Recycling at Towson University

Where we are and where we can go

ENVS 491
Senior Seminar
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Gladys Apolonio
Douglas Bange
Cathy Bay
Jessica Bilecki
Christi Boone
Megan Brosh
Paul Clark
Jim Clay
Christopher Connelly
Curtis Hall
James Karl
Jason Krankowski
Adrienne McDonough
Carla Quinn
Michael Schlenoff
Angelia Seyfferth
Lance Smith
Tausi Suedi
Mary Valentino

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PREFACE

All students completing the Environmental Science and Studies major enroll in ENVS 491, Senior Seminar, during their senior year. In this course, students are presented with an environmental problem and 'charged' with investigating it, analyzing it, and developing a range of solutions that are economically sound, logistically feasible and that incorporate stakeholder needs and constraints.

The Office of Contract Services within Facilities Management on campus provided us with this project (and assisted greatly in its execution). The University has a recycling program but in spite of our recycling program we expend significant funds removing waste from campus. They hoped that this group of students could look at the recycling and waste issue on campus and develop suggestions for improvement. What follows are the results of a semester of work on this issue.

The students have worked on this on their own. I provided only limited guidance and help as requested. They deserve the credit for their success.

CURRENT RECYCLING AT TU

History of Recycling and Current Programs

Towson Contract services were established in 1983. Their primary goal was to rewrite the existing housekeeping contract. It is responsible for approximately twenty- five service contracts (writing, evaluation and administration). Towson pays for the service rendered.

Towson's recycling program comes from the Governor's mandate of 1989 that 20% of waste products should be recycled. The recyclable items include aluminum, glass, metal, paper, plastic, toner cartridges and metal. In order to attain acceptable recycling levels, the program seeks student help.

The University's official definition of recycling is any process in which materials that would otherwise become solid waste are collected, separated and processed, then returned to the marketplace in the form of raw materials and products. The university has been mandated by the state of Maryland to recycle at a minimum of 20%. Towson currently recycles at 29%. Included in the recycling program are aluminum cans, glass bottles, steel/tin cans, plastic bottles, paper, cardboard, laser toner cartridges, light tubes, scrap metal and wooden pallets.

Aramark, the company that currently has the housekeeping contract, is responsible for running the recycling program on campus. Aramark is also responsible for appointing one of their own personnel as Recycling Coordinator. The Recycling Coordinator's responsibilities include operating, promoting, advertising, marketing and reporting components of the program. The program also allows for student involvement. A minimum of four part-time positions are available and to be used as supplemental labor. Currently, there are no students working in this program. There are three full-time jobs available.

Aramark, or any business holding the housekeeping contract, is required to create an advertising and promotional program for recycling. This includes flyers and posters to involve the campus community in recycling. Another of Aramark's responsibilities is to market the recyclables, attempting to find the most easily available and economically favorable markets. Revenues generated are to be split 60/40, with 60% going to the contractor and 40% going to the University. One of the constraints of the recycling program is the current market. If markets are not found the materials must go to the landfill with the non-recyclable waste.

The contractor is responsible for reporting all numbers and figures. These include monthly operating reports, monthly financial reports, and any other quarterly or annual reports.

Aramark is responsible for making sure the bins remain in their prearranged locations, as well as ensuring that the recycling labels may be clearly seen. The containers are to be wiped on a regular basis so they remain presentable. This includes wiping the wall behind the containers and sanitizing to prevent insect pests.

Recycling Survey

To improve the recycling program at Towson University, we must understand the current attitudes and behavior of the Towson community towards recycling. Dr. Jane Wolfson and colleagues developed a survey to gain this information from the community (Appendix A)._The first section of the survey consists of multiple-choice questions and the second half is made up of open-ended questions. The responses to the survey will help us increase our knowledge about the attitudes and behaviors towards recycling on campus and rationalize the reasoning behind the communities' recycling actions. Based on the communities' responses, we can make suggestions to improve Towson University's recycling program.

To fully understand the community, we tried to obtain a representative sample of the community according to each individual's status at Towson University. Our sample included the following groups: full time students, part time students, full time faculty, part time faculty, administrative staff, Aramark staff, and Chartwell staff. We sampled according to the proportion of the population that each status represents on campus (Fig. 1). Each member of the Environmental Science 491 class conducted approximately fifteen surveys (a total of 210) in a period of fourteen days. Full time students were the largest portion of the sample, followed by full time faculty, support staff Chartwell, support staff Aramark, part time students, administrative staff, part time faculty, and visitors, respectively.

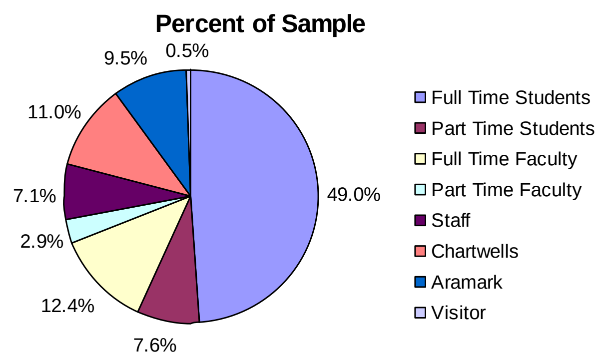


Figure 1: Pie chart representing the proportion of each status for our sample at Towson University.

The first portion of the survey was intended to learn more about the community's current recycling behavior and attitudes towards recycling. This portion of the survey asked respondents to state either how strongly they agree or disagree to a certain statements or how often they execute certain recycling behaviors. The responses, from the first portion of the survey, were entered into the SPSS program as nominal data. SPSS is a computer program, similar to Microsoft Excel, used to conduct statistical analyses on data. After viewing the results, we decided to condense full and part time students and full and part time faculty into two categories: one for students, and one for faculty. There was only one visitor interviewed, so this data was eliminated since the data would not accurately represent this group.

A series of tables were created to analyze the results according to each individual's status on campus (Appendix B). The results we found most interesting are given in Figures 2 – 5, which are discussed below. The graphs and tables show the variation of responses between the different groups of the Towson community. Additionally, figure 5 depicts the difference in behavior on campus and at personal residences.

The second part of the survey consisted of questions regarding the specific thoughts about and possible solutions to Towson University's recycling program. In order to better understand the community's thoughts on the issue, we asked each group the following three questions:

1. What do you think might make other people more willing to recycle on campus?
2. How could recycling on campus be made easier for you?
3. Since you came to Towson, do you recycle more or less?

The ideas of the different groups of the Towson community are important for developing possible solutions for improving Towson University's recycling program. Tables were created in Microsoft Excel using the responses of the second portion of the survey (Appendix C).

Figure 2 below depicts the results for questions 9 and 11. Question 9 focuses on people's views on convenience of recycling at Towson University and question 11 looks into their views on bin location. The trends of the responses for each status are similar in both questions (Fig. 2).

Figure 2: A comparison of responses between questions 9 and 11.

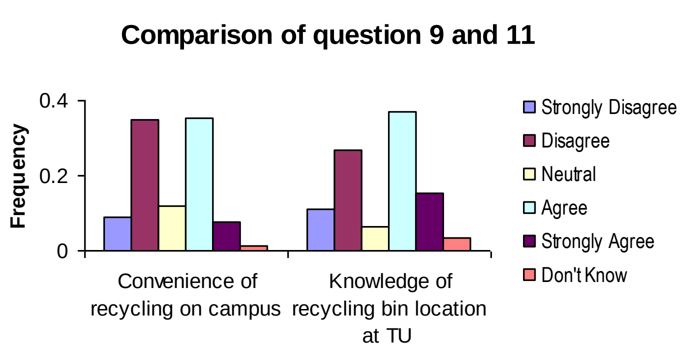


Figure 3 below shows the results of question 9 for both the administrative staff and the students. It depicts the different views of students and staff on the convenience of recycling at Towson (Appendix C). It is interesting to see that most students disagree with the question, whereas most staff members agree or strongly agree (Fig. 3).

Figure 3: Staff and Student responses about recycling convenience

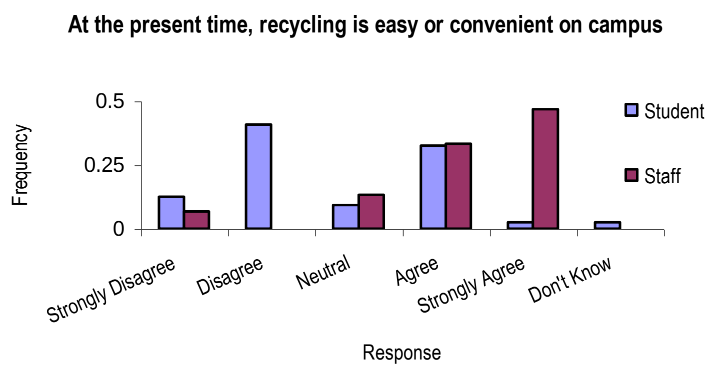


Figure 4 shows the results for question 11 for both the administrative staff and the students. It depicts the difference between the students' and the staff members' awareness of bin location. Most staff members strongly agree that they know the locations of bins whereas student responses vary, with a larger number of individuals who disagree (Fig. 4).

Figure 4: Staff and Student responses about awareness of bin location

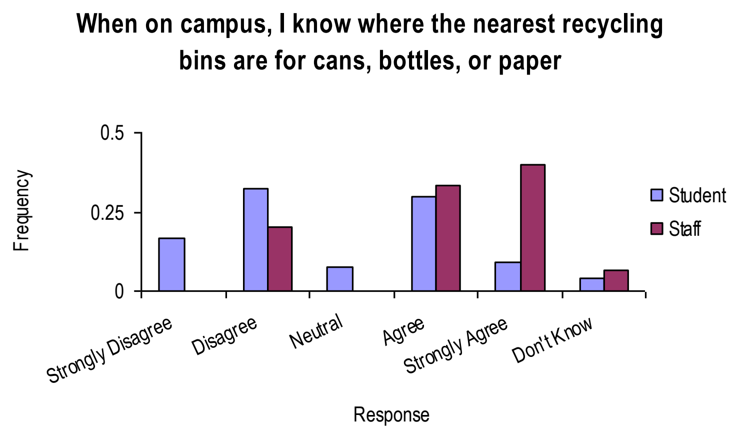
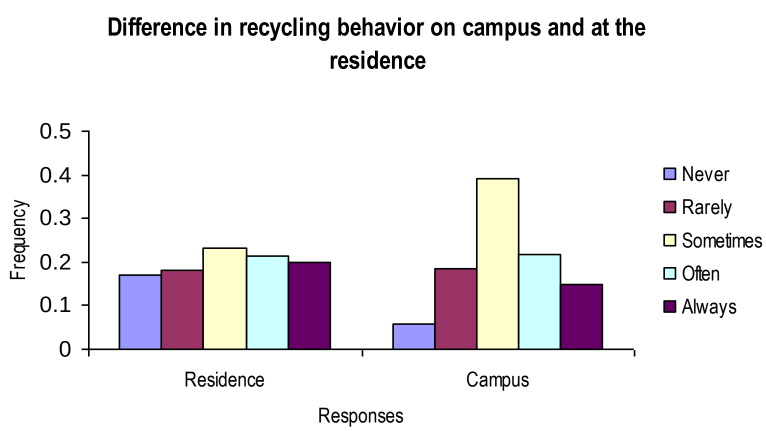


Figure 5 shows the results for questions 12 and 13 (Appendix C). It illustrates how behavior on campus differs from behavior at one's residence in regards to recycling. The responses for these questions show a larger variation in responses for on campus recycling than for residential recycling (Fig. 5).

Figure 5: Recycling behavior on campus and at residence



The first portion of the survey

To analyze the data from the first portion of the survey, we looked at current trends within the different groups of the Towson community. Assumptions were made about responses with a considerably higher frequency of occurrences than other responses, meaning the responses given more often (Figures 2 – 5). Some results show no substantial difference in the frequency of responses. Therefore, these questions show no difference in the views of the various statuses at Towson.

Some students that interviewed the Aramark personnel felt that the responses they received may not have accurately reflected the views of this group. This could have been partly due to communication difficulty or to a language barrier. Additionally, Aramark employees may have felt their answers could have had a negative effect upon the community's view of their work. Thus, the Aramark personnel may not have answered as honestly as they would have otherwise.

The results show that most people interviewed feel that recycling is important. Furthermore, the majority of the responses reflect that most individuals questioned know what materials can be recycled on campus, although their behaviors do not always correspond to this knowledge.

When we looked at the difference in responses from the various groups, most of the differences came between the student responses and the administrative staff responses. The survey shows that staff members feel recycling is convenient on campus, whereas students believe that recycling is not convenient (Fig. 3). Students may behave or act this way because they are mobile, moving from one place to another, while staff members remain in the same office. The staff members know where to place their recyclables because the recycling bins are always in the same location. The faculty responses differ from the administrative staff responses and are more similar to the students' responses. This may be because the faculty is also mobile, for they travel to different buildings throughout the day. This illustrates that recycling is convenient for persons who remain in one location throughout a day but not for those who travel around campus. The majority of those surveyed (47%) responded that they never keep recyclables to recycle later if no recycling bins are available. From this we can assume that if recycling is not convenient to mobile persons, then their recyclables will go into the trash.

When analyzing the difference in recycling behavior at residences verses on campus, we found that staff members recycle more when on campus, faculty members recycle more frequently at home than on campus, and student responses do not show a trend. This supports the indication that people are more likely to recycle when it is convenient. The data also show a greater variation in responses for on campus recycling than for off campus recycling. People sometimes recycle more when on campus than they do when they are off campus. This could also be related to the convenience issue. When on campus, if it is convenient to recycle at that time, one will dispose of their recyclables properly. If it is not convenient, individuals will not recycle.

Responses from Aramark personnel demonstrate that recycling was explained to them when they came to Towson. This explanation may occur because Aramark personnel are responsible for collecting the recyclables. When they start to work at the University, their training most likely teaches them how to handle recyclables and where to take them. The responses from students, faculty, staff, and Chartwell personnel suggest that recycling at Towson University was never explained to them. They were never educated on the recycling program or on the rules and locations of the bins.

The second portion of the survey

Question 17 was aimed at determining simple solutions of how recycling could be made easier for each group (Appendix C). Among the total surveyed population, the most frequent response was to increase the amount of recycling bins. Apparently, recycling is not convenient to most students when they are on campus. Chartwell staff, who work in food service areas, also attested to this statement. Other prominent recommendations were to improve the bin location and make them more noticeable via advertisements. The most startling response was by five faculty who claimed that enforcement had to be tighter to make sure that the Aramark staff do not simply place collected recyclables into the trash.

Question 18 asked the community for their views on how others may become more apt to recycle (Appendix C). Again, increasing the number of bins and improving the accessibility of these bins were a common response. In addition, many students thought that developing an incentive or awards program would further promote on-campus recycling. Additionally, the Towson community felt that improving recycling education around campus is needed.

Lastly, question 19 was asked in order to evaluate the overall recycling effort among the different groups of the Towson community (Appendix C). Overall, the results indicate that the Towson community recycled at various levels before they came to campus. However, the individual data for students, faculty, and administrative staff is in high contrast. According to the data, large majorities of students do not recycle as much now as they did before they came to Towson University (Appendix C). On the other hand, a large portion of both faculty and administrative staff responded that they recycle more now than they did before they worked at Towson University.

Overall, the results for the first part of the survey show convenience seems to play the largest role in the choice of recycling. When recycling is easy, people will place their recyclables in the correct container. However, people may dispose of recyclables in the general trash if it is more convenient. When given the choice of doing what is good for the environment or what is easy, most people do what is easy. People feel recycling is important, but will not keep recyclables until later if no bins are available.

The results of the second part of the survey were consistent with the first part of the survey in that people of the different factions of the Towson community seem to typically agree on the same issues, and opposing factions do not necessarily agree on the same issues. Clearly, according to the survey data, many students do not feel that recycling on campus is easy, and, in contrast, many university employees feel that the program is relatively convenient.

Campus Waste Audit

In order to assess the composition of campus trash, a waste audit was conducted between October 21 and 29, 2002. We sampled 5 bags of trash from each of four 30-cubic yard dumpsters. Each dumpster was sampled on two separate days which were days just after the dumpsters were emptied. Four dumpsters were sampled for a total of 10 analyses, or 50 bags of trash. The building dumpsters we sampled belong to Stephens Hall, Enrollment Services, Newell and Richmond dorms, and Ward and West dorms.

For each analysis, the initial weight of the trash was determined with a digital scale. The trash was then separated into piles of general trash, paper recyclables, plastic recyclables, glass recyclables, aluminum recyclables, and general metal recyclables. Then, each pile of recyclables was placed into a bag and weighed with the digital scale. The weight of general trash was calculated from the difference of the initial weights and the weights of the recyclables.

The percentages by weight of each recyclable were determined for each analysis and for the total of all 10 analyses (Appendix D). The combined weights of the recyclables are presented below (Table 1) and are compared to national averages estimated by the EPA in 2000 (EPA, 2000). From the data it is clear that TU recycling efforts are much better than the national averages. The weight in pounds was converted into cubic yards using conversion factors given by Charles Boaz (Appendix E). This density information was obtained from the Guide to

Commercial and Institutional Recycling prepared by the Northeast Maryland Waste Disposal Authority.

	TU		EPA	
	Weight in Trash (lbs.)	Percentage of Total Trash	Weight in Trash (tons)	Percentage of Total Trash
Paper	47.06	11.79%	17.3	44%
Glass	46.5	11.65%	8.3	74%
Al	9.19	2.30%	1.1	55%
Metals	2.38	0.60%	1.2	41%
Plastic	26	6.51%	10.2	91%

Table 1. Percentages and weights in pounds for the combined audited waste at Towson University compared to national averages estimated by the EPA. The total volume of trash audited from all 10 analyses = 399.12 pounds.

HOW TO IMPROVE RECYCLING AT TU

Suggestions

After our investigation of Towson University's (TU) recycling program, the Environmental Science and Studies 491 class saw potential solutions that may aid in improving the current recycling program. These recommendations were developed after we conducted our questionnaire, campus waste audit, and finally the interpretation of the results. These suggestions are in no way meant to demean the current program, but rather are presented in an effort to improve the current system and to offer ideas that may increase participation in the program. Since students make up most of the Towson University community, and because ARAMARK employees are vital to the success of the program, our solutions are focused on these two groups.

The NRC and the CURC

With the assistance of Gina Conroy, it was decided that TU would become a member and join the National Recycling Coalition (NRC). Founded in 1978, the NRC is a nonprofit organization of over 5,000 individuals, businesses, and government agencies. The NRC helps its members with aspects of recycling, waste prevention, reuse, and composting. Towson University and its recycling committee should use all the benefits and resources that this organization provides. An increase in recycling productivity and knowledge can be obtained through networking with other NRC members, reviewing all the latest developments in bi-monthly newsletters, attending conferences and workshops, purchasing discount products, and utilizing the help of advisors and expert consultants. TU's involvement with the NRC could help to improve the recycling program and thus affect the community in a positive way.

One benefit of membership in the NRC allows TU to join the College and University Recycling Council (CURC) for free. Formed in 1992, the CURC became a technical council of the NRC in 1995 and acts as a network for college campus recycling professionals. Not only does membership give TU full access to resources, archives, and toolkits on the members only section of the website, (http://www..nrg-recycle.org/councils/CURC) but TU's name will be added to a list of over 300 colleges and universities who are already active members of the CURC. These CURC institutions have been using the NRC to improve and to better manage their recycling programs, just as TU will.

Bin Placement

As evidenced by the results of our questionnaire and observations, bin placement seems to be a large problem around campus for students, which make up most of TU's population. In order to increase the amount of recyclable commodities collected on campus, it is imperative to address students' problems with the current placement of recycling bins. Inconvenience and lack of incentives make it difficult for many students to recycle on campus. The following bullets are some suggestions and ideas that we have compiled that may help to improve the inconvenience issue of TU's recycling program:

* Trash cans and recycling bins: never have one without the other. Trashcans significantly outnumber recycling bins on campus. Thus, it is more convenient to throw a recyclable away in the trash rather than to place it in a recycling bin. If trashcans are always coupled with recycling bins, student compliance should improve. Implementation of this should not increase work for ARAMARK since the number of trashcans would be reduced as more recycling bins are added.

* Clearly advertise the recycling containers. Many of the containers outside on campus look very similar to trashcans. If neon-colored advertisements were placed on the outside of the containers, the bin would be easier to see. In addition, if the advertisement contains information as to what is acceptable and what is not acceptable in the bin, contamination of the recyclable commodities would be reduced.

* Place more recycling bins in buildings and decrease the number of trashcans available. If small trashcans were removed from classrooms and more bins were placed in the hallway, students would be forced to recycle. Teachers could enforce cleanliness in classrooms by encouraging students to take their recyclables with them when they leave. We recommend that bins should be placed at both ends and in the middle of each hallway in all buildings.

* Promote recycling of the Towerlight and other newspapers. Have designated recycling containers for the newspapers and put advertisements on them that stress the importance of recycling on TU's campus. A catchy slogan could be placed on the container, perhaps "TU Cares, Do you?" Also, an encouraging slogan could be printed on the front page of the Towerlight such as "Recycle me."

* Have more recycling bins on campus. Trouble spots include the following locations: parking garages, bus stops, Towson Center, football and baseball stadiums, the porch between the Union and the Union garage, outside eating areas such as The Den and Susquehanna, and outside of Towson Run, Millennium Hall, Enrollment Services, and Smith Hall.

Awareness

In addition to the above suggestions, we recommend that students should become more aware of TU's recycling efforts. Awareness of recycling on campus is very important in the amount of materials recycled. If students are more aware of the recycling program, we believe they will be more likely to recycle. New students may become more aware of TU's recycling program if, as part of orientation, a special speech is given to educate students about TU's recycling program and the importance of recycling. A video on recycling could be shown at orientation or in a freshman English class.

Awareness of the recycling program could also be increased in the following ways:

* Educate residence attendants about recycling on campus and require them to pass along this information to their residents.

* Send a message to the TU community that recycling is important by closing the loop and purchasing recycled products. The copy center and the printers on campus could use recycled paper and the bookstore could sell mostly recycled materials. If students see that TU thinks recycling is valuable, they may be more inclined to recycle.

* Create a TU recycling website that contains all details and information about the recycling program. The website would educate the TU community of how, where, and what to recycle on campus. As an inexpensive way to do this, TU could have a contest between students

in the computer science or graphic arts programs to see who can make the best recycling website. TU could then reward the winner with a small prize and use the website.

Student Involvement

Since students are the majority of the population on campus, it is logical that they should be the targets of improvements to the current program. Gina Conroy and Charles Boaz identify the lack of student involvement as one of the limits to improving TU's recycling program. The following bullets are suggestions as to how students can become more involved in recycling on campus.

* Advertise the student Recycling Assistant positions that are available. A member of our class has already made a detailed job description and a brochure that advertise the position. We will give these materials to Charles Boaz and Gina Conroy for their future use in advertising the positions. It is our hope that these materials will encourage students to apply for these vacant positions. This job offer would be great for students with a busy schedule and a lack of transportation.

* Encourage Towson athletes to work in the recycling center and around campus as one of many fundraisers the athletes need to fund their trips to away games.

* Make the option available for Fraternities, Sororities, and other campus groups to work at the recycling center as a community fundraiser. This way the student organization benefits as well as the university as a whole.

* Give students the option of receiving class credit for working as a Recycling Assistant for a semester.

* With the help of students in the Environmental Science and Studies Program, TU can advertise recycling during events such as Earth Day. TU could also create "Towson Recycling

Week" and have it once a semester to encourage and educate the TU community about the importance of recycling.

* Force students who are getting in trouble to work at the recycling center for free. Students who get in trouble for drinking alcoholic beverages in dorms are often made to do community service work. If the student worked as a Recycling Assistant for their punishment, the delinquent would be taught a lesson and TU would benefit from the free labor.

Incentives

In addition to the above suggestions, student awareness and compliance of TU's recycling program can be accomplished through incentives. College students are notorious for not having much spending money and are always looking for a bargain or something free. The following bullets identify some possible incentives that would encourage more students to recycle and reduce the generated campus waste:

* Give incoming students a plastic mug with a recycling slogan on it as a gift. When using this mug to purchase beverages on campus, students would receive a discount on the beverage. This would greatly reduce the amount of disposable cups used, which will help to reduce campus waste.

* Give a cloth bag with a Towson University logo as a free gift with the purchase of $100 or more at the University Bookstore. Each time the student used the cloth bag to make purchases, they could receive a small discount on their purchase. This is an inexpensive way to reduce the amount of plastic bags used.

* Hold recycling contests between TU's residence halls and see who can recycle more in a given amount of time. Since students are known to be very competitive with one another, many

groups would likely participate. Whichever residence hall wins could be rewarded with a pizza or an ice cream party.

ARAMARK

Although students are the majority of the population, ARAMARK employees play a large role in the amount of recyclables that get collected and processed. Almost every piece of material that is to be recycled on campus passes through the hands of these often neglected employees. To increase the amount of recycled materials that make their way from the bins to the recycling center, collection should be made as easy as possible for these employees. The following suggestions are presented as ways that may make campus recycling easier for ARAMARK employees:

* Provide better carts to pick up materials. If the carts were better equipped to hold both recycling and trash, it would be less awkward for ARAMARK employees to maneuver the carts when picking up the materials.

* Have separate crews to pick up trash and recyclables if the above suggestion is not possible. One crew could collect the recyclables at night and another crew could just worry about picking up trash during the day. In this way, the awkwardness of trying to collect two types of materials at once is eliminated. Towson faculty and staff members who have recycling bins in their offices would have to be responsible for putting their recyclables out at night. ARAMARK employees could simply walk down he halls with mondos and collect the recyclables in front of each door. This would lessen the burden on ARAMARK employees and place more responsibility on Towson faculty and staff.

* Educate ARAMARK employees on the importance of recycling to TU and to the world as a whole. Education is critical because if people do not know the importance of recycling, they

are much less likely to go out of their way to recycle. A video could be shown to ARAMARK employees when they are hired and during regular meetings, which would educate them more about recycling.

* Entice ARAMARK employees to recycle more by offering incentives. One idea is to provide a Holiday bonus to ARAMARK employees for gathering a certain amount of recyclables in a given time period. The money generated by increased recycling could be used to fund this bonus.

WHY TO IMPROVE RECYCLING AT TU

Benefits to the TU Community

Recycling has many benefits that sometimes go unnoticed. There are several factors aside from the economic and biological point of view that can benefit the immediate community and the surrounding society. Recycling is a challenging topic to understand when you attempt to compare the environment and the economy. When the long-term view is taken into account, good environmental procedures will result in positive economic benefit. Also, the act of recycling offers both an extended future benefit and an aesthetic benefit.

In our college setting, the University can train students to recycle and hopefully motivate them to continue to do so throughout the rest of their lives. A new student coming to Towson University can be influenced that recycling is the best thing for both the community and the environment. Towson can also lead by example for other colleges, universities, local organizations, and surrounding companies. The program could also have an extending effect on both faculty and student homes. If a student or teacher gets into the habit of recycling while on campus, the behavior may very well carry over into their home. For a student studying to become a teacher, their actions may have an exponential effect. If the graduated student takes the role of recycling into the classroom and educates their new students on the issue, most students educated on the importance of the issue will carry the behavior into latter years of their life.

It is very important to start educating as young as possible. If freshman students coming to Towson have not been educated or have not begun recycling; the University should start the education process and stress its importance. The age of 17 or 18 is not too old to start!

If a recognized recycling program was in place for Towson University, it may attract students and other beneficial education opportunities may arise. A student interested in an Environmental Science or Biology program may choose Towson University over an academically comparable institution due to their renowned recycling program. Of course it would take both time and effort to get Towson to this point, but the results may be worth the time and energy if it increases student recruitment.

One way to represent the benefits is to look at other Universities and Colleges and the benefits they have gained by recycling. The University of Michigan, Ohio State University, Winthrop University, and University of Oregon have all received benefits from their recycling programs.

In 1999 the University of Michigan decided to divert polystyrene packaging from trash bins on move-in days (University of Michigan, 2001). As a result they diverted enough packaging including packaging peanuts, foam sheeting, and bubble wrap to fill one and half semi trucks (University of Michigan, 2001). They transferred this packing material to the campus Mail Box, Etc. store to be reused. This benefited the school in that they did not have to purchase this material and they did not have to spend money on waste disposal.

The University of Michigan now uses Eureka 100, a chlorine-free, 100% post-consumer recycled content paper (University of Michigan, 2001). The University decided to use this product to close the loop in recycling. It cuts costs, and is guaranteed to be as good as regular non-recycled paper. Another benefit the school has received is lower supply costs. The school has contracts with local vendors to take their used ink and laser cartridges. These vendors disassemble, clean, and re-fill the cartridges and sell them back to the school for half the cost of a new one.

As a result of the University's excellent recycling program they have won awards including the Michigan Recycling Coalition Award (University of Michigan, 2001). They have also received grants to fund their recycling program. Another benefit to the community surrounding the campus is that due to the increasing amount of recycling rates, the city of Ann Arbor opened a new Materials Recovery Facility (MRF) (University of Michigan, 2001). As a result of the MRF more jobs for students and residents of the surrounding area were provided.

Ohio State University is another example of a higher education school that has improved their recycling program. As a result of their improvements there has been a connection established between the Students for Recycling, Residence Life, Undergraduate Student Government, and Ohio University Activities Board (Ohio, 2002). This was the first type of program to link these groups together on an every day basis. The schools recycling program has received $6,100 in grant money from Coca Cola to put more recycling bins on campus (Ohio, 2002). They have also received $1,500 to be used towards the program (Ohio, 2002). The University has created a videotape to educate custodians, students, and staff on how to recycle and the possible benefits. The campus also conducts Donation Drives during move-out days of the residence hall (Ohio, 2002). They collect unneeded clothing, food, etc. that is given to the Open Shelter and Salvation Army (Ohio, 2002).

Winthrop University set up the W.E.C.A.R.E recycling program. In 1993 the University was awarded a South Carolina College and University grant, which funded advertising schemes for the campus (How, 2002). In 1996 the school received the first of many awards from the South Carolina Department of Health and Environmental Control. The first award was for $3,500, which was used to obtain 120-28 gallon containers to upgrade the recycling program (How, 2002). Since 1996 the school has received a total of $44,129 from the South Carolina Department of Health and Environmental Control (How, 2002). As a result of the Winthrop University program 14,658 trees, 3,535,389 KWH of electricity, and 51,737 pounds of sold air pollutants were conserved (How, 2002).

One school that has an excellent program to follow is the University of Oregon. The University of Oregon's recycling program is a student run program from volunteers, students on Work Study programs, and those students who receive credit toward graduation. This is a benefit to the school in that they do not have to hire full time employees with benefits. This in-turn cuts the cost to the school. Overall the recycling program at this school is remarkable. The students do the advertising, the research, and are a big part of the actual recycling since they are the majority participating (University of Oregon, 2002). The University of Oregon receives numerous amounts of grants and donations to the program that offset a majority of the costs. The recycling program runs activities with the staff and students. For example, incentive driven contests between dorms and faculty buildings are conducted to see who can recycle the most.

As documented above these schools have excellent established programs. As a result they are receiving awards, recognition, and money for their efforts. Towson University could use these schools or many others as models to assist in improving the current program. Towson University's recycling program can only benefit its community by incorporating these new recycling ideologies into its current protocol.

Economic Analysis of Increasing Recycling

The purpose of this research is to provide Towson University with a basic rough estimate of a cost benefit analysis for the increase of recycling on campus. A cost benefit analysis is a breakdown of the cost effectiveness of different alternatives in order to see whether the benefits outweigh the cost. In the case of this research, the analysis will determine whether the environmental benefit of recycling will create an economical benefit as well.

The importance of a cost benefit analysis of recycling will provide Towson University with a base money figure on the cost or savings with the increase of recycling, and will play a major role in the decision making process. This analysis should give TU sufficient data on the costs or benefits of increasing recycling on campus.

This cost benefit analysis will include the methodology that will explain where, how, and why we came up with are variables, and will explain how we put the data together. The calculations will show calculations used to determine current cost of recyclables in the waste stream, the cost of recycling recyclables in waste stream, and revenue made from recyclables in the waste stream. The results will be given in text, graphs, and mathematically, and will explain how much will be saved or spent due to an increase in recycling. The interpretation will provide information on both high and low estimates and different solutions from those results. Lastly, the conclusions drawn from our findings will provide exact information on what we have found from our campus waste audit.

This cost benefit analysis will consist of the recycling of plastic, glass, aluminum, non-aluminum metals, paper, and cardboard. Due to the differences in fees in hauling, disposal, tipping, and renting, as well as different market prices, each recyclable will be analyzed separately.

METHODOLOGY

The methodology includes assumptions that explain the methods use to determine cost savings, cost increases, and revenue, along with methods used to determine volume and weight.

Assumptions

- The percent of trashed recyclables and non-recyclables is held constant throughout FY 2002 and FY 2003.
- The days sampled in the waste audit are representative of a typical day at Towson University.
- Market prices for recyclable for this analysis are held constant using the latest prices from December 2, 2002.
- All recyclables in the waste stream will be recycled.
- The waste pick-up schedule is held constant throughout FY 2002 and FY2003 (Appendix F).

1) Volume
The sum volume (by % and cubic yards [cu/yd]) of each material (glass, plastic, paper, etc.) within a typical dumpster is found by multiplying total tonnage of waste in FY 2002 by 2000 pounds per ton to convert tons to pounds, next multiply that product by the density of the subject material (i.e., glass is 500-600 lbs. / CuYd). Lastly, multiply the latest product above by the subject material's percentage by weight (Appendix D). This yields the total CuYd of the subject material per year.

To find the sum volume percentage of each material divide each material's volume (CuYd) by the total volume in the waste stream per year.

2) Weight
The sum weight (by percentage & tons) of each material (glass, plastic, paper, etc.) is found by multiplying total tonnage of waste in FY 2002 by the subject materials percentage of total trash (Appendix D).

To find the sum weight percentage of each material divide each material's weight (tons) by the total weight in the waste stream per year.

Note: For all fees and costs below, refer to appendix G.

COST SAVINGS:

1) <u>For hauling fee</u>--- The hauling fee per year for all recyclables can be found by multiplying the hauling fee per haul of the subject dumpster by the number of hauls per week of all the same type of dumpsters. Next, multiply that product by the subject material's percent by volume. This yields the total hauling cost for the subject material per week for all of the same type dumpsters. Do this for each recyclable, then sum all of the recyclable's total cost per week. Then, multiply that by 52 weeks per year. Repeat the above for each dumpster type. Lastly, sum all of the dumpster type's total cost per year to get the grand total hauling fee for all recyclables in the waste stream per year.

2) For disposal cost--- The disposal cost per year for all recyclables can be calculated by multiplying the size of the dumpster (i.e., 30cy) per haul by the density of general trash. Then divide that product by 2000 pounds to yield tons/haul. Next, multiply that product by the subject material's percent by weight (refer to Waste Audit). Subsequently, multiply the latest product by the number of hauls per week of the same size dumpster. Then, multiply that product by the fee per ton. This yields the total disposal cost for the subject material per week for all the same type dumpsters. Repeat the above for each recyclable, then sum all of the recyclable's total cost per week. Next, multiply that by 52 weeks per year. Repeat the above for each dumpster type. This results in the total disposal cost for all recyclables in that dumpster type. Lastly, sum all of the dumpster type's total cost per year to get the grand total disposal cost for all recyclables in the waste stream per year.

3) For rental fee--- To calculate the rental fee per year for all recyclables multiply the sum of all the same type of dumpsters by the subject material's percentage by volume. Next, multiply that product by the subject dumpster's rental fee per week. This yields the total renting fee for the subject material per week for all of the same type dumpsters. Repeat the above for each recyclable and then sum all of the recyclable's total cost per week. Then, multiply that product by 52 weeks per year. This yields the total rental cost for all recyclables in that dumpster type. Repeat the above for each dumpster type with a different rental fee. Lastly, sum all of the dumpster type's costs per year to get the grand total rental fee for all recyclables in the waste stream per year.

4) For tipping fee--- The tipping fee per year for all recyclables can be found via multiplying the sum of all the same dumpster type's tips per week by the subject dumpster type's fee per tip. Next, multiply that product by the subject material's percent by volume. This yields the total tipping fee for the subject material per week for all the same type of dumpsters. Do this for each recyclable, then sum all of the recyclable's total cost per week. Then, multiply that by 52 weeks per year. Repeat the above for each dumpster type with a different tipping fee. Lastly, sum all of the different dumpster type's total cost per year to get the grand total hauling fee for all recyclables in the waste stream per year.

COST INCREASE:

1) For hauling fee--- The sum volume (by % and CuYd) of each component within a typical dumpster is found by multiplying total tonnage of waste in FY 2002 by 2000 pounds per ton to convert tons to pounds, next multiply that product by the density of the subject material (i.e., glass is 500-600 lbs. / CuYd). Then divide the numbers for CuYd by the 30 CuYd with is the amount of CuYd for the containers. Lastly, multiply by the $86.50, which is the hauling fees, this will give the amount of money spent per year on recyclables for hauling fees if all recyclables in waste stream are recyclables.

2) For disposal Cost--- The total tonnage of garbage thrown away throughout FY 2002, which is 1818.43 multiplied by the percentage of recyclable in trash, by weight will give us the tonnage of each different recyclable for FY2002. Next, the sum is multiplied by $10 which is

the cost for disposal fee, will give us the amount of money spent per year on recyclables for disposal cost if all recyclables in waste stream are recyclables.

3) For rental fees--- Only applies to steel, the amount of weeks, which is 10.38, divided over the amount of weeks in months, which is approximately 4.36, and then multiply the sum by $45, which is the rental fee per month for containers. The total will give us the amount of money spent per year on recyclables for rental fees if all recyclables in waste stream are recyclable.

REVENUE:

1) The total tonnage of garage thrown away throughout FY 2002, which is 1818.43 multiplied by the percentage of recyclable in trash, by weigh will gives us the tonnage of each different recycle for FY2002. Next then sum is multiplied by the going market prices which (for aluminum & Plastic needs to be converted from lbs. to tons) The total will give us the amount of money the markets will pay for the total tonnage of ton per year. Then, multiply the total amount by 40%, which gives us the amount of money Towson University will receive for its recyclables.

CALCULATIONS

The calculations will show data used to determine current cost of recyclables in waste stream, cost to recycle recyclables in waste stream with out revenue, revenue made by recycling, and total cost to recycle by combining revenue with cost to recycle recyclables in waste stream (Tables 2-5).

To the case of "Current Cost of Recyclables in the Waste Stream", the cost may include fees due to tipping, hauling, disposal, and rental. To find the total costs, we add all these sums together.

Table 2. Total weight in tons of recyclables and non-recyclables thrown away for FY 2002.

		Initial		Compromise	
Material	Total tonnage of waste in FY02	% of total waste	Tons/material	% of total waste	Tons/material
Plastic		0.0651	118.38	0.0663	120.56
Glass		0.1165	211.85	0.1185	215.48
Aluminum		0.023	41.82	0.0234	42.55
Metal	1818.43	0.006	10.91	0.0061	11.09
Paper		0.1179	214.39	0.1199	218.03
Cardboard		0.0208	37.82	0.0212	38.55
Total	**1818.43**	**0.3493**	**635.18**	**0.3554**	**646.27**

Non-recyclables		0.6176	1123.06	0.6277	1141.43
Grand Total	**1818.43**	**0.9669**	**1758.24**	**0.9831**	**1787.70**

The error in "initial" percent of total waste is caused by scale error and the weight of contents in containers. To compromise, the percents in the "compromise" column are averages between the "initial" percents or percent of total trash that is recyclable (includes water content) and remaining percent (excludes water content) from the waste audit. Since both percentages by weight of total tonnage of trash per year are off, the averages above are a compromise.

Table 3. Total volume in cubic yards of recyclables non- recyclables thrown away for FY 2002.

Material	Total tons of trash	lbs/ton	% material in waste stream	avg. cy/lbs	cy/yr/item	% cy
Plastic			0.06625	50	4818.84	0.2195
Glass			0.1185	550	783.58	0.0357
Aluminum			0.0234	60	1418.38	0.0646
Metal	1818.43	2000	0.0061	137.5	161.34	0.0073
Paper			0.1199	80	5450.74	0.2483
Cardboard			0.0212	45	1713.37	0.0780
Non-recyclables			0.6277	300	7609.52	0.3466
Total	**1818.43**		**0.98305**		**21955.77**	**1.0000**

Table 4. Current configuration of waste stream

Material	% by weight	% by volume
Plastic	6.7	21.94
Glass	12	3.57
Aluminum	2.4	6.46
Metal	0.6	0.74
Paper	12.2	24.83
Cardboard	2.2	7.79
Total	**36.1**	**65.33**
Non-recyclables	63.9	34.68

Note: Percents based on remaining trash from waste audit

Non-recyclables make up 65% of the total tonnage in the waste stream, yet they are only 34% of the volume. This observation is significant in relation to the prospect of cost effectiveness. Of the four costs (tipping, hauling, rental, and disposal) that relate to volume and weight, only the disposal fee is associated with weight. Tipping, hauling, and rental fees are positively correlated to volume. As shown above, recyclables maintain the majority of volume in the waste stream. Increasing the recycling program at Towson University, in light of these statistics, ought be considered grounds for cost savings. The tables below examine this in detail.

Table 5. Current cost of recyclables in TU's waste stream

Current Cost of Recyclables in the Waste Stream

TIPPING FEE

Type: 2cy

	Plastic	Glass	Aluminum	Metal	Paper	Cardboard
Tip fee ($ per)	12.4	12.4	12.4	12.4	12.4	12.4
# of tips/wk	117	117	117	117	117	117
% Volume	0.2195	0.0357	0.0646	0.0073	0.2483	0.078
Cost of Recyclable ($/wk)	318.4506	51.79356	93.72168	10.59084	360.23364	113.1624
Total ($/wk)	**947.95**					
Total ($/yr)	**49293.54**					

Type: 4cy

	Plastic	Glass	Aluminum	Metal	Paper	Cardboard
Tip fee ($ per)	11.08	11.08	11.08	11.08	11.08	11.08
# of tips/wk	1	1	1	1	1	1
% Volume	0.2195	0.0357	0.0646	0.0073	0.2483	0.078
Cost of Recyclable ($/wk)	2.43206	0.395556	0.715768	0.080884	2.751164	0.86424
Total ($/wk)	**7.24**					
Total ($/yr)	**376.46**					

Type: 6cy

	Plastic	Glass	Aluminum	Metal	Paper	Cardboard
Tip fee ($ per)	14.65	14.65	14.65	14.65	14.65	14.65
# of tips/wk	1	1	1	1	1	1
% Volume	0.2195	0.0357	0.0646	0.0073	0.2483	0.078
Cost of Recyclable ($/wk)	3.215675	0.523005	0.94639	0.106945	3.637595	1.1427
Total ($/wk)	**9.57**					
Total ($/yr)	**497.76**					

Type: 8cy

	Plastic	Glass	Aluminum	Metal	Paper	Cardboard
Tip fee (avg.$per)	16.98	16.98	16.98	16.98	16.98	16.98
# of tips/wk	19	19	19	19	19	19
% Volume	0.2195	0.0357	0.0646	0.0073	0.2483	0.078
Cost of Recyclable ($/wk)	70.81509	11.517534	20.841252	2.355126	80.106546	25.16436
Total ($/wk)	**210.80**					
Total ($/yr)	**10961.60**					

Tipping Fee Grand Total ($/wk)	1175.56
Tipping Fee Grand Total ($/yr)	**61129.36**

HAULING FEE

Type: 30cy o.t.

	Plastic	Glass	Aluminum	Metal	Paper	Cardboard
Hauling Fee ($/haul)	86.5	86.5	86.5	86.5	86.5	86.5
# of hauls/wk	2	2	2	2	2	2
% Volume	0.2195	0.0357	0.0646	0.0073	0.2483	0.078
Cost of Recyclable ($/wk)	37.9735	6.1761	11.1758	1.2629	42.9559	13.494
Total ($/wk)	113.04					
Total ($/yr)	5877.99					

Type: 20cy comp

	Plastic	Glass	Aluminum	Metal	Paper	Cardboard
Hauling Fee ($/haul)	86.5	86.5	86.5	86.5	86.5	86.5
# of hauls/wk	4	4	4	4	4	4
% Volume	0.2195	0.0357	0.0646	0.0073	0.2483	0.078
Cost of Recyclable ($/wk)	75.947	12.3522	22.3516	2.5258	85.9118	26.988
Total ($/wk)	226.08					
Total ($/yr)	11755.97					

Type: 30cy comp

	Plastic	Glass	Aluminum	Metal	Paper	Cardboard
Hauling Fee ($/haul)	86.5	86.5	86.5	86.5	86.5	86.5
# of hauls/wk	4.25	4.25	4.25	4.25	4.25	4.25
% Volume	0.2195	0.0357	0.0646	0.0073	0.2483	0.078
Cost of Recyclable ($/wk)	80.6936875	13.124213	23.748575	2.6836625	91.2812875	28.67475
Total ($/wk)	240.21					
Total ($/yr)	12490.72					

Hauling Fee Grand Total ($/wk)	579.32
Hauling Fee Grand Total ($/yr)	**30124.68**

DISPOSAL FEE

Type: 30cy o.t.

	Plastic	Glass	Aluminum	Metal	Paper	Cardboard
Disposal Fee ($/ton)	41	41	41	41	41	41
Tons/haul	4.5	4.5	4.5	4.5	4.5	4.5
# of hauls/wk	2	2	2	2	2	2
% Weight	0.0651	0.1165	0.023	0.006	0.1179	0.0208
Cost of Recyclable ($/wk)	24.0219	42.9885	8.487	2.214	43.5051	7.6752

Total ($/wk)	128.89
Total ($/yr)	6702.37

Type: 20cy comp

	Plastic	Glass	Aluminum	Metal	Paper	Cardboard
Disposal Fee ($/ton)	41	41	41	41	41	41
Tons/haul	6.5	6.5	6.5	6.5	6.5	6.5
# of hauls/wk	4	4	4	4	4	4
% Weight	0.0651	0.1165	0.023	0.006	0.1179	0.0208
Cost of Recyclable ($/wk)	69.3966	124.189	24.518	6.396	125.6814	22.1728

Total ($/wk)	372.35
Total ($/yr)	19362.40

Type: 30cy comp

	Plastic	Glass	Aluminum	Metal	Paper	Cardboard
Disposal Fee ($/ton)	41	41	41	41	41	41
Tons/haul	9.75	9.75	9.75	9.75	9.75	9.75
# of hauls/wk	4.25	4.25	4.25	4.25	4.25	4.25
% Weight	0.0651	0.1165	0.023	0.006	0.1179	0.0208
Cost of Recyclable ($/wk)	110.6008313	197.92622	39.075563	10.193625	200.3047313	35.3379

Total ($/wk)	593.44
Total ($/yr)	30858.82

Disposal Fee Grand Total ($/wk)	1094.68
Disposal Fee Grand Total ($/yr)	**56923.59**

RENTAL FEE

Type: 30cy o.t.

	Plastic	Glass	Aluminum	Metal	Paper	Cardboard
Rental Fee (avg.$/wk)	10.96	10.96	10.96	10.96	10.96	10.96
# of 30cy o.t. dumpsters	2	2	2	2	2	2
% Volume	0.2195	0.0357	0.0646	0.0073	0.2483	0.078
Cost of Recyclable ($/wk)	4.81144	0.782544	1.416032	0.160016	5.442736	1.70976
Total ($/wk)	14.32					
Total ($/yr)	744.77					

Type: 20cy comp

	Plastic	Glass	Aluminum	Metal	Paper	Cardboard
Rental Fee (avg.$/wk)	54.24	54.24	54.24	54.24	54.24	54.24
# of 20cy comp dumpsters	4	4	4	4	4	4
% Volume	0.2195	0.0357	0.0646	0.0073	0.2483	0.078
Cost of Recyclable ($/wk)	47.62272	7.74547	14.01562	1.58381	53.87117	16.92288
Total ($/wk)	141.76					
Total ($/yr)	7371.61					

Type: 30cy comp

	Plastic	Glass	Aluminum	Metal	Paper	Cardboard
Rental Fee (avg.$/wk)	54.5	54.5	54.5	54.5	54.5	54.5
# of 30cy comp dumpsters	5	5	5	5	5	5
% Volume	0.2195	0.0357	0.0646	0.0073	0.2483	0.078
Cost of Recyclable ($/wk)	59.81375	9.72825	17.6035	1.98925	67.66175	21.255
Total ($/wk)	**178.05**					
Total ($/yr)	**9258.68**					

Rental Fee Grand Total ($/wk)	334.14
Rental Fee Grand Total ($/yr)	**17375.06**

Sum Cost for Recyclables in Waste Stream ($ per year) **165552.68**

Cost increase of diverting Recyclables from the Waste Stream not including revenue

In the case of this analysis for the cost increase we look at how much it will cost to divert recyclables currently in the waste stream to the recycling stream. The cost may include hauling fees, disposal fees, and rental fees. The cost is broken down both for different fees and recyclable type.

Cost to recycle PLASTIC:
> Hauling Fee: **4,818.84cy / 30cy = 157.28 * $86.50 = $13,894.43 yearly**
> Disposal Cost: 118.3tons * $10 = $1,183.80 yearly
> Total Cost: = $15,078.23 yearly

Cost to recycle GLASS:
> Hauling Fee: 783.58cy / 30cy = 26.12 * $86.50 = $2,259.32 yearly
> Disposal Cost: 211.85tons * $10 = $2,118.50 yearly >
Total Cost: = $4,377.82 yearly

Cost to recycle ALUMINUM:
> Hauling Fee: 1,418.38cy / 30cy = 47.28 * $86.50 = $4,089.66 yearly
> Disposal Cost: 41.82tons * $10 = $418.20 yearly
> Total Cost: = $4,507.86 yearly

Cost to recycle STEEL:
> Hauling Fee: 161.34cy / 30cy = 5.34 * $86.50 = $465.20 yearly
> Disposal Cost: 41.82tons * $10 = $418.20 yearly
> Rental Fee: 10.38wks / 4.36wks = 2.38mths * $45 = $107.13 yearly
> Total Cost: = $990.97 yearly

Cost to recycle PAPER:
> Rental Fee: $150 * 12months = $1,800 yearly
> Total Cost: = $1,800yearly
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Revenue

For this analysis, our revenue includes the profit made from the market price of each recyclable. It is important, however, to understand that the market prices are different for every recyclable and that there may be a great deal of fluctuation in prices from time to time. According to the contract set up with ARAMARK, ARAMARK is entitled to 60% of the profits made form recyclables, while Towson University receives 40%. For the case of this analysis, we will use the most up to date market prices for our calculations.

MARKET PRICES**:** as of December 3, 2002 (Recycling.net 2002)

- Steel………..$85 ton
- Glass……….none
- Paper……….$25 to $250 tons
- Aluminum….$0.71 lbs.
- Plastic…...…$0.03 to $0.18 lbs.

Estimated profit for Towson University from each recyclable if all recyclables in the waste stream were recycled using today's market prices.

- Steel………..$85 ton * 41.82 tons = $3,554.70 * 40% = $1,421.88
- Glass……….NONE
- Paper………($25 & $250 tons) * 214.39 = ($5,359.75 to $53,597.50) * 40% = $2,143.90 to $21,439
- Aluminum…$0.71 lbs * 2000 * 41.82 tons = $59,384.40 * 40% = $23,753.76
- Plastic……...($0.03 to $0.18 lbs) * 2000 * 118.38 = ($7,102.80 to $42,616.80) * 40% = $2,841.12 to $17,046.72

TOTAL = $30,160.66 to $63,661.36 a year

Total Cost to Recycle Recyclables

In order to find the Total Cost to Recycle Recyclables, which are currently in Waste Stream, the revenues made must be combined with the cost to recycle recyclables in waste stream.

TOTAL REVENUE + TOTAL COST INCREASE = TOTAL COST TO RECYCLE

Total cost to recycle PLASTIC:

> ($2,841.12 to $17,046.72) + -$15,078.23 = -$12, 237.11 to $1,968.49 yearly

Total cost to recycle ALUMINUM:

> $23,753.76 + -$4,507.86 = $19,245.90 yearly

Total cost to recycle STEEL:

> $1,421.88 + -$990.97 = $430.91 yearly

Total cost to recycle PAPER:

> ($2,143.90 to $21,439) + -1,800= $343.90 to $19,639 yearly

Total cost to recycle GLASS:
> $0 + -$4,339.70 = -$4,339.70 yearly

TOTAL COST> = **+$5,405.78 to +$36,906.48**

RESULTS

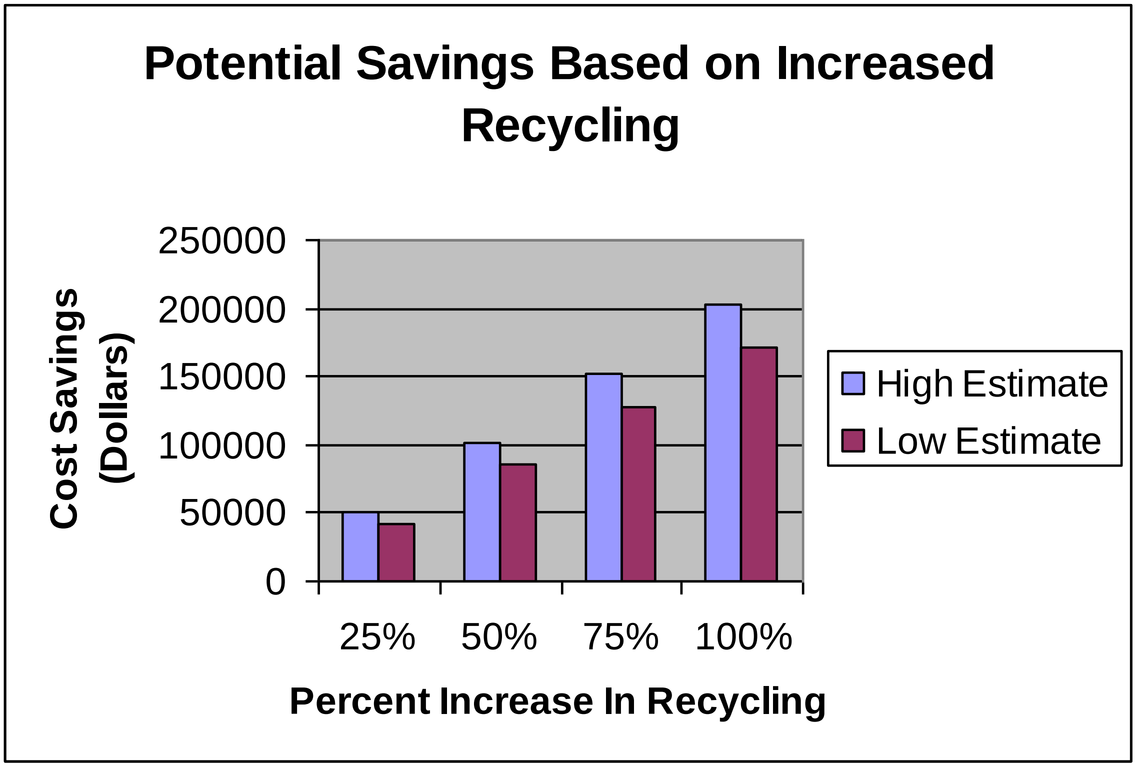
For the case of finding results we can state that there will be a savings, not loss, by subtracting the cost to trash by the cost to recycle will give use the amount saved.

TOTAL AMOUNT FOR SAVINGS:

COST TO TRASH - COST TO RECYCLE = AMOUNT SAVED

$165,552.68 **-** ($-5,405.78 to -$36,906.48) = **$170,958.46 to $202,459.16**
(Total amount saved)

Figure 6. Amount of Money expected to save if Recycling increased



Interpretation

When interpreting the results for our cost benefit analysis we found that it is not only in our best environmental interest to increase recycling on campus but also in our economic interest. The fact is that on average it costs $165,552.68 per year for the University to throw recyclables into the waste stream verses a profit of $5,405.78 to $36,906.48 a year to recycle it. This indicates that the University could save between $170,958.46 to $202,459.16 per year if Towson University recycled its recyclables that are currently in the waste stream. If Towson University was to increase recycling that is currently in the waste stream by 25%, Towson University will save between $ 42,739.62 to $50,614.79 per year, between $85,479.23 to

$101,229.60 at 50% and between $128,218.80 to $151,844.40 at 75% per year. The more we recycle the more money the University will save on its unwanted materials.

One point that needs to be made is that our results and interpretation do not include money that may need to be spent on employee salaries for individuals who may need to be hired for sorting purposes, as well as the possibility of an increase in the number of bins required to handle the increased volume of recyclables. Our interpretations also do not include the possible changes in the market prices for recyclables.

Conclusion

In conclusion, we found that recycling is not only favorable to conserve raw materials, which lead to a better environment over all, but the increase of recycling also has a great deal to offer economically as well. When the University finds itself in a situation where it will not only save money on trash fees but may find itself profiting from recycling, it makes good business sense to implement such a program.

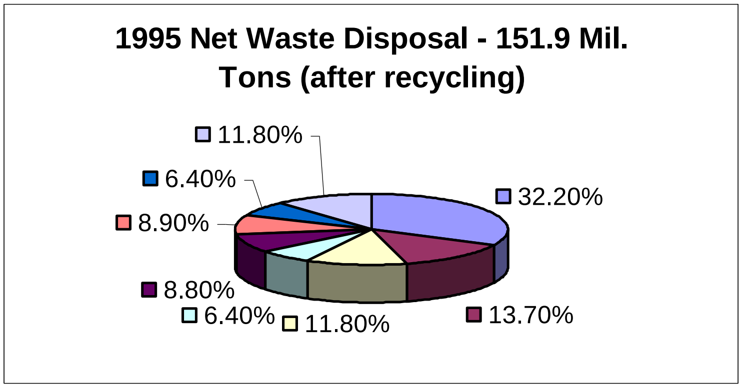
We also conclude that this cost benefit analysis disproves many myths, which proclaim environmental policies as having only negative effects economically. These myths have made it much more difficult to promote such programs. This analysis has shown that there are areas in which there may be positive economical and environmental benefits simultaneously.

RECYCLING: THE BIG PICTURE

LANDFILLS

Often, when people think of landfills, they think of mounds of trash infested with rats. However, landfills are carefully designed structures built into or on top of the ground in which waste is isolated from water, air, and pests (Freudenrich, 2002). Landfills are designed to eliminate the leaching of pollutants into run-off water, groundwater, or the soil, but may not be 100% successful in this task (Freudenrich, 2002). In addition, there are not enough landfills to accommodate America's trash. States are running out of room in their own landfills and are forced to send waste to other states. In fact, Maryland ranks among the top five states for the highest rates of waste exportation. (Zero Waste, 2002).

Recycling has many benefits as opposed to merely landfilling. Recycling reduces leaching and increases available space in landfills. EPA estimates that 98 percent of waste is recyclable; however, Americans only recycle 32% of waste they produce (Zero Waste, 2002). Another 66% of waste could be recycled and, in return, increase landfill availability by 66%. Figure 7 below shows the composition of America's trash, even after recycling. In addition to creating more landfill space and to decreasing leaching, recycling creates more jobs than landfills. For every one job in waste disposal, there are 5-10 recycling jobs (Zero Waste, 2002).



Paper – 32.2%

Yard Waste – 13.7%

Plastics – 11.8%

Wood – 6.4%

Metals – 8.8%

Figure 7.

(Source: Characterization of MSW in the US)

The process of establishing a suitable landfill site includes the analysis of many interrelated factors. This analysis attempts to find a site that will that eliminate the likelihood of both negative environmental impacts and health problems occurring after implementation. As a starting point in the process, a countywide study should be completed in order to identify available areas for the landfill. At which point, a review of potential sites can then be conducted.

When identifying a location for a landfill, a geologist must understand the types of the local rock and soil, and their structure. Porosity and permeability of the local rock is clearly a vital factor in a site's suitability. The ideal rock structure should keep any pollution and contamination to a minimum for as long as the waste presents a hazard, which even for normal wastes may be hundreds of years. Another issue when observing geological factors is to avoid areas where faults are located. Landfills in fault areas can be detrimental to the environment and to human health.

Before the construction of a landfill can take place, an understanding of the specific landscape requirements needs to occur. The location of a proposed site must provide an ample distance between the site and houses in the area. The Environmental Protection Agency states that a site must be more than 500 feet from a developed area (EPA, 1993). In addition, landfill sites may not be in high or low elevations. Landfills cannot be placed in lowland areas because these areas are susceptible to floods. Flooding in a landfill would carry away pollutants causing damage to nearby landscapes and water bodies. Locations at higher elevations are also found unsuitable due to the lack of slope stability in mountainous regions. These areas are susceptible to difficulties in construction, increased costs, and enhanced erosion. The EPA states that to prevent the problems of high elevation, the landfill site should have a slope lower than 40 degrees (EPA, 1993).

Landfills are designed to safely contain the waste we generate every day. The waste may contain toxic materials and, if landfills leak, groundwater would become contaminated. To avoid groundwater contamination, the landfill must be constructed within suitable soil. The type of soil controls the rate of mobility of toxic materials. The optimal type of soil is a nonporous and highly impermeable soil that compacts under pressure rather than falls apart. The permeability of the base soil layer is directly related to the amount of groundwater that could be contaminated.

Clay makes for an ideal liner when compacted because it has very low permeability. Clay forms a stiff, impermeable bedrock through which liquids have a difficult time leaking through. Clay should be manually packed on the sloped sides in order to prevent landfill leakage. Clay areas also have slower erosion rates. Types of soils that are inappropriate for landfill containment are better suited for growing grass and other vegetation. These soils are aerobic, porous, and highly permeable soils, such as sand and topsoil. EPA has established a rating for the permeability coefficient of the underlying soil as follows (EPA, 1993):

- Best < 0.0000001 cm/sec
- Middle = 0.01 - 0.0000001 cm/sec
- Bad > 0.01 cm/sec

The presence of nearby streams can lead to many negative effects on public health and the environment. Streams enhance the mobility of pollutants. For this reason, EPA strongly recommends that landfills should be kept more than 640 feet away from a stream. Also, a landfill cannot be placed within 1,400 feet of a water source which is used for drinking water, irrigate water, or cultivation. EPA recommends that no landfill should be constructed in wetland, unless (EPA, 1993):

- There is no alternative site
- Landfills legitimatize construction and operation
- The landfill will not severely damage wetland
- Developer will take phase-in procedure to avoid disappearance of wetland
- Developer has adequate information to support constructing landfill in wetland

Public facilities, such as historical sites, national parks, and airports, also play a role proper landfill location. To avoid destroying the original landscape, a landfill should be kept away from historical sites and national parks. Also, because birds are attracted to landfills, if a site is too close to an airport, birds can interfere with aircraft operation. Therefore, the placement of landfills near airports is prohibited unless one can show that birds are not a danger to aircraft transportation. If birds may be a danger, a landfill must be more than 10,000 feet from runways used by turbojets and more than 5,000 feet from runways used by piston-type aircrafts (EPA, 1993).

It is more aesthetically pleasing if a landfill is unable to be seen from most roads. However, to avoid increasing the transportation and construction costs, landfills should be located near a highway or smaller road. According to the EPA, landfills should be 3,700 feet away from a road designed for an eight-ton-per-axle vehicle (EPA, 1993).

Certain land may not have a landfill either because it is not zoned for it, or because the land does not meet the requirements for structural suitability as discussed earlier. Nature reserve districts may not contain landfills because these areas prohibit any destruction and conversion from their current environmental status. A landfill may not be placed within 500 feet of habitats where threatened or endangered species live (EPA, 1993). With increase of people moving into the Baltimore area each year, landfills are filling rapidly and new ones are constantly sprouting up. This can be seen through the land cover map. Land cover data can provide us with information on the areas that are growing and provide assistance in determining the possible location of new landfill sites.

According to the Federal Resource Conservation and Recovery Act, the design, construction, operation, and maintenance of landfills are the responsibility of the state. In Maryland, the Maryland Department of the Environment (MDE) is responsible for these duties. There are five phases to be able to obtain a permit to build a landfill in the state of Maryland. These phases are: Preliminary Information, Geological and Hydrological Report, Engineering Report, Internal Review and Preparation, and Public Comment. The Preliminary Report Phase includes a review of the land to see if there are any endangered species, wetlands, floodplains, Scenic Rivers, Critical Areas, historical sites or any other things that conflict with the Highway Beautification Act of 1965. The county in which the landfill is to be built then reviews a proposal to make sure it is in accordance with all of the area zoning laws, land use approvals, and the 10 Year Solid Waste Management Plan. Every county in Maryland must have a 10 Year

Solid Waste Management Plan. Maryland law also requires that an annual report be made to the state legislature reporting the amounts of solid waste dumped and recycled (MDE, 2002).

The Geological and Hydrological Report Phase consists of an environmental investigation by a geologist or geotechnical engineer of the area that the landfill is proposed to be built on. The Internal Review and Preparation Phase is a double-checking of the compliance of the plan with the applicable laws and regulations. The Public Comment Phase is a formal public hearing for the residents that live within 1,000 ft of the proposed landfill and elected representatives of the area. An MDE official then hears testimony and is presented with evidence to make a final decision about whether or not to grant a permit or to grant it under certain conditions. The State Solid Waste Program aspires to preserve public health and the environment from drinking water contamination.

Due to the problems with contamination and gas emissions around landfills, there are a lot of issues concerning the people that live near landfill sites. No one wants to have a landfill near his or her house, even though every one contributes to the waste. This mentality is referred to as, "not in my back yard" or NIMBY. Since no one wants the landfill near them, they usually end up in areas in which the population is unable to dispute the landfill site plan. These areas are usually ones consisting of populations of lower socio economic status. Often minorities occupy these areas and the problem of environmental racism occurs. Some people in these areas believe that landfills have been placed near them specifically because of their ethnicity.

Often solid waste is shipped from one state that does not have sufficient landfill space to another state in which the landfills are less full. The states to where the waste is being shipped cannot reject the wasted from being dumped there, unless the state passes legislation to do so. The State can only try to deter the out-of-state dumpers from wanting to dump in their State.

States receiving this extra waste may raise their tipping fees for out of state dumpers in order to discourage this behavior. Often, small business owners in the state receiving the extra waste end up getting the brunt of the extra costs by also having to pay the increased tipping fees. (ERF, 2001).

A policy that has been implemented to reduce the amount of trash produced by each person is the EPA's Pay As You Throw (PAYT) program. This is a program in which people get charged for the amount of waste that they throw away. It shows people a direct correlation between how much wastes they are discarding and how much money it costs to get rid of the waste (MJS, 2001). This program is currently in effect all over the country. The largest program is in Los Angeles, California with almost three and a half million participants. There is also a PAYT program in Charles County, Maryland where over 100,000 people participate. It has been found that since the implementation of this program there have been significant reductions in waste production and increases in recycling (EPA, 2002).

There are also problems with the most effective way to regulate the landfill protocol. One way is to have a landfill that is enclosed in plastic, which does not leach but also does allows the contents of the landfill to decompose. Another method is to have a completely open landfill that decomposes more quickly but allows leaching into the ground and greenhouse gases to escape into the air (ERF, 2001). It is evident that both methods have their costs and benefits.

PAPER

Early in American history, American paper mills used an old Chinese method of shredding old rags and clothes into individual fibers to make paper. As the demand for paper grew, the mills began to employ the more efficient method of using fiber from trees instead. Today, most of the trees that are used to make paper are grown on working forests and harvested specifically for making paper. Paper mills use recycled paper as well as wood chips and saw dust left over from lumber operations to make paper. Today, much of the paper we use is made with fiber from recycled paper. When we recycle our used paper, paper mills use it to make new newspapers, notebook paper, paper grocery bags, corrugated boxes, envelopes, magazines, cartons, and other paper products.

The used paper collected at local recycling centers is wrapped in bales and transported to a paper mill where it is used to manufacture new paper products. At the paper mill, the used paper is shredded, washed and mashed into a watery mixture called pulp. Unwanted materials are filtered out, and the pulp is spread evenly over a wire screen and pressed to remove excess water. The paper is then dried and rolled into a smooth, flat sheet. The sheet is wound onto a large roll and eventually split into smaller rolls or cut into sheets to make new paper. Products that have been manufactured using recycled paper are termed "post consumer products".

Old growth forests are extremely rare in the United States, especially on the East Coast. The only remaining old growth forests may be in the Pacific Northwest. Most of the old growth forests in the United States were destroyed by logging. Logging, whether for lumber and building materials or for paper products, has been economically important since colonization but has also caused devastation to local flora and fauna.

Logging takes place on private land as well as federal- and state-owned land. Some companies practice sustainable logging, and plant new trees in order to maintain an equilibrium of forest growth. Species which grow quickly and are most economically profitable are often used to replace trees which have been cut down. However, this practice typically results in a monoculture, with one dominant tree species. This new habitat does not maintain the biodiversity of its predecessor and indigenous species of plants and animals may not be able to survive in the new habitat. Logging also increases erosion and the amount of suspended particles in adjacent streams. The resulting stream bank erosion and sedimentation may decimate local fish and invertebrate populations.

Recycling paper provides economic and environmental benefits. One benefit is the use of a resource that would otherwise be wasted. Recycling paper reduces the amount of waste entering landfills. It reduces the costs involved in the disposal of waste, which ultimately leads to savings for the community. Recycling provides employment for people to collect and sort the paper. It is estimated that one job is created for every 500 tons of paper collected for recycling.
In addition, when the market conditions are favorable, office paper (such as computer and printer paper) can be economically profitable if it is separated from other types of paper. Currently, TU does not practice paper separation, and recycles paper as "mixed paper". At TU, there are no separate bins for recycling newspaper. Office paper is recycled along with the other paper products.

However, the economics of paper recycling are very complex. The Mandatory Source Separation and Recycling Act in 1987 caused states to adopt more strict recycling regulations. With more programs being established, supply often exceeded demand for some recyclable materials. In this situation, resell prices for paper may be lower than the cost of recycling, resulting in a net loss for a paper recycling program. However, when virgin pulp materials become relatively expensive, recycling becomes more cost efficient. While the market may fluctuate, the environmental benefits and the example we set for others may be enough motivation to pursue greater participation and cooperation form the University.

GLASS

The use of glass dates back many years. Overtime, humans have increased their usage of glass products due to its versatility. The properties of glass make it very difficult to breakdown in landfills. In addition, glass production from raw materials takes a lot of energy and contributes to air pollution. Recycling glass decreases the amount of landfill space used for glass products, energy used during productions, and air pollution. Listed below are key words associated with the glass recycling industry.

- Primary recycling –the process in which a material is put back into the same product (as defined by GPI).
- Secondary recycling – the process in which a material is reprocessed into other materials or products (as defined by GPI).
- Recycled Container glass (RCG) - a glass container made from recycled glass.
- Cullet – crushed container glass.

The first glass vessels were formed over 3,500 years ago (Ott, 1986). Glass began as a luxury item, but soon became a commodity (Ott, 1986). Over the years, the production of glass bottles and glass containers increased, escalating the disposal problem (Ott, 1986). Glass is very versatile, and cheap. Less than twenty years ago, all containers were created from glass because high-density plastics were not yet invented to perform this task (Lund, 1993). Even after the invention of these plastics, glass remains popular, but used less. It is estimated that the average American throws away about 85 pounds of glass each year (Lund, 1993). Glass is not biodegradable; therefore, it will only breakdown into smaller pieces, but will never disappear.

In 1897, the first recycling facility was opened in New York for glass and other items (AOL, 2002). Washington State opened the first recyclable buyback center in 1972 (AOL, 2002). They accepted beer bottles, aluminum cans, and newspapers. In the past in Maryland, one could take their soda bottles back to a store for a discount on their next purchase. The discount was considered their deposit on the soda bottle. The bottles would then be reused again, as soda bottles. In some states, Maryland excluded, buyback centers still exist but they do not reuse the bottle as a hole.

Today, the purpose of recycling bottles is the same as always, to reuse the glass, keep it from landfills, decrease energy consumption, and decrease air pollution. However, in the recent past, recycling has become very convenient. Bottles are collected through drop off facilities, or curb side collections. The glass is then separated by color and crushed. The crushed glass is referred to as cullet. The cullet is then sorted according to its appropriate use and reused in a variety of ways.

Glass is classified as a material which is brittle, translucent, completely insoluble, and nonflammable (Ott, 1986). Silica (sand) is the main raw material in glass (Ott, 1986). It is mixed with a variety of materials, mainly soda ash, to decrease the melting point (Ott, 1986). Limestone is added to the mixture to increase the hardness of the glass. Depending upon the type of glass being made, a number of other materials are also added to the mixture, creating the specific types of glass.

The four main categories of glass found in a recycling program are fused silica glass, soda-lime-silica-glass, lead oxide-alkali silicate glass, and Borosilicate glass (Ott, 1986). Fused silica and borosilicate glass types are used for special applications and are excellent in thermal shock resistance. These types of glass are rarely recycled (Ott, 1986). A popular artistic glass is the lead oxide-alkali silicate glass (Ott, 1986). Soda-lime-silica glass is used for plate glass, window glass, container glass, and electric lamp bulb glass. Soda-lime-silica-glass is the target glass for most recycling programs (Ott, 1986). It was historically the first form of glass used and remains to be the most common.

Glass is not biodegradable therefore; it will remain in landfills forever. It will break into small particles but will never disappear. Glass makes up 6.6 percent of municipal solid waste by weight and 1.5 percent by volume (EPI, 2002). These large numbers make glass the second largest contributor to landfills by weight just behind newspapers (EPI, 2002).

Energy Savings

Recycling RCG saves 74 percent of the energy it takes to make from raw materials (Oregon Department of Environmental Quality, 2002). Cullet needs less energy to melt than raw materials (sand, soda ash, and limestone). As a result, energy demands decrease approximately 2.5% per every 10% increase in cullet content (GPI, 2002). Recycling one glass bottle saves enough energy to power a 100-watt light bulb for 4 hours (GPI, 2002).

Lower air pollution emissions are associated with container glass recycling. When melting the raw materials for the first time, the majority of impurities leach out into the air. When the container glass or cullet melts a second time, there are fewer impurities therefore, less air pollution as opposed to virgin materials (ACI, 1999). The is an estimated 14 to 20% reduction in air pollution associated with recycling glass as opposed to manufacturing new glass from virgin materials (Tyler, 2002).

There are collection and sorting costs associated with the recycling of RCG. Usually RCG is collected and delivered to a central location for sorting. Sorting involves color separation and decontamination (Andela Products Ltd, 2002). According to Maryland Environmental Services, RCG as a primary recycled material is desirable if the supply is *color sorted* and *contaminant free*. Color sorting is necessary because if colors mix they produce a gray colored product that is very undesirable, and there are markets for each color (USAEC, 2001). Clear container glass is the most valued, followed by brown and then green. To increase the revenue from the sale of the RCG, it must be virtually free of contaminants (i.e., ceramics, metals, plastics, etc). The smallest impurity has the potential to manifest itself in the cooled, recycled product. There are also transportation costs incurred. Previous to being used as a raw material, RCG must be transported to the company that pulverizes it (turns it into cullet). Subsequently, the cullet is shipped to the manufacturer. Secondary recycling of RCG involves the same costs as the primary recycling of it except for the sorting costs.

Similar to primary recycling, secondary recycling requires no disposal costs. Both methods accrue a cost savings in this respect by being diverted from the waste stream. Also, RCG is the only product that is 100 percent recycled (Ott, 1986). In other words, one recycled soda bottle can form another soda bottle without any material or quality being lost. In addition, the amount of energy put into making the bottle from cullet is significantly less than when the product is from raw materials. This decreases the cost of production. Secondary recycling has an added benefit of requiring no sorting. This is because the glass can be sold as an aggregate (mixed colors) without jeopardizing the integrity and utility of its next use. Another benefit amassed by both methods is the revenue from its sale to help mitigate costs. Progress has been made in finding new secondary recycling end-markets for aggregate RCG. Despite the advances, aggregate RCG accrues less revenue relative to sorted glass (GPI).

Recovered container glass (RCG) is manufactured into new products by primary or secondary recycling. The predominant product made from either type of recycling process is new container glass. The second most produced product is fiberglass (EPA, 2002).

The market for RCG, as it relates to primary recycling, is not fairing as well as other primary recycling markets. The reason for this is substitutes, mainly plastic and virgin raw materials (sand, soda ash, and limestone). For example, bottlers say raw materials cost less than cullet (Land, Air, & Water Magazine, 2002). Moreover, increases in plastic recycling are causing a decrease in available markets for recycled glass CRI, 2000). To compensate the glass industry has consolidated due to increased competition from the plastics industry (EPA, 2002).

Though the market for RCG is not as vigorous and lucrative as other recycling markets, there is still opportunity to generate revenue from its waste diversion. For example, pulverizing the glass into cullet may be an economical alternative. Some examples of final goods are:

- Sandblasting
- Tile
- Aggregate base for roads
- Fiberglass
- Water filter medium

Similar to primary recycling, secondary recycling requires no disposal costs. It also requires no sorting. This is because the glass is sold as an aggregate (mixed colors) without jeopardizing the integrity and utility of its next use. Progress has been made in finding new secondary recycling end-markets for aggregate RCG. Despite the advances, aggregate RCG accrues less revenue relative to sorted glass (GPI).

Some local activities in Maryland are associated with the open loop waste diversion method. Baltimore, Maryland has used cullet to make roads downtown and parking lots over the past 20 years.

Recycling glass has many benefits. With the large use of glass, recycling will extend the life of landfills, preserve natural resources, reduce energy consumption, reduce air pollution, and reduce waste disposal cost (Powelson, 1992). However, the benefit of recycling glass depends strongly on the market. If the marginal cost of recycling is greater than the marginal cost of using virgin materials then we should use virgin materials. This seems to be the case today. As with the recycling of any product, the loop must close. If there is not a need for the recyclable then you are only increasing the cost of the disposal. Economically, glass recycling looks great from a distance. In reality, recycling any product is only good if there is a good market. Recycling is a closed loop cycle, when the loop is not closed it is not economically inefficient

PLASTICS

In the United States alone 75 billion pounds of plastic are produced every year (Nottingham Trent University, 1997). Plastic is a polymer that is created with the nonrenewable resources oil and natural gas. Some characteristics of plastic include being chemically resistant, lightweight, and having varying degrees of strength (American Plastics Council, 2000). The EPA estimates that 20% of solid waste in landfills is plastics (Nottingham Trent University, 1997). In order to help reduce the amount of waste going into landfills, in 1977 the first plastic bottle (PET) was recycled (Nottingham Trent University, 1997).

Most plastics are labeled using numerical coding (1-7) created by the Society of the Plastics Industry in the late 1980's (Nottingham Trent University, 1997). Each number corresponds to a different type of plastic. Plastics numbered 1 or 2 are recycled the most. Ones are found on polyethylene terephthalate (PET) containers, like soda and water bottles. While some goes back into the soda and water container market, recycled PET is mostly used in textiles. Carpet companies can use 100% recycled plastic to create carpets in many colors. It is also used as fillings for pillows, quilts, and jackets. Type 2 plastics are high-density polyethylene (HDPE) used in making milk jugs, laundry detergent bottles, toys, and some plastic bags. The recycled HDPE is used for plastic pipes, lumber, flowerpots, trashcans, or non-food application bottles (Maryland Department of the Environment, 2002).

Other less recyclable plastics are poly vinyl chloride (PVC), low-density polyethylene (LDPE), polypropylene (PP), polystyrene (PS) and any other plastic not covered in these groupings. PVC is used in garden hoses, shower curtains and siding. It can be recycled into fencing and siding. LDPE is used in making plastic bags, shrink-wrap, and garment bags. This hard to recycle material is used for plastic bags, trash bags, plastic tubing, agricultural film, and plastic lumber. PP's are used to make bottle tops, carpets, some auto parts and automobile battery casings. PS is used for meatpacking, plastic utensils and protective packaging (Maryland Department of the Environment, 2002).

Plastics are used in our everyday lives, and are very important to society. Their durability allows us to use them in plastic lumber, liners and medical supplies. Since they don't shatter they are safer than glass in some cases. They are lightweight and can save energy. A 1992 study showed that it cost less energy to process plastic packaging than it did to process glass paper or metal packaging. The study claimed plastic packaging saved 336 trillion Btu (British thermal unit). A Btu is the amount of energy necessary to raise the temperature of one pound of water by one degree Fahrenheit (TechTarget, 2000-20002). 336 trillion Btu's is the equivalent of 58 million barrels of oil, 325 billion cubic feet of natural gas or 32 billion pounds of coal (Berkeley Plastic Task Force, 1996). Plastic is overall an extremely versatile material that can be put to almost any use. However, it does have some negative impacts.

The most widely known drawback to using plastics is that they don't decompose readily. Any plastic that is not recycled has the fate of taking up space in a landfill where it sits for decades. Another drawback is that processing plastic resins uses non-renewable resources. Plastic resins, the basis of all plastic types, are derivatives of oil and natural gas (Anchorage Recycling Center 2001). It also uses resources in the form of energy. For example, nine times more energy is used to produce 1 lb. of resin (from non-recyclables) than 1 lb. glass (Berkeley Task Force, 1996). Additionally, the process of producing virgin plastics is a major source of pollution. In 1994 there were 1,834 plastics production facilities operating in the United States, and it was found that they produced more than 111 million pounds of toxic air emissions, 507 million pounds of production-related wastes, tens of thousands of pounds of discharges to surface waters, and hundreds of thousands of pounds of other pollutants (Natural Resource Defense Council, 1995). For example, when compared to producing a 16oz. glass bottle, producing a 16oz. plastic bottle results in 400 times the toxic air and water emissions (Berkeley Plastic Task Force, 1996). NRDC also states that in 1995, production of LDPE generated 500 million pounds of organic pollutants that needed to be managed somehow.

Recycling plastics can help lessen the negative impacts of using and processing plastics. Recycling is mostly a mechanical process, and the few chemicals it does use are not hazardous (Natural Resource Defense Council, 1995*)*. Therefore, recycling plastics greatly cuts down on toxic emissions. Also, with recycling there is no need to form new resins, and non-renewable resources like oil and gas can be conserved. Resources can also be conserved in energy costs.

Recycling three different grades of plastic shows a net energy savings in the range of 70-90% over manufacturing similar products from virgin oil (Natural Resource Defense Council, 1995). Finally, when plastics are recycled they aren't put in landfills, instead they are put to use in some other aspect. So why not recycle all plastics, saving landfills, resources and avoiding pollution?

As with most processes, recycling, while extremely beneficial also has a few drawbacks. First of all, mostly only plastics numbered 1 and 2 are recyclable, and plastics with any other label are not recycled. Plastic that is recycled cannot be recycled indefinitely due to a change in chemical composition during the recycling process, and they generally cannot be made into food containers. Problems encountered during the process of recycling include difficulty in cleaning some resins, and the expensive cost of sorting and collecting such lightweight material. The automatic equipment used to adequately sort the materials can be very expensive. Also, higher sipping costs may result from bulky plastics that don't pack well. Recycling may not be the best alternative. It has been shown that energy and therefore non-renewable resources are consumed less in producing glass from recycled materials than producing recycled plastics. Producing a PET bottle from recycled material consumed 32MJ while producing a glass bottle from recycled glass only consumed 26MJ (Berkeley Plastic Task Force, 1996). Virgin resins are cheaper, and some believe that a boost of recycling will lead to further use of plastic. This may result in additional production of plastics from virgin resources of which not all can be recycled.

An economically positive aspect to recycling is that the plastic markets are expected to grow in the coming years. In the U.S. in 2000, the plastic market was $1.3 billion, and is predicted to be at $2 billion and over $6 billion world wide in 2005 (3). For current market prices go to http://www.recycle.net/price/plastics.html. As of Nov. 13th PET went for $0.12 /lbs, PP for $0.18/lbs, and HDPE for $0.03/lbs to name a few. Recycling may be expensive and it may not be the absolute best solution to the problems plastics cause but it needs to be done. The long-term benefits of recycling such as saving resources, landfill space and reducing pollution, far outweigh any short-term costs it may incur.

METALS

According to Debi Kimball (1992), the first metal recycling in America was in 1776 when a statue of King George III was melted down and formed into bullets. Since that time, metal recycling in America has been increasing because it provides a domestic supply of metals. Metal recycling was started by the metal industries when these industries used pre-consumer scrap metal in the production of new metals. After recognizing the economic benefit of using scrap metals in the production process, these industries provided mechanisms to collect and reuse post-consumer metals thus realizing even more economic benefits. Today many residences and businesses, including Towson University, collect aluminum and tin cans for recycling. The aspects of recycling these well-known metal materials will be discussed in this section.

Aluminum cans are widely used for beverage containers, but aluminum has many other uses in America. Aluminum is lightweight and is resistant to corrosion. It is used to construct aircraft, automobiles, storm windows, railroad cars, and siding. Cooking utensils and electrical transmission wires are also made of aluminum because of the metal's high conductivity (Lewin, 2002). According to the Aluminum Association, Inc. (2000) 32.5% of US shipments of aluminum were for transportation, 20.4% of shipments were for containers and packaging, and 13.1% of shipments were for building construction. Lewin (2002) reports that Americans used 31% of aluminum for containers and packaging, 20% for transportation, 24% for building construction, and 10% for electrical equipment   In fact, the world's largest aluminum industry is that of the United States' (Aluminum Association, 2000).

America is the largest producer of primary aluminum in the world (Aluminum Association, 2000); however, it is not mined in the United States. To obtain aluminum from virgin materials, bauxite must be surface mined in areas such as Jamaica and Australia (Hartman, 2002). Bauxite, and impure aluminum oxide, must then be imported to the United States where it is refined to a pure aluminum oxide as impurities are driven off. Next, the aluminum oxide is sent to another plant where it is dissolved in cryolite (Na3AlF6) and the oxygen is stripped from the aluminum in an energy-expensive electrolytic reduction to form pure molten aluminum (EPA, 1998). The molten aluminum is formed into ingots and then shipped to different plants where it is formed into products.

The process of creating aluminum from virgin materials has many environmental drawbacks. Surface mining of bauxite ore involves removing large amounts of vegetation, soil, and rock. This intense land disturbance leads to erosion, to land subsidence, and to an alteration in the surrounding ecosystem as vegetation and soils are removed. In addition, large quantities of water are used and much dust and noise are created in the mining process (Ripley, Redmann, and Crowder, 1996). At the refining and reduction plants, emissions of harmful gases are unavoidable. These gaseous emissions include hydrofluoric acid, perfluorinated compounds such as CF4 and C2F6, carbon monoxide, carbon dioxide, sulfur dioxide, and other volatile organic compounds (EPA, 1998). Perfluorinated compounds along with carbon dioxide are greenhouse gases whereas carbon monoxide and volatile organic compounds have negative human health effects.

There are many benefits of using post-consumer aluminum products to obtain new aluminum materials. Recycling aluminum saves 95% of the energy it would take to create aluminum products using raw materials because the energy-expensive electrolytic reduction is not needed ("Environmental Tips"). Also, by using post-consumer aluminum, less bauxite ore is mined which reduces the negative effects of surface mining. As a result, there is less erosion, less noise pollution, and less water use when aluminum is recycled. Another benefit of aluminum recycling is the reduction of harmful emissions from the refining and reduction processes: associated air pollution is reduced by 95% (Kimball, 1992). Aluminum can be recycled over and over again without loosing any of its properties.

Pre-consumer aluminum recycling was started in the American aluminum industry in 1904 and the industry began recycling post-consumer aluminum products in 1968 (Kimball, 1992). Cans are probably the most common post-consumer source of aluminum and are picked up by many municipalities in America. In 1989, 60.8% of aluminum cans were recycled in America (Kimball, 1992). These cans are collected, cleaned, bailed, and shipped to a mill. There, the coatings are removed from the cans by heating, and then at higher temperature the aluminum is melted down. Then the aluminum is formed into ingots and shipped to the production plants. According to Hartman (2002), recycling fulfills one third of the aluminum industry's need. Thus, aluminum almost always produces a profit in community recycling programs, which is enough to offset the higher cost of other recyclables in the program.

The main reason aluminum recycling is so economically beneficial is due to the energy savings, but other reasons also exist. Since it takes only 5% of the energy to recycle aluminum than to derive the metal from raw materials, it is much less expensive to use recycled aluminum. The infrastructure put in place years ago to collect post-consumer aluminum products has already paid for itself. Thus, the US aluminum industry saves a great deal of money by using post-consumer aluminum in the production process. Because the domestic source of bauxite ore has decreased over the years, post-consumer aluminum creates a stable domestic supply (Hartman, 2002). Another reason for the economic prosperity of aluminum recycling is the creation of jobs in collecting, sorting, cleaning, and processing the scrap aluminum.

The market prices for aluminum have fluctuated a great deal over the years; however, the market prices continue to increase overall. Aluminum prices were $1100 per ton in October of 1997 and fell to $900 per ton in September of 1998 (Hernando Co. FL). However, as of October 25, 2002, aluminum prices reached $1,420 a ton (Recycling-Net), which is much higher than it was in 1998. This is equates to about $0.71 per pound whereas other recyclables are not priced nearly as high. Paper sells as high as $0.12 per pound, plastic as high as $0.18, and glass as high as $0.02 per pound (Recycling-Net). This assures that companies or municipalities that sell post-consumer aluminum products will continue to receive high prices for their materials.

Tin cans today are made of about 99% steel, the metal the world uses most (Tin Technology). Only about 1% of tin coats the inside of these food-containing cans to keep flavors fresh. Because so little tin is in them now, de-tinning the cans has become unfavorable. Tin-coated steel cans are just collected and sent to a steel plant to be recycled into new steel (Connecticut Metal Industries, Inc., 2001). Due to its strength, steel is used to make many products in which strength is important. These products include automobiles, appliances, structural beams, reinforcing bars, and steel plates (Steel Recycling Institute, 2001). Most of the steels are carbon steels, but other materials can be mixed into the steel to give the material different properties such as chromium addition for stainless steels (Allen, 2002).

Carbon steels are mostly made of iron with only 0.04 - 2.25% of carbon (Allen, 2002). To make carbon steel, iron ore must first be surface mined. Then, in processing the ore, 5 - 25 tons of water per ton of ore is used (Scott and Bragg, 1975 as cited in Kimball, 1992). Iron ore, mostly in the form of iron oxides, is placed into a furnace with coke, which is a reducing agent. Carbon monoxide from the coke reduces iron oxides to molten iron and carbon dioxide in the furnace, according to the reaction (Allen, 2002):

$$Fe_2O_3 + 3\ CO \rightarrow 3\ CO_2 + 2\ Fe$$

Steel is produced as oxygen is blasted through the furnace and oxidizes carbon out of the iron mixture until the desired amount of carbon is reached.

In addition to the vegetation loss, erosion, and dust and noise pollution described above for bauxite mining, iron mining also results in acid mine drainage. Acid mine drainage refers to sulfide, which is present in the waste rock of iron ore, being converted to sulfuric acid. The sulfuric acid can then dissolve heavy metals such as lead and cadmium present in the waste rock and transport the metals to ground and surface waters (Ripley, Redmann, and Crowder, 1996). Other degradation to the environment results from the refining process to make steel. Harmful emissions from refining iron ore include carbon monoxide, sulfur dioxide, and particulate matter (Ripley, Redmann, and Crowder, 1996).

There are numerous benefits of recycling steel, which is the most recycled material in the world (Kimball, 1992). Iron is magnetic so it is easy to remove tin-coated steel cans from other waste. By using scrap steel cans verses iron ore to make new cans, 74% of energy is saved (Kimball, 1992). Mining effects, such as vegetation removal, are lowered when scrap steel is used over new steel. Emissions from the refining process are lowered also when scrap steel is used. In addition, there is less potential for acid mine drainage to occur and thus less opportunity for heavy metal water contamination when scrap steel is recycled.

The steel industry has been recycling steel for over 150 years in over 1800 scrap processing plants (Steel Recycling Institute, 2001).   According to Hartman (2002), the oxygen furnace method described above uses about 28% scrap steel in addition to the ore, whereas the electric furnace method uses almost 100% scrap steel.   The electric furnace makes use of electricity rather than fire as the source of heat. Electric furnaces are equipped with automatic settings with which more controlled refining conditions are possible. This method works well to make stainless steels because they must be made to have a precise composition (Allen, 2002). In fact, 68% of all steel is recycled (Hartman, 2002).

Since it takes only 26% of the energy to use scrap steel than to use iron ore to produce new steel, it is always cheaper to use scrap in the manufacture of new steel products. In addition, using scrap steel stabilizes steel markets. If less iron ore is mined, it will be less scarce and more stable, which leads to a more stable market. Because steel is so widely used, there is hardly a problem finding a buyer for recycled steel products. Steel can be recycled over and over again and still be functional.

The steel market remains strong and, second to aluminum, it is one of the most profitable. Since the 1990's the market in reusable steel has increased. Steel prices were as low as $30 per ton in October of 1997 to as high as $70 per ton in June of 1998 (Hernando Co. FL). Prices rose to $85 a ton in October of 2002 (Recycling-Net), which was an increase of more than 100% from October of 1997. However, as is true with aluminum markets, there is also a great deal of fluctuation in scrap steel markets.

There seems to be little if any direct negative economic effects from the recycling of metals. However, one can identify some negative indirect effects as a result of this process. In 1993, the total employment of those working in the mining industry in America was around 50,000. The estimated production value of mining at that same time was $12.15 billion. With the onset of a high metal recycling rate ranging in the 60 percentile, the mining of ore decreased (EPA, 1995). As a result, in recent years we also find a decline in employment. The fact that most mines are found in rural areas of the country where jobs were already hard to come by causes great economic problems for these communities. If these rural communities can shift to recycling jobs verses mining jobs, the problem of a job market shift may be corrected.

There are a number of different items that will affect metal recycling in the future. The factors that play into the market today are the attitudes of society, the potential creation and exploration of new markets at home and abroad, environmental effects, and the amount of raw material available. Some experts say that because raw materials and resources will become scarce in future years, the market for scrap metal will move upward (American Iron and Steel Institute). However, if more post-consumer metals are available, an increase in supply may be realized thus assuring lower prices. Authorities also expect society will become more pro-recycling due to increased education and to the scarcity of resources. Overall the prediction seems to indicate that the metal recycling market will play a major role in the overall metal market of the future (Office of the Federal Environmental Executive).

FUTURE MATERIALS

Since the University aims to enhance the current recycling program on campus, reusing and marketing "other" recyclables needs to become a future focus. Most people know that paper, plastic, and aluminum cans can be recycled; however, most do not realize that the majority of the material in the waste stream can be reused.

Here at Towson University, keeping up with technology is a necessity. In order to provide the most beneficial education for the students, new computers, printers, projectors, etc. need to be purchased to replace the existing, out of date equipment. Here on campus the question of disposal of old equipment has been a growing problem. Currently the university is storing the old equipment here on campus. Little effort has been made to effectively find an end market for the reusable technology. Vassie Hollaman, Associate Director of General Services at UMBC, has been in contact with many of local universities and has proposed a future recycling program for electronics. He has been in contact with Larry Novicky with UNICOR. UNICOR is a company that was set up in 1934 under the Department of Justice, which provided jobs for prison inmates. They now have focused heavily on accepting and de-manufacturing electronic equipment in bulk and recycling them. They focus on minimizing electronic waste entering the landfills, and try to market and utilize every usable component of accepted electronics and safely dispose of the harmful components such as cadmium, beryllium, and lead that are found in the body of many electronics (UNICOR, 2002).

Another option that Towson could consider to effectively dispose of the surplus unwanted electronics is contacting the Lazarus Foundation. This foundation is locally based out of Columbia, Maryland and is run by a group of volunteers that test and recondition the unwanted electronics for future use. The reconditioned equipment is then distributed to charitable organizations and educational institutions such as the Howard Co. Association for Retarded Kids, The Florence Bain Senior Center, Mothers Against Drunk Drivers and any others in need of donated equipment. The donations to the foundation are tax deductible to the extent allowable under the Internal Revenue Code, where in most cases donors will receive the fair market value for their contributions. The foundation is also looking into setting up small classes and projects in the local school systems, where vocational classes could not only fix the donated equipment, but also learn from the hands-on experience as well (The Lazarus Foundation, 2002).

Since there are many options for recycling electronics, there is no need to store this valuable equipment when others could benefit from it. The university needs to become associated with one of the organizations and turn our excess trash into someone's treasure.

The flux of goods primarily entering the university campus is shipped in bulk quantity. Shipping and receiving of most bulk goods here on campus requires the use of wooden shipping pallets. With the university being an end-user of the majority of the shipped goods, pallets are difficult to dispose of once the transported merchandise has been offloaded.

Standard size shipping pallets that are used in the majority of the local shipping industry are constructed with the universal dimensions of 40 inches wide and 48 inches long. Here at Towson University, the majority of the pallets that enter the campus daily are carrying supplies for the bookstore. On an average day, the bookstore may receive 10-25 wooden pallets. The problem is that the majority of these pallets is not the universal size of 40X48 inches and is unwanted for reuse by the majority of the shipping industry. These unwanted pallets tend to linger around the shipping and receiving area until they become a burden, where they are then hauled away for a dollar a piece along with a thirty dollar per load fee (Suedi, 2002). The university could simply store these pallets on their own, and collect a large quantity that would be economically beneficial for a large pallet reuse/recycle company to market the collected goods. The only problem with recycling pallets is that quantity is important to make it worthwhile, due to the cost of transportation. Another option is using the excess pallets to ship the outdated electronics.

Textile recycling is another approach that the university could investigate to cut back on the outgoing waste flow leaving campus. With over 17,000 full and part time students attending class here Towson, there are many articles of clothing being worn daily. Of those 17,000 students 3,379 of them are residence on campus (Towson University Fact Sheet, 2002). In this day and age, keeping up with the latest fashion is a major concern. Old, out of style clothing is simply thrown into the trash. If the university could set up a collection area, possibly in the Union, the unwanted clothing could be collected and donated to organizations like the Goodwill or the Salvation Army and then distributed to those in need.

With over 3.9 million tons (4% of total solid waste entering landfills) of textiles entering the United States solid waste stream yearly, the importance of recycling is apparent, simply because over 93 % of textile can be reused. 48% of the post- consumer textile waste that is recovered is recycled as secondhand clothing or is sold or donated to third-world nations. Approximately 20% of the materials collected are processed and marketed as wiping cloths or rags, and 26% of the total collected textile waste collected is converted into fiber to be reused in a pre-consumer product such as upholstery covering, mattress padding, etc (Council for Textile Recycling, 1997).

Disposal of old carpeting is another potential recycling concern for the University. Heavily trafficked areas and remodeling in the residence quarters create an occasional flow of used, worn out carpet that is disposed of in the dumpsters. The majority of the carpet that is diverted from the total U.S. waste stream is ground up and reused either as insulation for housing construction, or is mixed into a resin which is molded for various building material such as fiber floor joist and decking material (Council for Textile Recycling, 1997).

CONCLUSION

As can be seen from this analysis, Towson University has a successful recycling program, but there is always room for improvement. If recycling is increased on campus, the University will save money in addition to benefiting the environment and the TU community. Students, faculty, and ARAMARK must work together in order to improve the current program.

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Appendix A: Recycling Questionnaire

Interviewer:_________________________ Date:____________________
Time of interview;____________________ Location:_________________
Sex of respondent: M F

RECYCLING QUESTIONNAIRE

[READ THE FOLLOWING TO ALL POTENTIAL RESPONDANTS] We are studying current levels of recycling on the Towson campus as part of a course we are taking. We would like to ask you some questions so that we can better understand activities and attitudes of members of the Towson Community towards recycling on this campus. Would you be willing to participate?

Your answers to our questions will be completely confidential. We do not want to know your name, and your responses will not be reported individually, but only as part of an entire group consisting of everyone we survey. Please give your best response to each question so that we can collect the most accurate information possible.

Have you completed this questionnaire previously with another interviewer? **[IF "YES," STOP AND THANK THE PERSON FOR THEIR TIME. IF "NO," PROCEED WITH THE SURVEY.]**

1. What is your primary status while at Towson University campus (the way you spend most of your time)?

Full-Time Student……...9
Part-Time Student…….. 8
Full-Time Faculty…….. 7
Part-Time Faculty…….. 6
Administrative Staff…...5
Support Staff-Aramark………..4
Support Staff-Chartwells……...3
Visitor/Guest……………..……1

Other_____________________0

2. **[IF THE RESPONDENT IS A STUDENT ASK]** Where do you live during the school year, _____on campus _______off campus.

3. What is your current age? ____________ **[IF THE PERSON DECLINES TO ANSWER SCORE THEM AS ABOVE 25 OR BELOW 25 BASED ON YOUR BEST GUESS . ABOVE BELOW]**

[FOR ALL RESPONDENTS] Please indicate your response to each of the following statements about your views about recycling.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Don't Know
4. I think that recycling of paper, plastic, glass and metal is important.	1	2	3	4	5	7
5. Most students on campus think that recycling is a waste of time.	1	2	3	4	5	7
6. Most faculty and staff who work on campus think that recycling is important.	1	2	3	4	5	7

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Don't Know
7. I know what materials can be recycled on campus.	1	2	3	4	5	7
8. When I came to Towson, campus recycling was explained to me.	1	2	3	4	5	7
9. At the present time, recycling is easy or convenient on campus	1	2	3	4	5	7
10. I get bothered when I see people who throw out materials that can be recycled.	1	2	3	4	5	7
11. When on campus, I know where the nearest recycling bins are for cans, bottles, or paper.	1	2	3	4	5	7

[FOR ALL RESPONDENTS] Now we need you to indicate your response to each of the following statements that best characterize your own recycling behavior.

	Never	Rarely	Some times	Often	Always	Don't Know
12. During the academic year, I	1	2	3	4	5	7

recycle where I live.						
13. I recycle while I am on the Towson Campus	1	2	3	4	5	7
14. I keep bottles, cans, paper and glass, to recycle later if no recycling bins are available.	1	2	3	4	5	7

[ASK QUESTIONS 16 ONLY OF TOWSON STAFF, ARAMAK STAFF AND CHARTWELL STAFF]

Now we need you to indicate your response to each of the following statements that best relates to your experience in the workplace.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Don't Know
16. When I started work at Towson, the reasons we recycle on campus were explained to me.	1	2	3	4	5	7

[ASK OF ALL RESPONDENTS] Last, we would like to hear your ideas about recycling on the Towson Campus.

17. How could recycling on campus be made easier for you?

18. What do you think might make other people more willing to recycle on campus?

19. Since you came to Towson, do you recycle more or less?
_____more ____same _____less

Appendix B: Results from part I of questionnaire

4) I think that recycling of paper, plastic, glass, and metal is important

		Responses					
		Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**	**Don't Know**
Status at Towson University	**Student**	2.50%	1.70%	2.50%	55.80%	36.70%	0.80%
	Faculty	0.00%	0.00%	3.10%	43.80%	53.10%	0.00%
	Staff	0.00%	6.70%	0.00%	26.70%	66.70%	0.00%
	Aramark	0.00%	5.00%	0.00%	80.00%	15.00%	0.00%
	Chartwells	0.00%	0.00%	0.00%	73.90%	13.00%	13.00%

5) Most Students on Campus think that recycling is a waste of time

		Responses					
		Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**	**Don't Know**
Status at Towson University	**Student**	0.80%	29.20%	7.50%	37.50%	10.00%	15.00%
	Faculty	3.10%	25.00%	25.00%	21.90%	3.10%	21.90%
	Staff	6.70%	33.30%	13.30%	26.70%	6.70%	13.30%
	Aramark	0.00%	40.00%	10.00%	30.00%	0.00%	20.00%
	Chartwells	4.30%	47.80%	17.40%	26.10%	0.00%	4.30%

7) I know what materials can be recycled on campus

		Responses					
		Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**	**Don't Know**
Status at Towson University	**Student**	2.50%	16.70%	3.30%	55.00%	17.50%	5.00%
	Faculty	0.00%	9.40%	3.10%	50.00%	37.50%	0.00%
	Staff	0.00%	0.00%	0.00%	53.30%	40.00%	6.70%
	Aramark	5.00%	0.00%	5.00%	60.00%	20.00%	10.00%
	Chartwells	0.00%	17.40%	0.00%	69.60%	4.30%	8.70%

6) Most faculty and staff who work on campus think that recycling is important

		Responses					
		Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**	**Don't Know**
Status at Towson University	**Student**	0.00%	13.30%	10.80%	48.30%	5.00%	22.50%
	Faculty	3.10%	12.50%	21.90%	50.00%	9.40%	3.10%
	Staff	6.70%	6.70%	0.00%	46.70%	33.30%	6.70%
	Aramark	5.00%	20.00%	0.00%	60.00%	0.00%	15.00%
	Chartwells	0.00%	21.70%	4.30%	56.50%	8.70%	8.70%

8) When I came to Towson, campus recycling was explained to me

		Responses					
		Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**	**Don't Know**
Status at Towson University	**Student**	50.80%	37.50%	4.20%	0.80%	4.20%	2.50%
	Faculty	50.00%	25.00%	12.50%	6.30%	3.10%	3.10%
	Staff	46.70%	20.00%	6.70%	13.30%	0.00%	13.30%
	Aramark	0.00%	20.00%	10.00%	50.00%	5.00%	15.00%
	Chartwells	4.30%	52.20%	4.30%	34.80%	0.00%	4.30%

9) At the present time, recycling is easy or convenient on campus

		Responses					
		Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**	**Don't Know**
Status at Towson University	**Student**	12.50%	40.80%	9.20%	32.50%	2.50%	2.50%
	Faculty	3.10%	28.10%	25.00%	28.10%	15.60%	0.00%
	Staff	6.70%	0.00%	13.30%	33.30%	46.70%	0.00%
	Aramark	0.00%	20.00%	10.00%	65.00%	5.00%	0.00%
	Chartwells	8.70%	47.80%	8.70%	34.80%	0.00%	0.00%

10) I get bothered when I see people who throw out materials that can be recycled

		Responses					
		Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**	**Don't Know**
Status at Towson University	**Student**	18.30%	32.50%	14.20%	25.00%	9.20%	0.80%
	Faculty	15.60%	18.80%	25.00%	21.90%	18.80%	0.00%
	Staff	13.30%	26.70%	0.00%	33.30%	20.00%	6.70%
	Aramark	5.00%	35.00%	30.00%	25.00%	0.00%	5.00%
	Chartwells	4.30%	34.80%	17.40%	17.40%	4.30%	21.70%

12) During the academic year, I recycle where I live

		Responses					
		Never	**Rarely**	**Some-times**	**Often**	**Always**	**Don't Know**
Status at Towson University	**Student**	16.70%	22.50%	21.70%	24.20%	15.00%	0.00%
	Faculty	0.00%	6.30%	31.30%	21.90%	40.60%	0.00%
	Staff	33.30%	6.70%	6.70%	13.30%	40.00%	0.00%
	Aramark	25.00%	15.00%	30.00%	15.00%	15.00%	0.00%
	Chartwells	26.10%	21.70%	26.10%	17.40%	8.70%	0.00%

13) I recycle while I am on the Towson Campus

Status at Towson University		*Responses*					
		Never	**Rarely**	**Some-times**	**Often**	**Always**	**Don't Know**
	Student	8.30%	25.00%	42.50%	18.30%	5.80%	0.00%
	Faculty	0.00%	6.30%	37.50%	34.40%	21.90%	0.00%
	Staff	0.00%	0.00%	26.70%	20.00%	53.30%	0.00%
	Aramark	0.00%	15.00%	20.00%	30.00%	35.00%	0.00%
	Chartwells	8.70%	17.40%	47.80%	17.40%	8.70%	0.00%

14) I keep bottles, cans, paper, and glass, to recycle later if no recycling bins are available

Status at Towson University		*Responses*					
		Never	**Rarely**	**Some-times**	**Often**	**Always**	**Don't Know**
	Student	53.30%	23.30%	10.80%	10.80%	1.70%	0.00%
	Faculty	31.30%	21.90%	9.40%	18.80%	12.50%	3.10%
	Staff	46.70%	20.00%	13.30%	0.00%	20.00%	0.00%
	Aramark	35.00%	20.00%	15.00%	15.00%	10.00%	5.00%
	Chartwells	47.80%	39.10%	0.00%	8.70%	4.30%	0.00%

16) When I started at Towson, the reasons we recycle on campus were explained to me

Status at Towson University		*Responses*					
		Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**	**Don't Know**
	Faculty	53.10%	15.60%	3.10%	3.10%	0.00%	0.00%
	Staff	40.00%	26.70%	0.00%	6.70%	13.30%	0.00%
	Aramark	5.00%	20.00%	25.00%	45.00%	0.00%	5.00%
	Chartwells	13.00%	30.40%	13.00%	34.80%	4.30%	4.30%

Appendix C: Results from part II of questionnaire

17. How could recycling on campus be made easier for you?

Responses	**Students**	**Faculty**	**Staff**	**Aramark**	*Chartwells*	**Totals**
Nothing, it's already easy		3	5	2		**10**
N/A, I don't recycle	2				10	**12**
Increases of bins	46	6	1	5	12	**70**
No response/Don't know	11	1		8	2	**22**
Place next to every trashcan	13					**13**
Encourage people to put in proper bins				4		**4**
Education program for students	3				1	**4**
Improve bin location/placement	23	1		1		**25**
Improving convenience/accessibility	9	2	1	1		**13**
Increase paper bins in classrooms	6	1				**7**
Merely spread bins out on campus	1					**1**
Recycling by trash chutes in residence areas (dorms)	14					**14**
Recycling by trash cans in food service areas	4				3	**7**
Increasing Advertisements/noticibility	12	1	1			**14**
Periodically email/remind students/staff about Towson recycling			1			**1**
Improved campus-wide effort	2	1	1	1		**5**
Bigger recycling bins					3	**3**
Make sure bins are emptied; free of debris and bees	2		1	1		**4**
Color coded bins	6	1				**7**
Enforcement to make sure things get recycled, not trashed		5	2			**7**
Put recycling bins on Aramark carts		1		1		**2**
Bottle/can bins for dept. offices		1	1			**2**
Bins for off-campus students (apt. buildings)	2					**2**
Bins in Garages	1					**1**
Bins in Offices		3				**3**

Responses	Students	*Faculty*	Staff	Aramark	Chartwells	Totals
18. What do you think might make other people more willing to recycle?						
Nothing	3				1	**4**
Increases of Bins	12	7	1	1	4	**25**
No Response/I don't know	19	6		8	6	**39**
Improved education program	23	7	3	4	5	**42**
Improve bin location/placement	3	2	1		1	**7**
Improving convenience/accessibility	23	3	1		3	**30**
Increase bins in classrooms	2	3			1	**6**
Recycling by trash chutes in residence area (dorms)	1					**1**
Recycling by trash cans in food service areas				1	2	**3**
Increasing advertisements/visibility	10			1	2	**13**
Improved campus-wide effort	1	1				**2**
Color-coded/better marked bins	2	1		1		**4**
Enforcement to make sure things get recycled, not trashed	1	1				**2**
Incentive/awards programs (contests between groups)	22	5		1	1	**29**
Disturbing pictures of litter ("w/dead people")	1					**1**
Fines				1		**1**
"Paper campaign"		1				**1**

19. Since you came to Towson, do you recycle more or less?						
Response						
More	10	14	12	5	7	48
Same	59	14	4	14	9	100
Less	48	1		1	2	52

Appendix D: Results from waste audit

Building & Sample day	Initial Weight (lbs.)	Plastic (lbs.)	Glass (lbs.)	Aluminum (lbs.)	Metal (lbs.)	Paper (lbs.)	Cardboard (lbs.)	Remaining Trash (lbs.)
Ward/West Tuesday	9lbs. 6oz. 10lbs. 2oz. 7lbs. 12oz. 15lbs. 9oz. 12lbs. 8oz.	10lbs. 6oz.	10lbs. 13oz.	3lbs. 1oz.	0	1lb. 4oz.	3lbs. 3oz.	29lbs. 4oz.
Total=	55lbs. 5oz.							
Ward/West Thursday	8lbs. 11oz. 7lbs. 6lbs. 13oz. 4lbs. 10oz. 4lbs. 2oz.	3lbs. 2oz.	9oz.	1lb. 3oz.	0	~3-5lbs.*	2lbs. 5oz.	23lbs. 7oz.
Total=	31lbs. 4oz.							
Newell/Richmond Monday	12lbs. 9oz. 11lbs. 8oz. 14lbs. 4oz. 17lbs. 13oz. 14lbs. 6oz.	2lbs. 3oz.	4lbs. 8oz.	10oz.	0	1lb. 4oz.	12oz.	57lbs. 2oz.
Total=	70lbs. 8oz.							
Newell/Richmond Thursday	10lbs. 10lbs. 5oz. 12lbs. 1oz. 2lbs. 1oz. 11lbs. 4oz.	3lbs. 11oz.	25lbs. 1oz.	1lb. 10oz.	0	0	0	16lbs. 1oz.
Total=	45lbs. 11oz.							
Enrollment Friday	13lbs. 11oz. 14lbs. 12oz. 18lbs. 5oz. 13lbs. 7oz. 8lbs. 14oz.	2lbs. 8oz.	1lb. 1oz.	1lb. 2oz.	0	13lbs. 15oz.	1lb. 12oz.	46lbs.
Total=	69lbs. 1oz.							
Enrollment Monday	16lbs. 1oz. 15lbs. 8oz. 15lbs. 6oz. 9lbs. 15oz. 14lbs. 8oz.	1lb. 11oz.	0	4oz.	1lb. 7oz.	17lbs. 8oz.	0	43lbs. 6oz.
Total=	71lbs. 6oz.							
Stephens Thursday	5lbs. 11oz. 3lbs. 1oz. 4lbs. 12oz. 5lbs. 7oz.	1lb. 3oz.	1lb. 10oz.	13oz.	9oz.	2lbs. 13oz.	5oz.	12lbs. 6oz.

	3lbs. 2oz.							
Total=	22lbs. 1oz.							
Stephens	3lbs. 3oz.	1lb. 4oz.	2lbs. 14oz.	8oz.	6oz.	10lbs. 5oz.	0	18lbs. 14oz.
Tuesday	14lbs. 1oz.							
	5lbs. 7oz.							
	4lbs. 13oz.							
	6lbs. 6oz.							
Total=	33lbs. 14oz.							
Overall Total=	399lbs. 2oz.	26lbs.	46lbs. 8oz.	9lbs. 3oz.	2lbs. 6oz.	47lbs. 1oz.	8lbs. 5oz.	246lbs. 8oz.
% of total trash that is recyclable=		6.51%	11.65%	2.30%	0.60%	11.79%	2.08%	61.76%

* indicates that the paper was contaminated and could not be recycled. Estimate is of what could be recycled if there was no contamination. These estimates are not included in the total.

Appendix E: Conversion from pounds to cubic yards

Newell/Richmond Monday	Newell/Richmond Thursday	Enrollment Friday	Enrollment Monday	Stephens Thursday	Stephens Tuesday
.0365-.0547	.0615-.0922	.0417-.0625	.0281-.0422	.0198-.0297	.0208-.0313
.00750-.00900	.0418-.0501	.00177-.00213	0	.00271-.00325	.00479-.00575
.00893-.0125	.0232-.0325	.0161-.0225	.00357-.00500	.0116-.0163	.00714-.0100
0	0	0	.00958-.0115	.00375-.0045	.00250-.00300
.0139-.0179	0	.155-.199	.194-.250	.0313-.0402	.115-.147
.0150-.0188	0	.0350-.0438	0	.00625-.00781	0
0.19	0.0535	0.153	0.145	0.0413	0.0629

Appendix F: **Schedule for pick up**

Oct-02-02 08:53A ARAMARK Campus Services 410 8302024

21. The following schedule will be used for pickup at Academic & Administrative (Program 0 Auxiliary Service buildings (Program 08).

LOCATION	TYPE	PICK-UP DAYS
PROGRAM 07		
Administration	8 cy	Tues, Thur
Auburn House	6 cy	Fri
Burdick Hall	8 cy	Tues, Thur
Fine Arts	8 cy	Tues, Thur
Fine Arts	30 cy o.t.	Tues
General Services	30 cy comp	lst Sat each month
General Services Bulk Trash	15 cy o.t.	On call
Hawkins/Psychology	20 cy comp	Tues
Lida Lee Tall	4 cy	Fri
Smith Hall	20 cy	Sat
Stephens Hall	8 cy	Mon, Wed, Fri
Towson Center	20 cy	On call
7720	30 cy o.t.	Thur
7800	8 cy	Tues, Thur
PROGRAM 08		
Burkshire	3 x 2 cy	Mon, Wed, Fri
Burkshire	8 cy comp (VIP)	Fri
Glen Dining	30 cy comp	Fri
Glen Tower A	2 x 2 cy	Mon - Sat
Glen Tower B	2 x 2 cy	Mon - Sat
Glen Tower C	2 x 2 cy	Mon - Sat
Glen Tower D	2 x 2 cy	Mon - Sat
Newell Dining	30 cy	Sat
Newell/Richmond	8 cy	Mon, Wed, Fri
Prettyman	20 cy comp	On call
Residence Tower	2 x 2 cy	Mon - Sat
Towson Run	30 cy comp	Fri
Trax	8 Cy	On call
University Union	30 cy	Sat
Union Garage	8 cy	Fri
Ward/West	8 cy	Mon, Wed, Fri
CARDBOARD		
Administration	6 cy	Tues, Fri
Burdick Hall	6 cy	Tues, Fri
Burkshire	6 cy	Tues, Fri
Fine Arts	6 cy	Tues, Fri
General Services	6 cy	Tues, Fri
Glen Dining	6cy	Tues, Fri
Newell Dining	6 cy	Tues, Fri
Psychology/Hawkins	6 cy	Mon, Tues, Fri
Smith Hall	6 cy	Tues, Fri
Stephens Hall	6 cy	Tues, Fri
Towson Center	6 cy	Tues, Fri
University Union	6 cy	2x Mon, 2x Tues, 2x Fri
7800	6 cy	Tues, Fri

Appendix G: Information on campus waste costs

Material	Type/Size (cubic yds)	Tipping Fee	Hauling Fee	Rental Fee	Disposal Cost
Waste	2 cy	$12.40	XXXX	XXXX	XXXX
	4 cy	$11.08	XXXX	XXXX	XXXX
	6 cy	$14.65	XXXX	XXXX	XXXX
	8 cy	Avg. $16.98	XXXX	XXXX	XXXX
	20 cy compactor	XXXX	86.50per	avg. $54.24/wk	$41.00/T
	30 cy compactor	XXXX	86.50per	avg. $54.50/wk	$41.00/T
	30 cy open top	XXXX	86.50per	avg. $10.96/wk	$41.00/T
Cardboard	2 cy	N/A	XXXX	XXXX	XXXX
	4 cy	$3.43	XXXX	XXXX	XXXX
	6 cy	$3.43	XXXX	XXXX	XXXX
	8 cy	N/A			
Plastic	30 cy open top	XXXX	86.50per	XXXX	$10.00/ton
Paper	Compactor	XXXX	XXXX	$150.00/month	XXXX
Glass	30 cy open top.	XXXX	86.50per		$10.00/ton
Cans	30 cy open top	XXXX	86.50per		$10.00/ton
Steel	30 cy open top.	XXXX	86.50per	$45/mo (10.38 week)	XXXX

Appendix H: Local Recycling Resources

Northeast Maryland Waste Disposal Authority
Contact Cliff Dowling,
Commercial Recycling Specialist
Phone: 410-333-3066
mdrecycles@charm.ne

Richard Keller, Chief of Recycling,
Associate Director of General Services
Maryland Environmental Services
2011 Commerce Park Drive
Annapolis, MD 21401
(410) 974-7281
rkell@menv.com

Jim Peck, Director
Maryland Environmental Services
2011 Commerce Park Drive
Annapolis, MD 21401
(410) 974-7281
jpeck@menv.com

Charles M. Reighart, Recycling and Waste Prevention Manager
Baltimore County Bureau of Solid Waste Management/Recycling Division
111 West Chesapeake Ave. Room 225
Towson, Maryland 21204
410-887-2182
creighart@co.ba.md.us

Larry Novicky
Unicor
320 First Street, N.W.
Washington, DC 20534
202-305-3732

Appendix I: Closing the loop

Responses of office staff to questions regarding their purchasing of recycled materials.

Department	Used Recycled?	Reasons/Comments
Accounting	don't know	order through someone else
Art	don't know	order through someone else
Biology	no	has never been an option
Chemistry	yes	shops for the best price, which usually is the recycled products
Communication Sciences	no	
Computer Science	sometimes	buy recycled tablets
Early Childhood Education	no	order through someone else, and don't think it is an option
Elementary Education	no	paper doesn't feed into printers properly
Finance	yes	
Geography	no	has in past but paper doesn't feed into printer properly
Gerontology/Fam. Studies	sometimes	depends on price, bought pads once but not good quality
Management	yes & no	
Marketing and e-Business	yes	no to paper, yes to envelopes folders
Modern Languages	don't know	
Music	no	
Nursing	yes	
Occupational Therapy	yes	buy recycled folders, also have problems with recycling pick up and sometimes have to take home
Physics, Astron. & Geosci.	don't know	get from somewhere else
Political Science	sometimes	some note pads, but not printer paper
Secondary Education	no	do recycle
Sociology	yes	paper says it is partially made of recycled materials
Theater	no	usually just think cheapest price, but thinks they should be more aware
Women’s Studies	no	wouldn't be against it