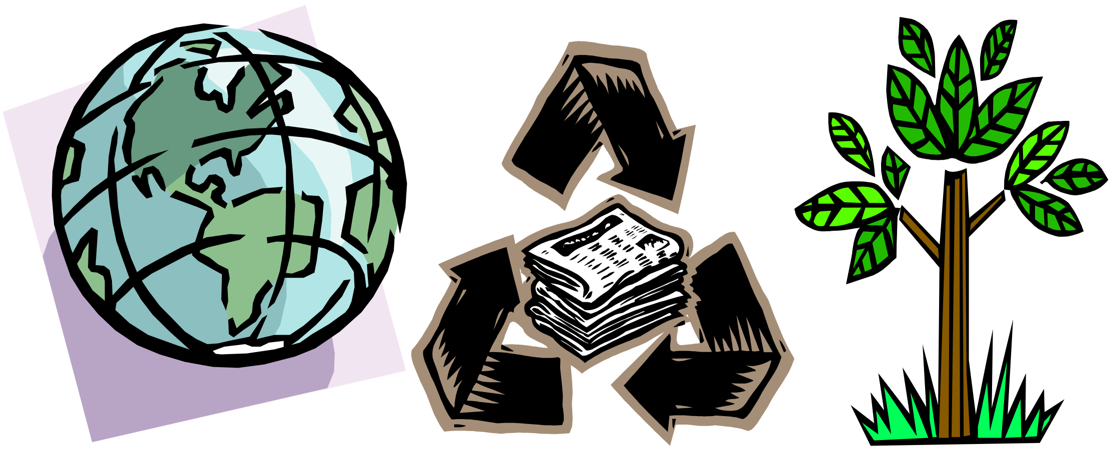
Composting at Towson University: A Feasibility Study



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I. Purpose Statement

To prepare for entry into the environmental workforce, the students of the Environmental Science and Studies senior seminar course chose to focus on alternative methods for solid waste disposal on the Towson University Campus. We were able to incorporate elements from each of our courses (i.e. biology, economics and public policy) into the solving of the solid waste problems that were encountered.

On Wednesday September 5, 2001, Ms. Gina Conroy, Interim Manager of Contract Services spoke with the class about the University's current waste removal methods. The statistics that Ms. Conroy provided revealed that the compactors behind the campus' dining facilities contained more waste than those of the residence halls' and academic buildings' compactors combined (746 tons to 588 tons respectively).

After contacting several authorities and conducting extensive research we feel that composting would reduce the problem of having to remove large amounts of solid waste. We have prepared a feasibility study on incorporating a food waste composting facility on campus. Such a facility would bring Towson University into the environmental forefront not only in Baltimore County but also the state.

II. Introduction to Composting

Composting is the process of transforming organic material, through decomposition, into a soil-like material called compost. It is a natural way of recycling biodegradable waste. Certain materials that facilitate this natural process should be added to the compost pile. Other materials should not be added because they slow the process down.

Materials easily decomposed:	Materials difficult to rapidly decompose:
- wood, leaves and grass	- coal, charcoal
- brown paper	- colored, glossy paper (magazines, catalogs, etc.)
- vegetables/fruits	- non-biodegradable items (plastic, glass, aluminum, metal)
- kitchen scraps/food waste	- pet litter
	- large quantities of grease, oil, or fat

Following separation of materials that are not compostable, the first step in transforming biodegradable waste into compost is to mix the waste with wood chips into a pile. The wood chips are incorporated to provide adequate moisture and aeration throughout the pile. This is necessary to allow aerobic microbial activity to occur, which provides an odor-free environment. Then, two types of decomposers, macroorganisms and microorganisms, break down the material. Macroorganisms are the invertebrates and insects that aid in the physical reduction of waste by shredding, digesting, and mixing the material. Examples of these macroorganisms include millipedes, centipedes, sow bugs, snails, slugs, mites, spiders, ants, flies, and different worms. Microorganisms play the greatest role in the decomposition process by changing the chemistry of the material. Bacteria and fungi are important organisms within the compost pile and account for eighty to ninety percent of the billions of microorganisms found in one gram of compost (Campbell 1998).

In order for the organisms to decompose the material, certain conditions must exist within the compost pile. They need an ideal temperature, a sufficient energy source (carbon), a protein source (nitrogen), oxygen, and moisture. The temperature inside the compost pile should be between 50-60°C (120-150°F). Also, the carbon to nitrogen ratio must be between 25:1-30:1. Ventilation, turning of the pile, and preserved air spaces around the wood chips will provide enough oxygen for aerobic decomposition. The moisture content of the pile must be maintained at a level between 40 to 60%. If these conditions are met, a pile that is 6'by 6' will be reduced by 50% in 3-4 weeks, without any odor. When the decomposition process is complete, the final product is nutrient rich compost that can be used in landscaping, gardening, etc.

III. Composting Benefits

Composting waste is an effective, less expensive way to manage organic waste. It recycles valuable natural resources and produces a high quality, inexpensive soil amendment, without adding to environmental problems.

The standard means of disposing waste requires sending it to a landfill or incinerator. These practices are not as environmentally or economically sound as composting and recycling. Approximately 30% of the waste produced by the U.S. comes from yard waste and food materials, both can be easily composted. If these materials were composted, the amount of waste entering the Municipal Solid Waste stream would be reduced by 25% (Compost Resource Page 2001). Placing organic waste in a landfill takes up space that could be used for other materials that cannot be recycled. Yard waste (i.e. grass clippings) in the landfill breaks down much slower than under natural conditions due to low oxygen levels. As the material in the lanfill decomposes, it produces methane and acidic leachate, which can cause many environmental problems. Building a composting facility and additional recycling at Towson University would reduce the amount of waste the university sends to the landfill by 80%.

There are many benefits of mixing compost with existing soil. These include improving soil structure, texture, aeration, and water retention. It can also provide erosion control, increase soil fertility, maintain proper pH balance, and promote healthy root development in plants. Furthermore, adding compost can decrease nutrient runoff, soil compaction, disease, and pest infestation and reduce or eliminate the use of chemical fertilizers (Compost Resource Page 2001). The compost generated from our facility can be used to enhance the structure of the university's landscaping and any excess compost may be distributed to the students and to the faculty.

There is not enough landfill space remaining to accommodate all the waste that is produced nationwide. Incineration is becoming more unpopular because the incineration of moist organic waste results in poor combustion and increases the amount of pollutants that need to be removed by pollution-control devices (Compost Resource Page 2001). Alternative means of disposing waste need to be utilized due to these circumstances.

Universities across the country have changed their means of waste disposal by building composting facilities on-campus. Cornell University, Washington State University, Brown University, University of Vermont, Ithaca College, and Rice University are among the large institutions across the country that have successfully implemented composting systems. The Towson community could be proud to have its name associated with these universities as being a top environmental contributor and problem solver. Towson University would become a role model for the surrounding schools and community.

Many students, faculty, staff, and the public are unfamiliar with composting. Towson University could use the composting program to educate their students as well as other people in the surrounding communities. Cornell University, which currently has approximately the same size student population as Towson University, instituted a composting program. The program has been used as a resource for research projects at the undergraduate and graduate levels, as well as for outreach programs with other local businesses (Cornell University Website 1998).

A composting project at Towson University could also bring positive attention to the campus and attract potential students. Washington State used its composting program to boost student enrollment. At the 1992 Palouse composting symposium, high school students, whom had participated in these educational outreach programs, gave presentations on composting. Of these students, fifty enrolled at WSU within the next two years (Washington State University Website 2001). A composting program at Towson could be a possible selling point for the university. Waste disposal is a major problem, not only in Maryland, but also in the entire country and this project would enable Towson to be an environmental leader in the community.

IV. Regulations Pertaining to University Composting

Composting in Maryland is regulated by the Maryland Department of the Environment Solid Waste Division. The regulations governing composting within the university are rather simple. The university is permit exempt if it only composts material that is generated on campus. Should the university decide to accept waste from other sources (such as the surrounding community or Towson High) possibly as an outreach gesture, then there is a specific permitting procedure that requires the employment of a certified operator (COMAR 26.04.07.23.). We would need to refer to the Code of Maryland Annotated Regulations (COMAR 26.04.07.23.) to determine which regulations apply. In contrast, accepting organic waste, such as woodchips, from an outside source does not require a permit because the chips aren't considered solid waste. By understanding current regulations, we were able to proceed in developing a composting program that would be feasible at Towson University.

According to Mr. Kavah, of the Maryland Department of the Environments' Solid Waste Division, the largest potential concerns are odor and pest control. Regulations require that all composting operations should be free of any objectionable odor and does not attract any nuisance animals. Should these problems occur, the operation could be shut down. A fifty-foot distance from any property line is required to help reduce the chances of a neighbor complaining. If there is a direct line of site between the facilities and its activities, a tree-line buffer is needed (COMAR 26.04.09.07.). These regulations developed because of the concern about complaints. They serve to make the facility as unobtrusive as possible and will help to prevent a false complaint.

Composting on Towson University campus would have very few regulations other than the primary concerns of smell and pest control. If the University has an area that is buffered from the public and an operation that doesn't produce an objectionable odor or attract nuisance animals, then we would be free to operate without permits or other supervision from the state of Maryland (COMAR 26.04.07.23.).

V. Characteristics of Composting Systems

Several different composting methods were evaluated before coming to a final decision of which would be the most effective for our campus. Our class consulted Mr. James Marion, the Resource Management Director of the New York Correctional Services, to assess the possibility of composting on the University campus. Mr. Marion has built over 30 composting facilities since 1990 and is an expert in composting at large facilities. He introduced us to a number of different composting methods along with their advantages and disadvantages, and he described the procedure for construction and maintenance of a large scale composting facility.

We initially looked at the least expensive method, the windrow system. This method consists of a series of connected piles of organic waste that are turned successively every other day. The piles sit in long row, in the open with only minimal site preparation necessary. It takes approximately 3-4 weeks for the first pile to be sufficiently decomposed. This system is very inexpensive, requiring only a concrete pad and a vehicle that is used to turn the pile. However, the pile may be considered unattractive and excess water from rainfall could cause saturation to the piles. Saturation could interrupt the process and cause an unpleasant odor.

In contrast to the open windrow method, we also looked at fully enclosed systems. These structures take up a relatively small area (10 x 35 x 10 feet) and keep the entire process covered, so that risks of odor and visual obtrusiveness are minimized. However, this system can be expensive with costs ranging from $200,000 - $400,000.

There are also additional installation costs and employee training costs for the filtering and computer systems.

The best alternative, we felt, was to create an enclosed aerated static bay system. This involves building a barn-like structure that is on a cement floor with open compost bins inside. This will also provide a place for the finishing pile and the screening device (to filter out products that are not composted). The bins hold relatively small piles of waste that would be easier to manage. The barn would keep the entire process covered, eliminating unsightly piles and reducing the risk of saturation. The structure would also provide protection for employees from harsh weather. The composting process would require 3-4 weeks for initial decomposition and would require less daily maintenance than the windrow system and would be much less expensive than the in-vessel system.

VI. Composting Site Selection

Our proposed composting facility, based on the amount of material generated, would need to be at least 60 feet in length, and 20 feet in width. There are not many vacant places on campus that could accommodate a structure of this size. We evaluated three sites taking into consideration access to the land, centrality of the location, and availability of water, sewer, and electric. After evaluating the three sites, a location near the Grounds Building was chosen as the best placement for the composting facility.

Directly adjacent to the new grounds building, behind the Towson Center, lies an empty parcel of land approximately 80 feet by 40 feet, which we will refer to as the Grounds Building Site (Site A- Appendix 2). This amount of land could easily accommodate the necessary building. We will only need approximately 2/3 of the land that is available at this site, so there will be room for expansion if needed in the future. The site is located just west of the Towson Center (Appendix 2) and is isolated from students and surrounding traffic. The Towson University practice fields nearby would not be affected by the composting facility. George Krause, the facilities planner, has assured us that there are no expected uses for this area in the university master plan for the next ten years. Water, sewer, and electric connections are available from the nearby grounds facility, and connecting to the preexisting lines is far less expensive than running new lines to the location. In addition, it is possible that somebody from the grounds building could be assigned the responsibilities of overseeing the composting facility.

There are also preexisting bays located next to the grounds building on the corner of the parking lot. The bays could be used for storage of wood chips or supplies for the facility, when they are not being utilized for other reasons. Some of these bays are currently filled with mulch and small equipment (i.e., skid-steer loader). The mulch could be kept there, and the small equipment could be stored inside the composting facility. The companies supplying the wood chips also can easily reach this area. Upon reviewing this location, we feel that this site, the Grounds Building Site, is most appropriate for our facility.

The second site visited was located down a dirt road next to a practice field just south of the Grounds Building Site (Site B). This will be referred to as the Practice Field Site. First, there may not enough land to accommodate a composting facility, and traveling to the site would be more difficult due to the rough condition of the road. The road could be improved, however there would be added costs of doing so. This site is more isolated from staff and traffic and has no available equipment nearby, at the current time. Finally, water, sewer, and electric would have to be run to this site, which ultimately would increase costs. We feel this site is not as appropriate as the Grounds Building Site.

The final site visited was the Auburn Road Site (Site C) located on the corner of Auburn Drive and Osler Drive. This site is located directly next to a major route through campus. There may not be enough space is available at this site to accommodate the proposed facility. This property is also surrounded by neighbors who might oppose such a structure, in which case some type of barrier would have to be constructed. Water, sewer, and electric would have to be connected to the site, which adds to the costs. We think it should only be considered as a last alternative. Given all these considerations, the Grounds Building Site is the best location for the Aerated Static Bay Composting System.

VII. Operating an Aerated Static Bay Composting

The proposed aerated static bay system would require a 60’ by 20’ pole barn with a cement floor. The facility would house six, 6’ by 6’,open bays, an area for a finishing pile, and an area for a screening device. Adequate space must be included in the plan to allow a skid-steer loader to maneuver between the bays. Walls, constructed out of 2” by 12” pressure treated lumber would separate the bays. To provide aeration to the composting piles, each bay must have its own 24” fan that is mounted in the ceiling. The air would be funneled through a 3” diameter pipe into the center of the bay. It is suggested that the fans be mounted in the ceiling to keep the cords out of the way and prevent any potential accidents. In order to prevent the pipe from being crushed, an eight –inch layer of wood chips covers the pipe. The fans must be set by timers to provide two and a half minutes of aeration to the pile four times a day. The floor in the building will be sloped to a central drain, which is directly connected to a sewer line. Any leachate that may be produced can be easily rinsed into the drain. Water must be available to maintain the moisture in the compost, and electric outlets would be needed in order to run the fans.

As The Glen and Newell kitchens are currently run, the products that are compostable are reasonably easy to extract from the rest of the kitchen waste. Presently, the waste from dinner trays are sent to a pulper and placed in a waste container. The other compostable products come from the food prep stations. Dave Tosi, Facility Manager, has informed us that the separation into extra bins would require minimum additional effort for the kitchen staff. At the end of the day, the trash containers would be rinsed out, as is currently done with the container that collects the pulp. There is also a possibility for increasing the amount recycling performed in the kitchen and since this was practiced in the past. Mr. Tosi, the manager of the Glen Dining Facility, has informed us that it would only require getting the appropriate bins in place.

Once the facility is constructed, the food from the dining halls would be collected in several large plastic bins that could be easily dumped and hauled to the pole barn. The material would need to be picked up several times a week. The waste entering the composting facility would be mixed in layers with wood chips at a ratio of two parts wood chips to one part food material. According to Matthew Anacker, Executive Director of the Maryland Arborist Association, local tree companies could provide the wood chips without any charge. In order for composting to take place, the pile must be a minimum of six feet high. Each bay has been designed to hold approximately 1 week worth of food and the corresponding amount of wood chips. Once enough material is generated, it is then allowed to sit for 3-4 weeks. After this decomposing period, the pile would be run through a screener to remove any contamination, such as plastic or metal. Once screened, the composted material would remain in a finishing pile for 30-60 days, in order for it to fully cure.

VIII. Glen Dining Facility Audit

In order to further assess the feasibility of composting on campus, we needed to determine the composition and the quantity of the waste being produced at the dining facilities. Mr. Dave Tosi allowed us to conduct an audit of the waste being produced on an average day. All the waste produced during the preparation of the food was separated into food scraps, plastics, tin, cardboard, and non-recyclable materials. These items were then weighed to determine the amount of each that accumulated in a single day. The waste from the dining area is composed of food scraps and paper napkins, which are both compostable. This waste was processed through a pulper and weighed. Our audit produced an approximate quantity of waste produced at the Glen Dining Facility in an average day.

In order to assess the amount of waste produced in a single day at the Newell Dining Facility, we compared the amount of meals served at each location. The Glen served 1,175 meals to students on the day of the audit compared to 592 at Newell. We then used the proportion of meals served at Newell compared to the Glen to calculate the approximate amount of waste produced per day at the Newell Dining Facility (Table 1). The total waste per year was then calculated by multiplying the total waste per day for each facility by the amount of days that the facility is open per year. The audit is important because it shows the relative proportions of all the different types of waste that are generated at the two dining facilities.

Table 1. Waste Audit

	Glen	**Newell**	**Both Facilities**
Meals Served	1175	592	
Facility Schedule (days/year)	357	165	
Food Waste (lbs./day)	711.0	355.0	
Food Waste (lbs./year)	253,827.0	58,575.0	
Food Waste (tons/year)	127.0	29.0	
Food Waste - Total Tons			156.0
Plastic (lbs./day)	36.2	*9.1	
Plastic (lbs./year)	12,916.0	1,493.0	
Plastic (tons/year)	6.5	0.7	
Plastic - Total Tons			7.21
Tin (lbs./day)	40.0	10.0	
Tin (lbs./year)	14,280.0	1650.0	
Tin (tons/year)	7.1	0.8	
Tin - Total Tons			7.96
Non-recyclable (lbs./day)	206.3	51.6	
Non-recyclable (lbs./year)	73,653.0	8511.0	
Non-recyclable (tons/year)	36.8	4.3	
Non-recyclable – Total Tons			41.08

* We calculated this number by comparing the two facilities food waste proportions (29 tons/127 tons = .229% is approximately .250 or 1/4. This number works best because the facilities are open different number of days per year.

IX. Economic Analysis

The proposed program focuses on composting food materials associated with the Glen dining hall and Newell dining hall. Both of these are "all you can eat" facilities, where patrons are apt to take more than they are going to eat. Thereby, producing more food waste than in the other dining areas on campus, at which patrons pay for the separate servings. According to Gina Conroy, the buildings that house these two facilities had the highest tonnage of waste compared to the other buildings on campus. Towson University spends between $240,000 and $250,000 on waste removal per year, which includes trash from dorms and classrooms as well as the food facilities. It is estimated that by implementing the proposed program on campus, the university could save between $33,502 to $34,548 per year. The reduction in waste removal costs will cover the initial start up costs approximately within the first year of operation.

According to the waste audit that we conducted, we determined that the dining halls produce 156 tons of food waste in one academic year. Under the current waste hauling contract, a 30 cubic yard compactor is located behind each dining hall. Our audit numbers for total waste are different from those provided by the university, therefore we used some assumptions to figure the amount of waste produced. Assuming that the compactors are full each time they are dumped, the dining halls combined would produce 520 tons of waste annually. The proportions of compostable, recyclables, and non-compostable wastes calculated from the audit were used to extrapolate the annual tons generated in each category based on the assumed 520 tons (Appendix I Tons of Waste Generated Yearly and Recycling and The Money Gained Through Increased Recycling). The university rents these containers and is charged a hauling fee of $80.00 per compactor each time they are dumped which works out to be once a week. Additional fees are charged to dump the waste at the landfill on a per ton basis, which locally costs $75.00 per ton. Using our extrapolation the estimated cost of food waste disposal for these two facilities currently adds up to $47,320 per year. If the food waste and recyclables were removed from the main waste stream, we estimate that the university would save approximately $42,000 per year in hauling fees and landfill charges (Appendix I Potential Savings).

A composting program will benefit Towson University immediately, but the benefits will increase after the program has been in operation. Initial startup costs for this facility will range from $20,000 to $24,000. Once the startup costs are covered, the composting program that we have designed will cost about $9,300 to operate each year thereafter. Towson should save roughly $33,500 to $34,500 in deferred expenses such as waste removal, purchasing compost, and recycling, as a result of a composting program. (Appendix I Final Analysis).

Table 2. Cost breakdown of start-up costs.

Start-Up Costs			
Item	Quantity	Price per Unit	Total
Pole barn w/ 6” cement floor *	1	$16,000- $20,000	$16,000- $20,000
Skid loader	1	University already owns one	$0
24” Industrial fan	6	$99.00	$594.00
Pipe (3” diameter)	110 feet	$ 5.79 / foot	$64.00
Temperature probe	1	$93.00	$93.00
Timer	6	$59.00	$59.00
Waste containers	8	$24.00	$192.00
Vehicle for hauling	1	University owns one	$0
Wood chips	312 tons/year	Provided by local tree companies	$0
Screening device	1	$2000	$2000
Training	1 person	$800	$800
		Total Start up Costs	$19,802-$23,802
Annual Expenses			
Facility Operator	1	$14.10 per hour (208 h/yr)	$2932.80 per year
Other Salaries (waste hauling)	2	$10.17 per hour (624 h/yr)	$6346.08 per year

* Information provided by Rasche Brothers Construction, Taneytown, MD.

X. Possible Funding Sources

Should the University decide to go forward with this project, there are several possible funding sources available to finance the construction and operational expenditures for the proposed composting facility. One source would be a grant from the Environmental Research and Education Foundation in Washington DC, who provides grants ranging from $10,000 to $50,000. Awards are given for projects that involve solid waste management, including waste minimization and waste recovery, such as composting.

Other grants are also available to non-profit organizations from a variety of sources as listed in the Catalog of Federal Domestic Assistance put out by the Environmental Protection Agency, Office of Solid Waste. The awards will not cover the construction of the building but will cover the purchase of equipment such as the screener, a new bobcat and other supplies such as fans and piping. The awards could also pay for training and educational materials. The awards range from $5,000 to $250,000.

Mary Louise Healy, Director of the University Research Services, supplied additional funding possibilities such as the National Fish and Wildlife Federation Challenge Grants and the Chesapeake Bay Small Watershed Grants Program. She stressed the need to "emphasize the watershed protection element" of the composting project. Other possible funding sources are the Maryland Department of Natural Resources Governor's Watershed Revitalization Partnership Program for Stream Restoration, and the Ittleson Foundation, which focuses on environmental education.

XI. Conclusions

Currently, the University spends a large amount of money on waste removal, and we wanted to try to develop a mechanism to lower these costs. We chose to focus on composting based on the fact that a considerable amount of the waste being generated is food waste and food is readily compostable. We took into consideration potential costs (construction costs, supplies and training) and potential savings (additional recycled materials, tipping and hauling fees) and according to our waste audit calculations, we anticipate substantial savings, which could cover the start up costs within a year. In addition to the economic benefits, composting at Towson University could provide many other benefits such as community and educational outreach programs.

There are very few regulations governing composting within the university, and funding is available from outside sources making the program easier to initiate. After considering all of these factors we determined that composting is not only feasible but also advantageous.

VIII. Appendix 1--Economic Analysis

*Two estimates of the amount of waste that the University generates annually were used to estimate the economic benefit of implementing a composting facility on campus. The first estimate was based strictly on the tons of waste that were generated as a result of the waste audit on Oct.3 in the Glenn Dining facility. Any calculations using this estimate are referred to as “based on audit.” From that estimate we calculated the proportions of food waste, metal, plastic and miscellaneous waste on an annual basis and at Newell Hall. The second estimate is based on the assumption that the compactors that are located behind the dining facilities are always full when they are dumped. Using this assumption, the university would generate 520 tons of waste annually. The proportions of waste types from the waste audit were then applied to the 520 tons. Any calculations based on these estimates are referred to as “based on extrapolation”.

Tons of Waste Generated Yearly

	Yearly Tons (Percent of Total) Based on Audit	Yearly Tons (Percent of Total) Based on Extrapolation*
Food Waste	156 (73%)	379.6 (73%)
Metal (Tin)	7.96 (4%)	20.8 (4%)
Plastic	7.21 (3%)	15.6 (3%)
Miscellaneous Waste	41.08 (20%)	104 (20%)
Total Waste	212.25 (100%)	520 (100%)

Recycling and The Money Gained Through Increased Recycling

	# of Tons Generated ($ Gained/ Year) Based on Audit	# of Tons Generated ($ Gained/ Year) Based on Extrapolation
Metal ($40.26- $90.54/ ton)	7.96 ($320.47- $720.70)	20.8 ($837.41- $1883.23)
Plastic ($140 /ton)	7.21 ($1009.40)	15.6 ($2184)

Totals	15.17 ($1329.87-$1730.10)	36.4 ($3021-$4067)

Source of Waste Removal Costs
(Based on Extrapolation Data)

	Current Cost For Waste Removal	Anticipated Costs After Compost and Recyclables are Removed
# of Compactors	2 (30 cubic yards)	2 (30 cubic yards)
Compactor Load	5	5
Times Dumped Per Year	52	12
Total Tons Dumped Per Year	520	104
Hauling Fees	$ 80.00 per haul	$ 80 per haul
Hauling Fees Per Year	$8,320	$1,920
Tipping Fees at Landfill	$75.00 per ton	$75.00 per ton
Tipping Fees Per Year	$39,000	$7,800
Waste Removal Costs Per Year	$47,320	$9,720

Source of Waste Removal Costs
(Based on Audit Data)

	Current Cost For Waste Removal	Anticipated Costs After Compost and Recyclables are Removed
# of Compactors	2 (30 cubic yards)	2 (30 cubic yards)
Compactor load	2.04	5
Times Dumped Per Year	52	9
Total Tons Dumped Per Year	212.25	41.08
Hauling Fees	$ 80.00 per haul	$ 80 per haul
Hauling Fees Per Year	$8,320	$1,440
Tipping Fees at Landfill	$75.00 per ton	$75.00 per ton
Tipping Fees Per Year	$15,919	$3,081
Waste Removal Costs Per Year	$23,951	$4,521

Potential Savings

	Based on Audit	Based on Extrapolation
Potential $ Saved in Waste Removal	$19,430	$37,600
Potential $ Gained Through Recycling	$1,329.87-$1,730.10	$3,021- $ 4,067
$ Not Spent on Purchasing Compost	$2,000	$2,000
Total Saved	$22,759.87-$23,160.10	$42,781-$43,827

Final Analysis

	Based on Audit	Based on Extrapolation
Start-Up Costs	$19,802- $23,802	$19,802- $23,802
Operation Costs	$9,279	$9,279
Annual Saving From Years 1 and 2	$45,519.74-$46,320.20	$85,562-$87,654
Construction and Operation Costs from first 2 years	$38,360-$42,360	$38,360-$42,360
Difference	$3,960.20-$7,159.74	$45,294-$47,202
Amount saved each year thereafter	$13,480.87-$14,331	$33,502-$34,548

IX. Appendix 2—Towson Campus (this document is linked)