMMENDED SOLUTIONS

In the previous section, the bin liner problem in UBC has been extensively discussed. It has drawn into a conclusion that the green cart is the main focus of the problem in UBC. There are two main bin liners nowadays- plastic bag and paper bag. Plastic bag is non-degradable and thereby is not suggested to be the bin liner for green cart (and also violates UBC Composting System); while paper bag has been reported by UBC staffs that it does not fit well for the green cart. Every problem comes with a baggage of solutions; among all possible recommendations that have been suggested by stakeholders and other sources , the group has finalized the best two recommendations of the bin liner problem - building a new mechanical part and designing a new paper bag.

3.1. MECHANICAL SOLUTION

3.1.0. LIMITATIONS OF PAPER BAGS

After meeting with stakeholders, it is suggested that paper bag would be the best choice for the bin liner of the green cart. This is because firstly, paper bag is degradable and compostable which would greatly improve the sustainability of UBC as bin liners are replaced many times every day; secondly, paper bag is inexpensive so that this would substantially reduce the financial burden of UBC on balancing the cost and the concept of sustainability. However, Mr. Bud Fraser, who is the project client, suggested that most of the paper bags in the market do not fit well for the green cart due to limitation of size and quality of the paper bags; as a result, paper bag used as the bin liner of the green cart would cause leakage of food scraps and thereby makes the green cart dirty and smelly. The following diagram clearly depicts the limitation of paper bag used as the bin liner of the green cart.

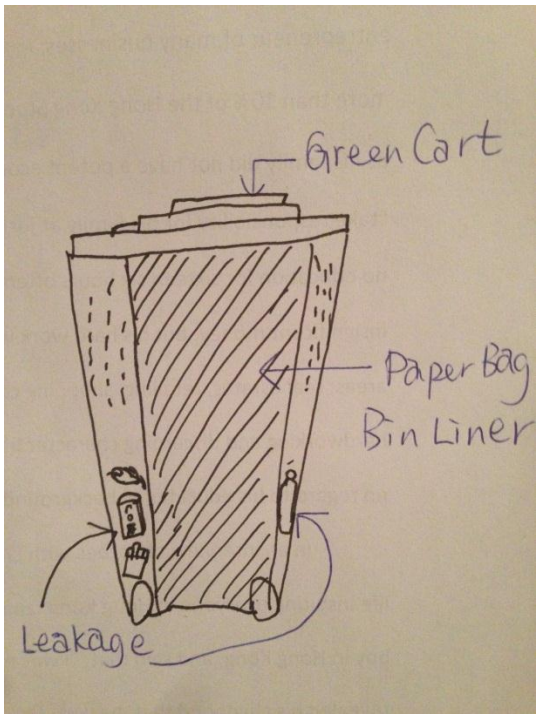

FIGURE 7 LEAKAGE PROBLEM WITH AVAILABLE PAPER BAGS

3.1.1. BUIDING A PIPE INSIDE THE CART

The idea is to build a pipe through which people throw garbage into to the liner. Therefore, when people throw garbage into the green cart the pipe acts as a barrier to prevent garbage from leaking inside the green cart. More specifically, the pipe physically blocks garbage from going into the sides of the green cart which are not covered by the paper bin liner. The diagram below shows the design and the use of the pipe in the green cart.

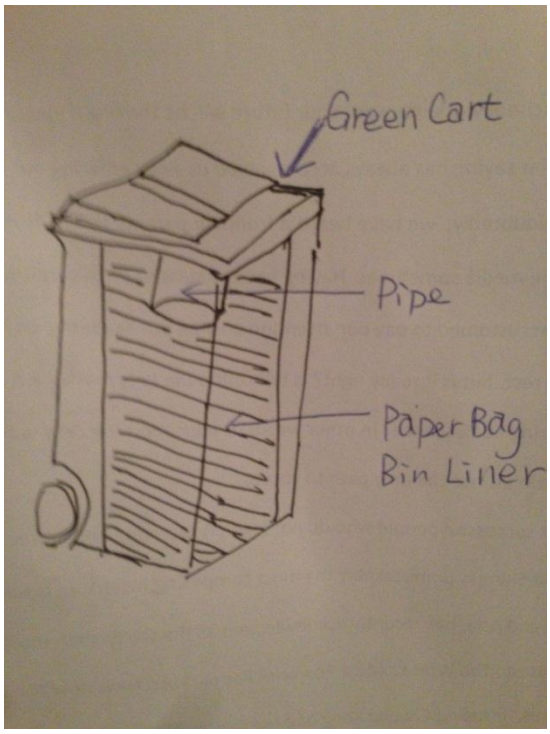

FIGURE 8 THE PIPE AT THE TOP OF THE CART

The idea originates from one of the mechanical engineering projects on the design of bins in UBC. Currently, the mechanical engineering project group is working on building the pipe for small pails so as to eliminate leakage of food scraps. When the pipe for small pails is tested and evaluated as a mature design the idea can also be applied in larger bins in UBC such as the 140-litre green cart.

3.1.2. MATERIAL

Among various researches on possible materials of the pipe, the best material for the pipe would be stainless steel. According to the information provided by Australian Stainless Steel Development Association ("Benefits of stainless," 2013), stainless steel has many benefits in various area. Firstly and most importantly, stainless steel is corrosion-resistant and high and low temperature resistant; thus, the pipe is sustainable as it could be used for many years. Next, due to smooth surface of stainless steel and the presence of stainless steel cleaner on the market, it is very easy to be cleaned so that this reduces the cost and time of UBC staffs to

maintain hygiene of the pipe. Also, among all possible sustainable materials, stainless steel is relatively cheap. Therefore, stainless steel is evidently the best choice of the material of the pipe.

3.1.3. ADVANTAGES

The stainless steel pipe is a sustainable design that can be used for many years without frequent maintenance and replacement, and can be cleaned very easily. And, paper bin liner with the design of the pipe is not only a sustainable idea that solves the green cart problem, but also an inexpensive design speaking of the balance between cost and the concept of sustainability.

3.1.4. CONSTRAINTS

Mandy Bains, who is the assistance supervisor of custodial services in UBC, points out the difficulty in replacing bin liners due to the presence of the pipe. At this moment, UBC staffs move the green cart out for changing bin liners of the green cart and cleaning the green cart. After a pipe is built at the top of the green cart as shown in the FIGURE 8, the pipe is required to be repositioned at the right place (so as to prevent leakage of garbage) whenever UBC staffs replace with new bin liners. It needs special care which might take extra efforts and cost.

To conclude, the design of the pipe is a sustainable and low cost solution to the green cart problem. However, the need of the pipe to be repositioned frequently is an issue to UBC staffs. Therefore, the idea of the pipe would be recommended as a short term solution.

3.2. DESIGNING CUSTOMIZED PAPER BAGS

3.2.0. PAPER BAG V.S. PLASTIC BAG

Paper bag is always 100% compostable and biodegradable; while plastic bag on the market nowadays is usually non-compostable which produces wastes that are difficult to be completely decomposed and might last for at least 450 years (O'Connor, 2011).Thus, UBC Composting

System prohibits plastic-made items in the bins, including plastic bag or plastic bin liner. In other words, paper bag is the only choice for the bin liner.

3.2.1. NEED FOR DESIGNING CUMSTOMIZED PAPER BAGS

As discussed in the previous sections, paper bag is more beneficial in economic, social and environmental factors than plastic bag. (More details would be discussed in the section TBL Analysis.) Also, it is a fact that paper bag on the market does not fit the size of the green cart well. As a result, the group suggests that there is a need of designing a new, special paper bin liner for the green cart at UBC. The new paper bin liner does not only solve the green cart problem in UBC, but also provides a sustainable choice of bin liner for householders to decide for their 120-litre waste bins outside their houses. (More details would be discussed in the last part of this section.)

3.2.2. CUSTOMIZED PAPER BAGS

The idea is to design a new paper bin liner that can cover the green cart in UBC without leakage of food scraps and other garbage. The commercial name of the green cart is called Schaefer USD 35 Green Cart. From the information of the manufacturer of Schaefer USD 35 Green Cart ("Price to compete made to last”), the perfectly fitted size of its paper bin liner would be 22.75 inches x 22.35 inches x 36.25 inches. However, the perfectly fitted paper bin liner does not attach to the green cart; thus, leakage of food scraps would still exist. The group has decided to perform experiments to determine the method for allowing paper bin liner attach perfectly to the green cart.

3.2.3. VERIFICATION OF DESIGN

The first experiment is using biodegradable paper clips to clip the perfectly fitted paper bin liner to the green cart. This idea is inspired by a website called thriftyfun ("Keeping garbage bags in place", 2012). After several tests on the method, the result is that, the bin liner is loosely attached to the green cart due to the shape of the green cart and thus, the problem of leakage still exists. As a result, the idea of biodegradable paper clips fails.

The second experiment is to design an oversized paper bin liner, rather than a perfectly fitted paper bin liner. The idea is to wrap the oversized part of the paper bin liner around the green cart so as to consolidate the bin liner. The group tested the experiment with different sizes. The result is that, the oversized bin liner is more firmly attached to the green cart than the previous method and effectively reduces the leakage. Among all sizes of the paper bin liners, the 24.0 inches x 24.0 inches x 43.0 inches paper bin liner is tested to be the best choice.

3.2.4. CONSTRAINTS AND RECOMMENDATIONS

It is difficult to look for a manufacturing company of bin liner to make a completely new design of bin liner. Since the companies already have their own manufacturing system to produce a specific type of bin liner currently on the market, they are not willing to accept any new design. However, if the companies visualize the future of the new design, their willingness to accept new design might change.

From the information of city of Vancouver ("How to order, replace, or change bin size", 2014), the 120-litre green bin outside householders' houses is 22.0 inches x 24.0 inches x 40.0 inches. Therefore, the 24.0 inches x 24.0 inches x 43.0 inches paper bin liner can definitely be firmly attached to the household green bin and prevent leakage of food scraps. Once the design of the new paper bin liner is mature, it can also be used for the 120-litre household bins in future. This news does not only substantially raise the interest of manufacturing companies, but also complies with the concept of UBC as a Living Lab.

To conclude this section, the 24.0 inches x 24.0 inches x 43.0 inches paper bin liner is proved to be the best choice of the bin liner of the green cart in UBC. Speaking of possible plastic bags in future, biodegradable and compostable plastic bag is prevalent on the market nowadays. These plastic bags do not pollute the society and the environment and are sometimes cheaper than compostable paper bags. A suggestion to the UBC Composting System is that, biodegradable

plastic bags should also be allowed to be disposed so that biodegradable plastic bin liner can exist in UBC.

4.0. TBL ASSESSMENT

4.1. MECHANICAL SOLUTION

4.1.0. ENVIRONMENTAL

As a mechanical solution, compostable paper bags are used to replace non-compostable plastic bags. In this case, the bag will be changed three times a day instead of once every two days. Therefore, by making a cover for the organic compost bin and using compostable paper bags, the odor come from the compost bin will be reduced and compass residents will be more likely to dump their food waste into the organic compostable bin. In doing so, the organic waste will be divert from the landfill. In addition, using this solution will reduce contamination in the organic compost since the bags are 100 percent compostable.

4.1.1. GREENHOUSE GAS

The organics recycling process saves more energy and reduced greenhouse gas emissions. Composting organic waste keeps the waste out of the landfill and reduces the amount of methane emission due to decomposer readily digest the organic matter.

4.1.2. TRANSPORTATION

The transportation of garbage for landfill coast large amount of gasoline and emit greenhouse gas. The distance from UBC to places for landfill is much further than the distance to the UBC composting facility. In this case, throwing more compostable organic waste reduce the greenhouse gas emissions in the transportation process.

4.1.3. ECOMOMICAL

In this solution, extra cost is added in making the pipe inside the green cart; however, this solution involving with using smaller and therefore cheaper bags that are out in the

market. Never the less, due to the complexity in changing the bags every time, the cost of labor will increase.

4.1.4. SOCIAL

By using the mechanical solution, more labor work will be required in changing the bag by hand every time. This process is time consuming and my possibly case health problems to people pick up the organic waste. However, compass residents will be more likely to dump their food waste into the organic compostable bin due to the reduction of odor coming from the compost bin.

4.2. CUSTOMIZED PAPER BAGS

4.2.0. ENVIRONMENTAL ANALYSIS

In terms of environment, the new design of paper bag causes some effects on energy consumption, ecological footprint and global warming potential.

4.2.0.0. ENERGY CONSUMPTION

The 100% compostable material of new paper bag is called cellulose. The characteristic of this material is leak-resistant and strong. Therefore, the breakdown process causes more carbon dioxide emission from manufacturing and processing. However, comparing with greenhouse gases emission from landfill, manufacturing does not cause much adverse effects in overall. Therefore, this adverse effect of cellulose can be overlooked by taking all factors into consideration.

4.2.0.1. ECOLOGICAL FOOTPRINT

Transportation is also a major factor in environmental assessment. Since less organic food waste goes to landfill because of using paper bags, greenhouse gases emissions will be reduced during transportation. It is known that sending food waste to landfill takes a long distance

comparing to current UBC compost system. Thus, more carbon gases are emitted during transportation.

4.2.0.2. GREENHOUSE GAS EMISSION

Global warming potential is an impact model assessed for environmental analysis. Greenhouse gases model is used to evaluate global warming potential. Greenhouse gases have carbon dioxide, nitrous oxide, water vapor and methane in Earth's atmosphere. Compared with current situation, which is using plastic bags, adopting paper bags for green carts encourage people to throw food waste more frequently since less odor emitted. Therefore, less food waste is sent to landfill. According to greenhouse gas emissions/savings by substance statistics (P41), it is observed that a greenhouse gases saving during composting process. Therefore, it will not cause adverse effects on global warming issue.

4.2.1. ECONOMIC ANALYSIS

4.2.1.0. LIFE CYCLE ANALYSIS MODEL

Life cycle analysis model is used for economic assessment. The estimate costs for waste collection, processing and transportation are determining factors. Since fewer waste goes to landfill, waste collection frequency are decreased and thus collection cost will be lowered. Despite of considering collection costs, in terms of transportation, labor costs, truck capacities and truck pick-up times are determining factors. It is observed that labor costs and truck capacities can be reduced.

Moreover, based on the following table citrated from TBL assessment of Food Organics Management document, as seen in bar1 between bar 2, even there is an increased amount of cost for compost system, but with the same amount of waste, the overall cost of waste management will be reduced.

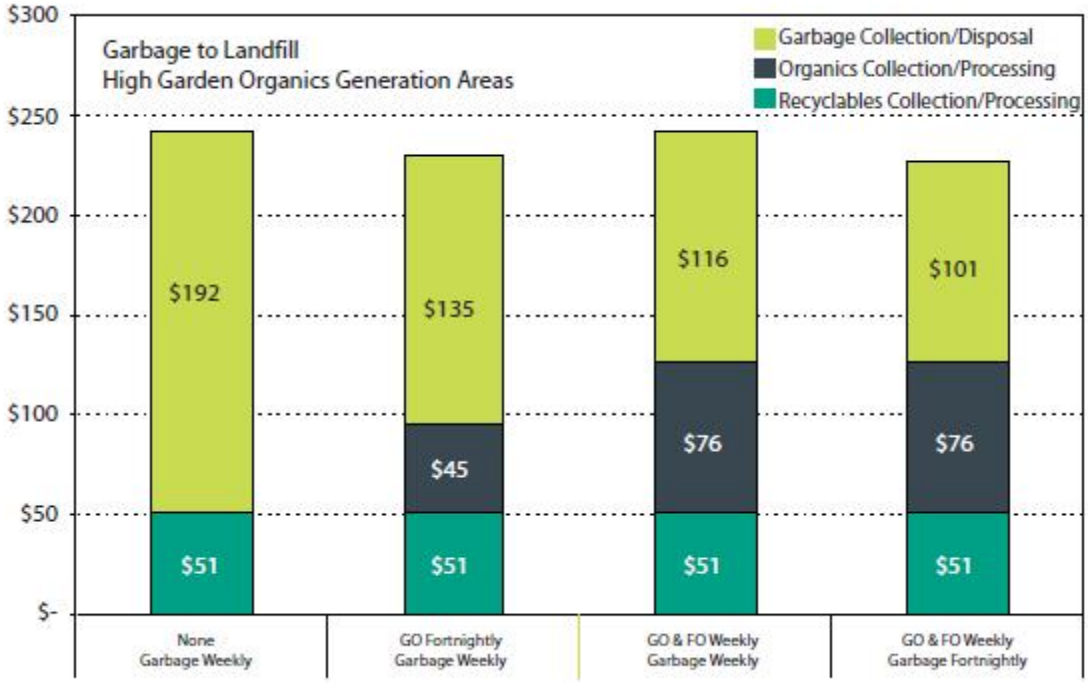

FIGURE 9 TBL ASSESSMENT OF FOOD ORGANICS MANAGEMENT

4.2.1.1. USAGE OF LAND

Use of paper bag causes less garbage to landfill. Therefore, the area of landfill will be reduced and thus improve land utilization efficiency. The land can be utilized for construction or farming, and it may improve economic development in the future.

4.2.2. SOCIAL ANALYSIS

Two categories are used to evaluate potential social impacts.

4.2.2.0. INDIVIDUAL IMPACTS

In terms of public perception of risk to health, the possibility of odor and potential for attracting vermin are considered. New paper bags reduce the degree of odor and encourage people to use green carts. Thus, it will reduce the collection frequency of the garbage stream.

4.2.2.1. RESIDENTIAL IMPACTS

UBC compost system also has impacts on campus residence. Reduced garbage sent to landfill results in decrease in odor, debris and traffic movements. Thereby, new paper bag will have positive impacts on residential on campus.

4.2.2.2. ENVIRONMENTAL AWARENESS

The adoption of paper bags may inspire people's awareness of sustainability. The new design may provide a clue for people to come up with innovative improvements on compost system. In terms of education, the aim of new design enables people to have concern about compost system and environment issues.

5.0. CONCLUSION

In this report, the group has finalized two elaborative solutions of the bin liner problem - building a new mechanical part (short term) and designing a new paper bag (long term). The first solution is to build a short pipe inside the green cart to prevent garbage from leaking into the sides of the cart, which solves the short term bin liner problem currently in UBC. And, the second solution is to design a new paper bag for the green cart, which is acknowledged as a long term solution that will be beneficial to UBC and the city of Vancouver. Both solutions ensure that the waste is well contained inside the bin liner so that it reduces unwanted odor coming from the bins so as to keep bins clean and odorless. At the same time, both solutions are widely evaluated by TBL assessment. The solutions are proved to be sustainable in the three areas - economics, social and environmental. Speaking of the concept of sustainability, engineers should always take sustainability into consideration, such as applying TBL assessment to their solutions to the engineering problems. Improvement in the history of human beings would not exist without the concept of sustainability.

REFERENCES

Bag to Earth Inc. (2014). *Food waste bags.* Retrieved from http://www.bagtoearth.com/eng.our_products.food_waste_bags_informational.html

Benefits of stainless steel. (2013). Retrieved from https://www.assda.asn.au/benefits-of-stainless-steel

Campaign for Recycling (2014). *How does recycling decrease greenhouse gas emissions?* Retrieved from http://www.campaignforrecycling.org/faq/ghg

How to order, replace, or change bin size. (2014, January 03). Retrieved from http://vancouver.ca/home-property-development/garbage-bins-and-green-bins.aspx

Keeping garbage bags in place. (2012, June 1). Retrieved from http://www.thriftyfun.com/tf92529215.tip.html

O'Connor, K. (2011, October 31). *How long does it take a plastic bottle to biodegrade?*. Retrieved from https://www.postconsumers.com/education/how-long-does-it-take-a-plastic-bottle-to-biodegrade/

Price to compete made to last. (n.d.). Retrieved from http://www.consolidateddisposal.com/brochures/carts_SSI_Brochure.pdf

Triple Bottom Line. n.d. In Wikipedia. Retrieved April 9, 2014, http://en.wikipedia.org/wiki/Triple_bottom_line

Bains, M. (28 March 2014). Interview

Bonamis, L. (26 March 2014). Interview

Duff, D. (28 March 2014). Interview

Fraser, B. (24 March 2014). Interview