UBC Social, Ecological Economic Development Studies (SEEDS) Student Reports

An Investigation into Degradable Plastic Bags

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ABSTRACT

Garbage bags are everywhere; in homes, at the office, in schools and on the streets. The purpose of this report is to delve into alternate garbage bags then purely petroleum-based plastics. Though there are many alternatives to this type of garbage system, this report will primarily look into degradable plastic garbage bags, where an additive is added to the plastic, and then will look into feasibility of initiating a bag-less system at UBC.

Currently UBC uses degradable plastic bags. This report will look into the economical, environmental and social aspects of using this technology, addressing issues such as the final product of the degrading process, a comparison of similar products, and how people should be educated for use of these garbage bags. UBC is also currently operating a bin washer to clean compost bins. By request of the shareholder, this report will analyze the feasibility of implementing a waste management system that does not use garbage bags for UBC, highlighting the current process, costs for implementing a campus wide waste system, and proposing possible changes to the process to make it more feasible. This report will equip the shareholders with valuable information for making decisions pertaining to UBC's waste management.

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GLOSSARY

Degradable Bags	- Oil-based products - Break down through chemical reactions
Biodegradable Bags	- Plant-based products - Break down through micro-organisms
Compostable Bags	- Plant-based products - Break down by micro-organisms - Has a stricter qualification standard

LIST OF ABBREVIATION

ASTM	- American Society for Testing Materials
EN	- European Norm
UVA	- Ultraviolet Light, Type A -Long-wavelength Ultraviolet Light
UVB	-Ultraviolet Light, Type B -Short-wavelength Ultraviolet Light

1.0 INTRODUCTION

1.1 WHY BIODEGRADABLE?

The current processes of recycling disposable bags weaken the plastic bags and therefore, the recycled bags can be reused only for limited number of times (Mattoro, n.d.). Many-times recycled plastics are used in carpets or fillers in building materials and at the end of their life time, they will end up in landfills where it takes more than 1000 years for plastics to degrade (Mattoro, n.d.).

Almost all of the plastic bags are made from derivatives of oil; therefore, they are heavily dependent on the oil price and supply. Disposable plastic bags have many undesirable impacts on the environment. For example, many plastic containers (e.g. plastic bottles, bags) can find a way to oceans and cause health issues for the aquatic animals (e.g. Figure 1).

Figure 4: This turtle is eating a "jellyfish"

This turtle has mistaken a piece of plastic bag for jellyfish! (Wilson, 2007)

1.1.1 TYPES OF DEGRADABLE BAGS

The two types of degradable bags are Photodegradable and Oxo-biodegradable bags. Photodegradable bags require UV light to degrade; therefore, they will not degrade properly if buried in a landfill or kept in a dark environment ("Degradable Bags", n.d.) (Figure 2).

Figure 5: A photodegradable bag (from Bags & Shoppers)

Oxo-biodegradable bags (figure 3) degrade in two steps. In the first step, the plastic reacts with oxygen and converts to molecular fragments, then these small fragments converts into carbon dioxide, water and biomass (“Degradable Bags”, n.d.).

Figure 6: An Oxo-biodegradable bag (from Bags & Shoppers)

1.1.2 HOW SUSTAINABLE ARE THE DEGRADABLE BAGS?

Using biodegradable bags will reduce the occupied portion of the landfills. Biodegradable bags degrade into harmless fragments (i.e. carbon dioxide and water). Garbage in biodegradable bags decomposes more quickly than in standard polythene bags (“Degradable Bags”, n.d.) .

1.2 UNDERSTANDING DIFFERENT TYPES OF GARBAGE BAGS

It is important to understand the differences between degradable, biodegradable, and compostable plastic bags. Depending on the different methods used to process the garbage, different types of bags need to be used in order to activate their degradation to contribute to less waste. One example of this would be compostable bags which are designed to degrade the same way and in roughly the same amount of time as the organic waste they hold. In order for these bags to be classified as degradable or compostable, they need to be tested to comply with regional standards such as the American Society for Testing Materials (ASTM), European Norm (EN), etc ("ASTM", n.d.).

Other labels such as the EcoLogo also exist to help consumers choose their environmentally friendlier product options in terms of how much recycled materials were used in production ("EcoLogo", n.d.). However, these labels should not be confused with the actual standards of the material degradability.

Figure 4: Various labels for garbage bags (from "ASTM" and "EcoLogo")

For the purpose of our project, as majority of waste produced on the UBC Vancouver campus are solid waste, so we will focus on the non-compostable bags which would eventually end up in landfills. All of the solid wastes from UBC are treated just like other domestic garbage collected in the Greater Vancouver (UBC Waste Management, n.d.). Garbage collected in Vancouver are taken to transfer stations where garbage is sorted and compacted, then driven to either the waste-to-energy facilities, the Vancouver Landfill in Delta, or the Cache Creek Thompson-Nicola Region. At waste-to-energy facilities, energy is created from incinerating the garbage. Energy produced at these plants can then be fed back into the power grid to be used by local communities. At the landfills, garbage bags are further compacted to their designated sites and are covered by soil on a daily basis (Vancouver Solid Waste Management, n.d.).

Due to the processes that take place, an idea garbage bag would be one that degrades in an anaerobic environment and also does not need UV light to trigger degradation. To date, various degradable garbage bag technologies have come close, but have yet to create a bag degradable in all landfill conditions. Garbage bags that are buried deeper in the landfill often do not degrade as they are supposed to. Other factors such as the geological location of the landfill may also affect the average temperatures of the landfill causing variance in the bags' degrading performance.

2.0 TYPES OF BAGS

2.1 TRADITIONAL GARBAGE BAGS

Garbage bags, like majority of other plastic materials, are made out of polyethylene. Polyethylene is a long chain of ethylene monomers, which is extracted and refined from petroleum and natural gas.

Polyethylene can be recycled through chemical processes, but cannot degrade effectively on its own. This means garbage bags of this type ending up in landfills will not degrade for several centuries (Phillips & Ziegler, n.d.), (Nobelprize.org, 2007).

Figure 5: Typical non-degradable garbage bag

In order to compare the cost of non-degradable bags with degradable ones, we decided to compare bags of the same strength made by the same company from the same supplier. UBC's garbage bag supplier is Acklands Grainger. From their online catalogue, it shows that the non-degradable garbage bags are much cheaper than the degradable bags by approximately $0.05-$0.10 per bag (Acklands Grainger, 2010).

WxL	Description	Type	Colour	Bag/Case	Price/Case	Price/Bag
35x50	Regular strength, recycled materials	Ralston 2700 series	Black	200	$56.87	$0.28
30x38	Regular strength, recycled materials	Ralston 2700 series	Black	250	$46.33	$0.19
26x36	Regular strength, recycled materials	Ralston 2700 series	Black	250	$38.06	$0.15
35x50	Regular strength, degradable	Ralston 2600 series	Black	200	$78.95	$0.39
30x38	Regular strength, degradable	Ralston 2600 series	Black	250	$64.35	$0.25
26x36	Regular strength, degradable	Ralston 2600 series	Black	250	$52.75	$0.21

Note: Above shows the online catalogue price of the bags from Acklands Grainger, but price reported by UBC is actually much lower.

Table 1: Price comparison between non-degradable and degradable bags (from Acklands Grainger)

2.2 BUFFALO BAGS

Currently, UBC is still using a green degradable garbage bags from Buffalo Bags. According to documents provided by Christian Beaudrie, the Outreach Coordinator of UBC Waste Management, these bags are currently being phased out to be replaced by Ralston 2600 series degradable garbage bags (UBC Garbage Bags Final, n.d.).

Figure 6: Buffalo Bags (from Buffalo Bags)

Buffalo bags claim to be 100% degradable in compliance with the ASTMD6954-04 test standard. The bag incorporates the Trioxo-d additive formula which allows the garbage bags to degrade in several stages. The first stage is triggered by heat, UV, mechanical stress and oxidation. This causes the additives to break the polyethylene chains in the material into smaller chains. The smaller ethylene-oligomer chains with presence of oxygen and micro-organisms can then to go through a second biodegradation stage to create heat, carbon-dioxide, water, and biomass (Greenkleen, n.d.).

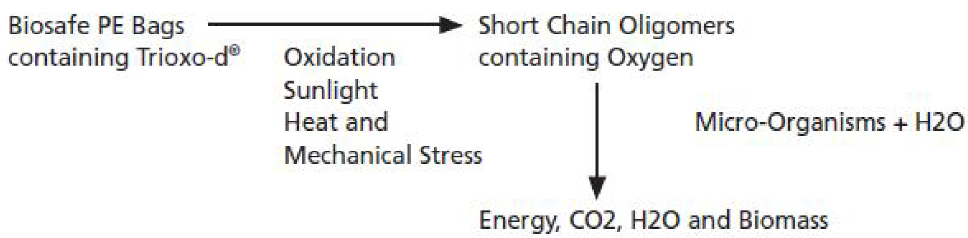

Figure 7: Degradation process for Buffalo Bags (from Greenkleen)

Various accelerated lab tests indicate that Trioxo-d plastics generally have a shelf life of 12-18 months. The first stage of degradation takes 12-24 months, and the second stage biodegradation takes another 12-24 months. These time frames will vary from different environmental conditions that the bags are disposed in (Greenkleen, n.d.).

2.3 RALSTON 2600 SERIES DEGRADABLE GARBAGE BAGS

Ralston 2600 Series Degradable Garbage Bags are another type of bags currently in use on UBC campus, and as stated in the previous section, they are expected to completely replace Buffalo Bags for garbage disposal purposes (UBC Garbage Bags Final, n.d.). The following two tables compare the prices for Buffalo Bags and Ralston 2600 Series Bags, and it can be seen that Ralston 2600 Series Bags have a clear advantage in terms of costs over Buffalo Bags:

W xL	Descrip.		Stock#	Colour	Comments	Amount	Cases/Year	Bags/Case	Price/Case	Price/Bag
35X50	Reg-liner		92	Green		$21,713.43	740	150	$29.34	$0.20
30X38	Reg-liner		2923	Green		$109,943.76	4,610	150	$23.85	$0.16
24X30	Reg-liner		4472	Green		$31,740.64	1,172	250	$27.08	$0.11

Table 2: Prices for Buffalo Bags (from UBC Garbage Bags Final)

W xL	Descrip.		Stock#	Colour	Comments	Amount	Cases/Year	Bags/Case	Price/Case	Price/Bag
35X50	regular		2665-01	Black	OXO Degradable	$28,725.72	1,172	250	$ 24.51	$0.10
30X38	Strong		2673-01	Black	OXO Degradable	$14,755.60	740	200	$19.94	$0.10
26X36	regular		2661-01	Black	OXO Degradable	$75,557.90	4,610	250	$16.39	$0.07

Table 3: Prices for Ralston 2600 Series Bags (from UBC Garbage Bags Final)

Note: The above prices for Ralston 2600 Series Bags are the ones reported by UBC and are actually much lower than the ones on the online catalogue from Acklands Grainger mentioned in Table 1.

Produced by W. Ralston (Canada) Inc. and distributed by Acklands Grainger Inc., Ralston 2600 Series Bags are categorized as "Oxo-biodegradable bags", and incorporate the additive known as Reverte Oxy Additive Masterbatch, which is supplied by Wells Plastics Ltd. located in the United Kingdom (Wells Plastics Ltd., n.d.). According to Wells Plastics, the addition of this particular additive formula allows the garbage bags to degrade in two stages very similar to how the degradation processes for Buffalo Bags work. The first step involves breaking down the polymer chains into smaller pieces in the process known as "oxy-degradation", which is catalyzed by the presence of the additive (Barclay, 2008). The second step is known as "biodegradation", where the smaller pieces of polymer chains are consumed by microbes in the presence of oxygen and converted into carbon dioxide, biomass, etc (Barclay, 2008). Wells Plastics claims that the additive it produces can greatly promote the growth of microbial colonies in order to enhance the biodegradation process (Barclay, 2008). The following is the figure depicting how the addition of Reverte additive enhances the breakdown of the polymer chains:

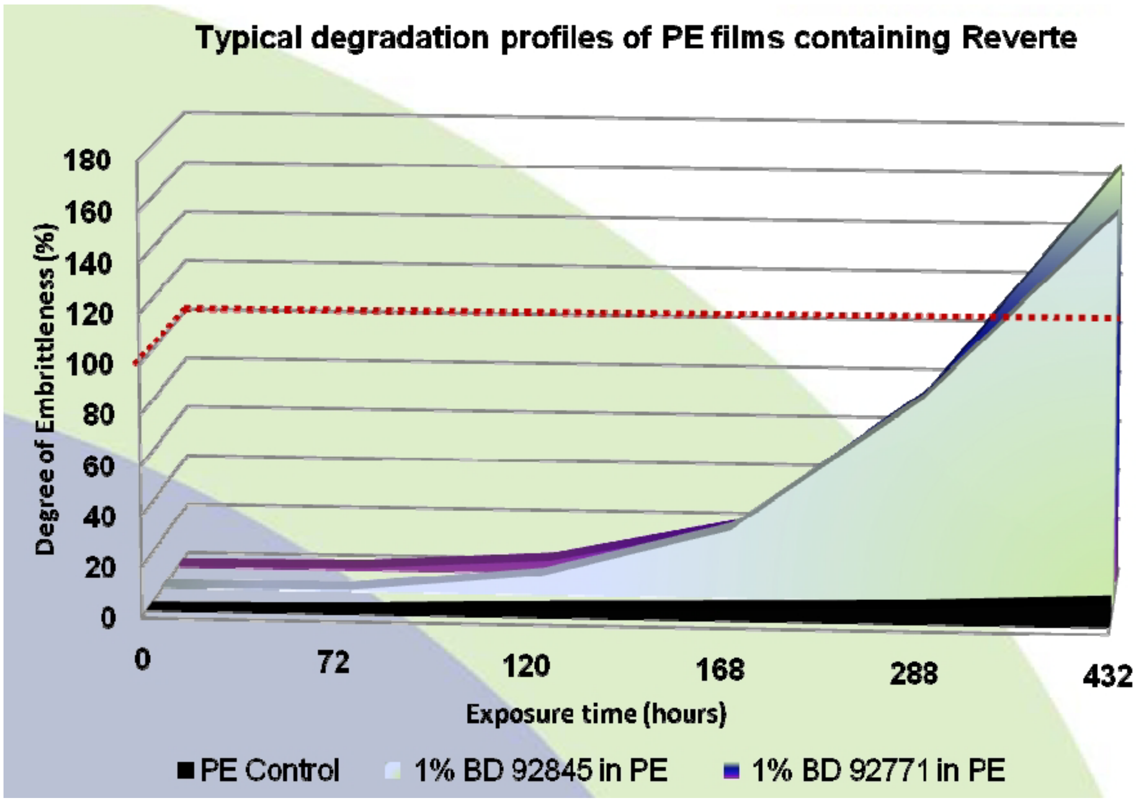

Figure 8: Degradation profiles of PE films containing Reverte additive (from Wells Plastics Ltd.)

According to the above figure provided by Wells Plastics, adding only 1% of Reverte additive (typified by BD 92845 and BD 92771 in the figure) can greatly improve the breakdown of the polymer chains, reaching a state of full embrittlement after approximately 300 – 400 hours. However, it needs to be taken into account that the result shown in the above figure was obtained in a test chamber at an ideal condition, with UVA and UVB lamps to simulate sunlight and an elevated temperature ranging between 35°C and 50°C (Barclay, 2008). Therefore, it is very likely that the results will be considerably different in the real world environment where the temperature and sunlight conditions vary throughout the year.

2.4 EcoSafe® ECO-DEGRADABLE GARBAGE BAGS

Besides investigating the Buffalo Bags and the Ralston 2600, we also looked into another brand of degradable garbage bag: EcoSafe Eco-degradable garbage bags. These bags are produced in two different sizes: 33'x44' and 35'x50'. They cost $0.73 per bag and $0.83 per bag respectively. (EcoSafe Plastic, n.d.) The company, EcoSafe, claims these garbage bags will completely degrade in landfill environment in a time period of 12 to 24 months under mild temperature condition (20°C to 35°C). Once in the landfill, these bags will begin to degrade under direct sunlight and oxygen exposure. (Guardian, 2009) When these bags are broken down into small enough pieces, microbes can complete the degradation process by ingesting the remaining pieces from the bags and converting them into harmless organic carbons. This two step process is called "oxo-biodegradation" by the manufacturer (much the same as "oxy-degradation" mentioned in the previous section). In order to produce plastics with oxo-biodegradation property, special additives are added to the plastic during the manufacturing process. According to the manufacturer, even with the added property of accelerated degradation, the quality and strength of these bags are comparable to normal plastic bags as long as they are used before the expiration date. On paper, these bags appear to be the superior choice for environmentally conscious consumers who do not mind the added cost per bag compared to regular plastic bags. But like the other two degradable plastic bags we compared, the claims of complete degradation in 12 to 24 months by EcoSafe should be taken with a grain of salt. The tests for the degradation process are usually done under consistent optimal condition throughout the whole test period; which is not realistic under real world environment.

3.0 BIN WASHERS (BAG-LESS SYSTEM)

Every option has an extreme, in the world of waste an extreme is to stop using garbage bags altogether. To do this at UBC, a number of issues would have to be addressed, such as the investment into new garbage bins, purchasing a garbage truck and the hiring of more employees. In order for the shareholder to make an informed decision on the idea of a bag-less system, we will look into the economical, environmental and social ramifications for this conversion to happen. Suggestions will be made on how to be a viable option after analyzing these 3 factors.

UBC currently has in place a bin washing system that processes the compost bins around campus on a weekly rotation. The shareholder envisioned that the process of cleaning and emptying bag-less garbage cans would be similar. This process is the following: bins are rolled outside once a week, bins then are picked up by handlers driving trucks, each truck picks up 10 of these carts swapping clean bins with dirty bins, trucks then bring back dirty bins to composting facility where they are washed by the bin washer. An additional step would be added to empty the bins by a garbage truck before swapping the clean and dirty bins, as seen in figure 9.

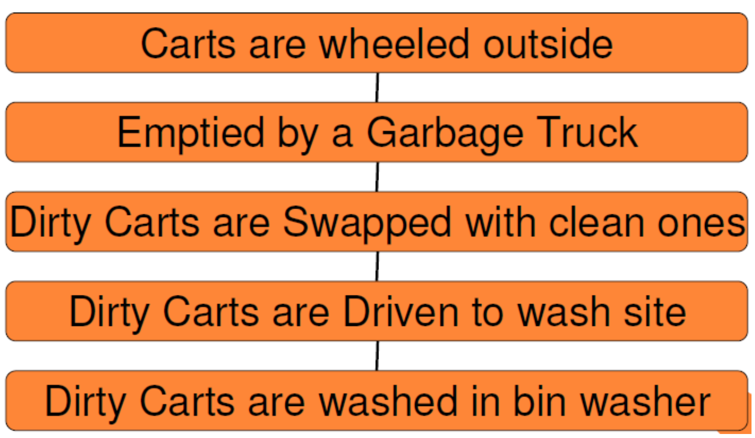

Figure 9: A flow chart depicting the process of a bag-less system

This process works well for the compost bins, where they currently use 1 truck, 1 bin washer, a facility helper who spends 1-2 hours a day processing the bins and a part-time swapper who wheels the carts in and out of the building. They currently process 40-50 bins a day, taking an hour to run them through the bin washer. The reason the shareholder is interested in this concept is that the bin washer, an investment of $250,000 as seen in Appendix A, is currently being used at 15% of its maximum throughput. While the number of compost bins will increase over the years it will take a number of years before the bin washer is at its maximum potential. By incorporating the bin washer into the designs of a bag-less system it will make more use of the bin washer.

Here are some numbers to better analyze the economical, environmental and social impact of initiating a bag-less system at UBC (All of this is lain out in Appendix B). Part of the integration to this new system would involve switching the current 25 gallon black cylindrical garbage cans to the same type of bins as the ones used to process the compost material. This is because the type of bin washer is designed to interface with this particular cart. To make this switch, 5000 garbage carts (Mountain Media, n.d.) would have to be bought to replace the current garbage cans. This would cost approximately $75,000, but with possible resale of the current garbage cans this number could be halved. As mentioned, a new garbage truck would have to be bought to empty each of these bins, as the current system uses a garbage truck that empties dumpsters (Trash Trucks Online, n.d.). This and an operator to handle the garbage truck would cost (with a 10 year depreciation cost) $134,000/year. Projecting the number of bins the bin washer currently washes per hour, to what it could do over an 8 hour period (without downtime) a single machine could wash 320 carts per day. This means that in a week a single bin washer could wash 1600 carts (assuming 40 hours a week). In Figure 10, a picture of the bin washer can be seen. The shareholder proposed that with this new system, bins would be washed and emptied as needed averaging out to be once a week. In order to clean all 5000 bins, UBC would have to invest into another 2 bin washers, 2 more wash sites and pay for 3 full-time facility helper, approximately $75,000 per year plus upkeep costs of sites and equipment. The current process uses standard pickup trucks to transport the carts to and from the wash site. Each truck is able to move 10 carts with an average round trip time of 30 minutes, so a single truck could move 120 of these bins a day. This would mean that 7 trucks would need to be bought, operated and maintained; which is approximately $680,000 a year. On top of this the carts would have to be moved from their places on campus to an empty and pickup location, by 2 part-time swappers; which would be approximately $19,000 a year.

Figure 10: An inside view of UBC's bin washer

Economically, mitigating the large capital costs of purchasing all this new equipment (bin washers, garbage trucks, new garbage cans, etc.) the approximate price per year to implement this system would eclipse the current system that has a garbage truck operator, janitors to empty garbage bins daily, and an annual garbage bag purchase price of $120,000. This option is not economically desirable.

Environmentally, while there would be no garbage bags, the current system would consume a large amount of gasoline, due to truck bin swappers, and a large amount of water and energy used to clean the carts. This option is on par environmentally with degradable bags.

Socially, there would not be too much difference other than possible hesitation in disposing of trash as the waste would be sitting for up to a week, whereas in the current system with daily bag replacement, a max of 2 days (Saturday, Sunday) would have trash sitting in one place. This hesitation would come from the smell associated with the sitting garbage. With some education on the positives of using the system, however, people could overcome their initial hesitation.

After analyzing this option on the 3 different levels, it does not seem a viable option. Possibly with some switches to the current process this might be a viable option. Options such as having wash sites spread across campus, and using a larger, flatbed truck to transport bins to and from the wash site instead of pickup trucks could be considered. This way one could reduce transportation time, reduce fuel consumption, and would require less personnel to move bins.

In the meantime, UBC could strive to optimize the current bin washer by choosing sites closer to the current wash site, switching these garbage cans to the required garbage carts, and developing a ramp or a robotic system to integrate with the dumpsters to allow handlers to easily empty the carts on their own into the dumpster, allowing for use of the current dumpster system and garbage truck. Doing a trial run at this scale would allow for further study of what would be required to implement this system UBC wide.

4.0 TRIPLE BOTTOM-LINE ANALYSIS

In our project, we looked into regular plastic bags, degradable garbage bags, and a bin washer system that can eliminate the use of any form of garbage bags. In this section we are going to assess the viability of these three options using the triple bottom-line assessment: economical, environmental, and social.

4.1 ECONOMICAL ANALYSIS

To analyze the economical aspect of these three options, we are going to first make a few assumptions. First of all, we are going to assume there are approximately 5000 garbage bins located around UBC. Each of these bins will be required to empty once a week. In order to empty the garbage bins, we will have to hire 7 labourers at a cost of $685,671 per year. This cost is approximated using the cost of hiring the cart-swappers for the bin-washer system as stated in the previous section. Because the three different types of degradable bags we compared seem to have similar properties with the only significant difference being the price, we will be using the Ralston 2600 in the comparison since that is the cheapest ($0.39 per bag for 35'x50') out of the three. The following table shows the cost of a year (52 weeks) of operation using each of the three options.

Options	Implementation Cost	Cost/bin (35'x50' bag)	Labour Cost	Additional Cost	Total Cost in a Year
Regular Garbage Bags	$0.00	$101,400	$685,671	$0.00	$758,471
Degradable Garbage Bags	$0.00	$72,800	$685,671	$0.00	$787,071
Bin-Washer System	$825,000	$0.00	$730,637	$134,020 (Trucks)	$1,689,657

Table 4: Economic analysis of the three options

As can be seen from the table, the cheapest option is regular garbage bags, followed by degradable garbage bags, with the bin-washer system being the most expensive. The difference in cost between using regular garbage bags and degradable garbage bags is negligible (3.8%). The cost of using the bin-washer system is significantly higher than the other two options due to the high capital cost needed to upgrade the bins ($825,000). Even if we were to disregard the capital cost, this would still be a more expensive option ($864,657). The savings from not using any bags are not enough to balance out the cost of hiring additional labourers and the cost of operating the trucks needed to transport the bins to the washers. Through this analysis, we can see that using regular plastic bags is the most economical option.

4.2 ENVIRONMENTAL ANALYSIS

In terms of environmental impacts, regular garbage bags appear to be the worst since plastics take a long time to degrade naturally. The production of these plastic bags uses petroleum and harmful gases may be produced as a by-product of the manufacturing process. (natural-environment.com, 2008) Degradable plastic bags are also produced in the same manner as regular plastic bags with the only difference in the added additive to the plastics in order to promote accelerated degradation under certain conditions. The problem with these degradable bags is that oxygen, sunlight, and microbes are needed in order for the degradation process to progress. In a normal landfill, most of these elements are non-existent or are extremely rare. This causes questions to be raised about whether these bags truly degrade fast enough under real world conditions. On the surface, the bin-washer system appears to have the lowest environmental effects because of its non-reliance on garbage bags of any type. In reality, other environmental impacts are created. In order to wash all of the bins on campus every week will require the consumption of a lot of water. Also, the transportation of all of the bins on campus to the site of the bin-washers requires the utilization of several trucks. These trucks create carbon emissions and uses gasoline when in operation. In terms of environmental impacts, all three options are equally suspect in the impacts to the environment they cause. If the degradation claims of the degradable bags are, to some extent, true, then it seems the degradable bags will be the better option in terms of environmental analysis.

4.3 SOCIAL ANALYSIS

In terms of social impacts, regular garbage bags and degradable garbage bags will have the least. Since we are already using regular/degradable garbage bags at UBC, no additional trainings or hiring will be needed to implement either of those options. For the bin-washer option, new workers will need to be hired in order to operate the machineries (trucks and bin-washers). Existing workers that are accustomed to the old system of using garbage bags will also need to be retrained in order to adjust to using the new bin-washers. Students and staffs at UBC will most likely need to be educated about the new system to prevent misuse (i.e. proper disposure of certain chemicals in order to avoid damage to the bins). Out of the three, the bin-washer system will cause the most social impacts if put into full service at UBC.

5.0 CONCLUSION

In conclusion, recycling disposable bags is a time and energy consuming process. Disposable plastic bags are heavily based on petroleum; therefore they can have many undesirable impacts on the environment. Two alternatives for plastic bags are degradable bags and bag-less systems. Degradable bags need sunlight or oxygen to degrade. In order to reach the goal of being sustainable, people should be informed properly about the differences between biodegradable, degradable, and compostable bags. The economical analysis of disposable plastic bags, degradable bags, and bag-less systems shows that the regular disposable plastic bags are the most economical bags to use but the environmental analysis shows that degradable bags are the best for environment and therefore they are more sustainable. The social analysis of the three options shows that bag-less bins are the best since it requires hiring more labor for the bin washer site.

Out of the three options, we believe the best choice currently would be to use degradable garbage bags (specifically the Ralston 2600 as that is the cheapest). The cost of using degradable bags is comparable to using regular plastic bags (3.8% difference) with the added benefit of accelerated degradation. The social impacts of using degradable bags are much lower than using the bin-washer system as no additional hiring or trainings are needed. In the future, the bin-washer system might become a good alternative if further improvements can be made to the process so that it will become more efficient (i.e. use fewer trucks, lower water consumption).

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APPENDICES

Appendix A

Equipment Costs for Bin Washers

Number of garbage bins	Price per 32 gallon bin	Capitol Cost		
5000	165	**825000**		
	Capitol Cost	Maintenance/year		
Bin Washer	**250,000**	**2000**		
Water usage per bin (liters)	Amount of water used (liters) over 5 days	Price per year for water consumption		
3	4800	**12480**		
Time to rinse 2 bins (mins)	Current utilization of washer (%) for 8 hour day	Max amount of bins that could be washed per day	Max number of bins washed per week (5 days)	Number of Bin Washers needed to wash bins once a week
3	15.6	320	1600	3
Bins moved by truck in one trip	Average Round Trip (mins)	Bins rotated per hour	Bins moved by one truck in a day	Number of Trucks needed to move max amount of bins per day
10	30	15	120	7

Appendix B

Personnel Costs for Bin Washers (Wongharichao, K, n.b.)

		$ rate		Quantity	$ per year	$ per year for 7
Cart Swapper						
1 Truck Drivers (Medium)	Labour rate / hour, plus the benefits and backfill	$28.00	Working hours / year	2,000	$54,603	$382,221
Pickup Truck, depreciation over 10 years	Depreciation per year	$12,000		1	$12,000	$84,000
Gasoline consumption	Estimated cost / week	$487		52	$25,350	$177,450
Vehicle maintenance, 10%					$6,000	$42,000
					$97,953	**$685,671**
Dumpster - garbage truck						
Operator/Driver Heavy Equipment	Labour rate / hour, plus the benefits and backfill	$35.18	Working hours / year	2,000	$68,600	
Garbage Truck, 70% utilized for garbage, depreciation over 10 years	Depreciation per year	$25,000	70% of the collection is garbage	0.7	$17,500	
Gasoline consumption	Estimated cost / week	$585		52	$30,420	
Vehicle maintenance, 10%					$17,500	
					$134,020	

Facility Helper	Labour rate / hour, plus the benefits and backfill	$14.00	Working hours / year	2,000	$25,919
					$25,919
Swampers - 2 staff, 2 days a week, 4 hours each	Labour rate / hour, with the benefits but no backfill since working PT	$22.89	Working hours / year	832	$19,047
					$19,047