

Whitman College:

Recommendations for the Right Start

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Summer Research Internship 2004

EXECUTIVE SUMMARY

Introduction

As a new undergraduate dormitory, Whitman College represents a unique opportunity to begin a tradition of environmental awareness on campus. The purpose of this report is to suggest changes in current University policy and practice that can be accomplished relatively painlessly; this report focuses upon the mitigation of campus waste and the improvement of current campus energy use policy and practice.

Solid Waste

While current campus waste reduction efforts are credible they fall short of excellence; there still remain many areas in which Princeton University can reduce the net flow of waste from this campus. This paper focuses upon the reduction of waste generated by Dining Services, the reduction of student waste generated during the move-out period and the improvement of current recycling practices.

Dining Services

The reduction of campus food waste is unfortunately limited by both the nature of the residential buffet dining system and the inefficient design of the current dining hall facilities. However, the disposable nature of the Dining Services system of commercially operated café's and cafeterias should be addressed. While the reusable mug initiative sponsored last year by Greening Princeton was largely unsuccessful, the concept of offering reusable beverage containers for sale is fundamentally sound. In order for any such reusable beverage container drive to succeed however, it is important not only to cater to student tastes, but also to actively advertise and seek student participation. Along

these lines, **Princeton University should sponsor another reusable beverage container drive with the full backing and exposure that such a drive deserves.**

Student Move-Out Waste

The annual waste flow of Princeton University peaks in May of each year during the student move-out period. This peak is so large that the volume of waste generated during the third quarter of each fiscal year is half again as large as the volume of waste generated during any other quarter. Clearly, any waste reduction program must attempt to reduce the amount of waste generated during the student move-out period. **Princeton University should create an integrated plan to address all areas of student move-out waste. Not only should the University streamline current used clothing and carpet reclamation programs, the University should consider the introduction of new waste reduction programs, such as a program to collect used furniture. Also, on a more basic scale, in order to prevent contamination of recycling wastes, it is important to ensure that a sufficient number of garbage and recycling dumpsters exist at each trash collection point.**

Recycling

Jon Baer, Director of Building Services, estimates that Princeton University currently recycles just 40% of the consumer recyclables (i.e. paper, bottles, cans, etc.) generated on campus- a credible, but hardly excellent effort. The question as to how this recycling rate can be improved however is exceptionally difficult to answer. While a certain degree of waste is entrenched into the function of the University, the bulk of un-recycled waste is the result of student apathy. **In order to increase the rate of student recycling, it is important to ease the process of recycling as much as is possible. Large posters**

clearly delineating recyclable from non-recyclable goods should be prominently posted around campus. Students should be encouraged (through the provision of separate containers for separate types of waste) to sort their waste prior to visiting the trash room. Upon reaching the trash room, students should find clearly marked bins or chutes for each type of waste.

Campus Energy Use

While the provision of energy to the Princeton campus is remarkably efficient (thanks largely to the Princeton Co-Generation Plant), the consumption of this energy does not match the same standards of efficiency. Inefficient appliances, currently employed by student's faculty and staff, exist as an obvious source energy waste.

University Appliance Choice

It is important for Princeton University to choose energy efficient appliances not only for the monetary savings that such appliances represent, but also for the purpose of making a statement in favor of energy efficient behavior. That said however, the potential for energy savings (and thus monetary savings) presented by efficient appliances is far from insignificant. Unfortunately, as it currently stands, the current University purchase policy toward Energy Star, or energy efficient appliances, is fragmented at best; while some University appliances are Energy Star certified, the vast majority are not. **For the sake of constancy, Princeton University should develop a central policy to direct the purchase of appliances across campus. For the sake of the environment, not only should Princeton University make an effort to utilize**

energy efficient appliances, Princeton should publicize the fact that such appliances are in use.

Student Appliance Choice

The potential for energy savings presented by ‘proper’ University appliance choice pales in comparison to the potential for energy savings presented by individual student appliance choice. It is therefore greatly unfortunate that whereas University purchase policy toward Energy Star appliances is fragmented, University policy toward student appliance choice is virtually nonexistent. In order to truly influence student appliance choice, **Princeton must first increase awareness concerning the existence of energy efficient appliances.** Campus awareness can be increased first by publicizing the fact that Princeton University itself commonly makes use of energy efficient appliances, and second by creating a program similar to Tulane’s “Energy Star Showcase Dorm Room” program. On a wider scale, **Princeton should reduce the need for students to purchase inefficient appliances by supplementing the current dorm room furniture with a source of mobile, energy efficient task lighting.** Ultimately however, energy savings will only be realized if students themselves choose to purchase energy efficient appliances. There are two potential approaches by which Princeton can encourage the student purchase of energy efficient appliances. First, through the use of vouchers or rebates, the University can choose to subsidize student purchase of energy efficient appliances. Second, by creating a program similar to OIT’s Student Computer Initiative, Princeton can itself become a vendor of energy efficient appliances.

Introduction

In 2007, with the unveiling of Whitman College, the Princeton undergraduate student body is scheduled to begin its first expansion since the introduction of coeducation in 1969. From any perspective, this increase presents a unique opportunity to reshape the Princeton student body. To quote the Wythes Committee Report, the proposed increase poses the opportunity to “further strengthen the diversity and intellectual quality of each class,”¹ to admit “a small number of transfer students of exceptional abilities and promise,”² and to allow “Princeton to benefit from more of the talents and perspectives currently available in the applicant pool.”³ In addition to these compositional alterations, the creation of Whitman College is to herald the coming of the Four-Year Residential College; Whitman, Mathey and Butler are to become Four-Year Residential Colleges. Arguably, however, the most interesting feature of this proposed expansion is not to be found in the new population statistics of the student body, or even in the plans for the new residential college system itself. It is the rationale of the trustees and administration in creating this new residential college that presents the most intriguing facet of the proposed expansion.

In addition to a stated responsibility to safeguard the resources of the University, the Wythes Committee Report proclaims

Princeton has an important obligation to optimize its contributions to higher education, to the world of scholarship, and to society in ways that are consistent with its mission.⁴

¹ Wythes Committee Report (Princeton University, 2000), Recommendations, 4

² Ibid

³ Ibid

⁴ Ibid, Introduction 2

In essence, through the medium of the trustees and the Wythes Committee, Princeton University proclaims that the increase in its student body is the result of a sense of social responsibility, to paraphrase, the result of a responsible institution fulfilling an obligation to the world of scholarship. In a far smaller sense, the fulfillment of this obligation is also the guiding spirit behind this report. While such lofty ambitions as obligation to society and the world of scholarship form an important element of the Princeton institution (indeed, the unofficial Princeton motto is nothing less than “In the Nation’s Service and in the Service of all Nations”), this report was conducted in the name of a more earthly obligation- the obligation of environmental stewardship. By very nature, physical growth is associated with environmental impact. The creation of Whitman College shall be no different. In addition to the purely physical toll of construction itself, the students of Whitman College shall undoubtedly pose an environmental burden of their own. In the name of sustainable growth and environmental stewardship it is a basic obligation of all responsible institutions, indeed of all responsible individuals, to minimize their environmental impact as far as is practical. This is the lofty ambition of this report, to propose a number of practical recommendations that shall allow Princeton University to mitigate its environmental impact in the face of the Whitman College expansion.

Reasons to Conserve

The question inevitably arises, why is environmental conservation important? Quite frankly, environmental awareness is a difficult value to cultivate, especially within the bounds of the American culture of consumption. Furthermore, on the most basic level,

even the so-called “American way-of-life” seems to contradict the ideals of the environmentalist. America is known around the world as a culture of material indulgence and inordinate consumption. In this land where bigger is better, conservation almost seems to exist as an un-American ideal. It is important to note, however, that the lifestyle of the average American is unsustainable on a global scale. For better or for worse, change looms in the future of America.

However, why does this concern Princeton University? What can one institution do and why should we act? To answer from the perspective of the environmentalist, the affairs of the environment are a global concern in which no party is exempted. Every socially conscious individual or institution is responsible for ensuring the welfare of future generations to come. It is also important to note however, that economic considerations provide further incentive for environmental stewardship. For any financially minded institution there exists a simple line of practical reasoning in the favor of environmentalism: environmental efficiency and long-term cost efficiency have a strong positive relation. This is especially true in the case of Princeton University where much of the environmental impact is the result of waste; waste that is expensive to produce and dispose. Mitigation of such waste serves the purpose of both cost-effective management and environmental stewardship.

The creation of Whitman College presents an individual opportunity for Princeton University to take a step toward ‘green’ policy and practice. As a new residential college, Whitman is not saddled with any ingrained traditions or habits, presenting a sort of institutional tabula rosa. Whitman is therefore the perfect forum in which to begin a new tradition of environmental awareness on a campus already rich in tradition. Any

proposed change in policy further benefits from the status of Whitman as a residential college rather than an upperclassman dormitory. Freshman, as new initiates to the college process, have traditionally been eager for guidance and would be expected to respond well to lessons imparting the necessity of environmental stewardship.

Areas for Consideration

As it currently stands, Princeton's environmental record is relatively indistinguishable from the general body of all Universities. The high note in Princeton's quest to create an environmentally friendly campus has been the ability of the Co-Generation plant to efficiently generate power, while the rising volumes of solid waste produced on campus create a perennial problem. As a University that seeks nothing less than to 'optimize its contributions to society' there is a long road ahead before environmental excellence shall be achieved. This report includes a number of recommendations that would allow Princeton to begin its journey toward becoming an environmentally friendly campus. The focus of this report is upon the two arenas in which Princeton can most easily improve- the mitigation of solid waste and the creation of a central campus energy policy.

Solid Waste

Summary of Current Waste

To approach the current waste flow of Princeton University by the numbers, in 2003, Princeton University produced 30121.18 tons of waste material (refer to Appendix A for complete figures). Of this waste, only 3240.7 tons, or a little over 10% of the total waste flow, reached a landfill. It therefore appears as if the majority of waste produced by this University is recycled rather than 'trashed' in the traditional sense. While this is true to a

certain extent, a strictly numerical approach fails to present a true picture of recycling at Princeton University. Based strictly upon a non-discriminating numerical approach, the percentage of recycled waste in comparison to total waste is skewed upwards of the expected sum. This is due to the fact that the bulk of the waste recycled by Princeton University takes the form of industrial waste (e.g. concrete, organic material, etc.) rather than consumer recyclables (i.e. bottles, cans, paper). While such recycling practices are laudable and indeed significant, the percentage of industrial waste that is recycled is largely static; the amount of industrial waste generated by the University is highly dependent upon external factors such as campus construction rather than internal habits of recycling. In comparison, the recycling of commercial wastes is highly volatile. Jonathan Baer, the Director of Building Services, estimates that consumer recyclables are currently recycled at a rate of approximately 40%. In order to increase campus recycling and decrease the flow of waste, Princeton University must concentrate on the reduction of consumer wastes. Campus recycling should therefore focus upon increasing student participation in recycling programs.

The issue of waste and waste reduction is one that faces any University, one that inevitably shall be accomplished better at some than others. In the opinion of Building Services Director, Jon Baer, the current efforts to reduce waste at Princeton University are credible but fall short of excellence. With the upcoming expansion of the undergraduate student body, the issue of waste production and perhaps more importantly waste reduction should grow in prominence. The primary categories of waste affected by the size of the student body are (refer to Appendix A) municipal waste, mixed paper, bottles/cans and food scraps. Using the 2003 waste figures and the estimate of 4600

students on the Princeton campus, an increase in the student body by 500 would be expected to increase the production of municipal waste by 349.674 tons, mixed paper by 103.485 tons, bottles and cans by 24.734 tons and food scraps by 69.384 tons.⁵ The landfill cost for a ton of solid waste is \$102 while the disposal of food waste costs \$60/ton. Consumer recyclables are disposed on a no-cost break-even basis. The expansion of the student body is thus expected to increase the total cost of waste disposal by \$39,827.63. A reduction in the amount of solid waste or any increase in the percentage of recycled consumer waste is therefore desirable in the name of cost efficiency.

Suggestions for Waste Reduction

Strictly based upon an increase in the flow of waste, the creation of Whitman College is expected to significantly increase the environmental impact of Princeton University. As University Building Services does not maintain waste flow records by building or by dormitory (the load from each waste pick-up truck comes from many sources, therefore only the total end volume is recorded at the landfill or recycling facility), the waste flow of Whitman College will effectively be indistinguishable from the waste of the University at large. Therefore, to consider the reduction of waste at Whitman College is necessarily to holistically consider methods by which Princeton University can reduce its waste flow. That said, the management of waste is properly approached from two tracks, reduction and reclamation. While it is first important to attempt to reduce the flow of waste at the source, as potential for waste reduction is often limited, it is then important to stress the techniques of reclamation as a means by which to reduce the overall flow of waste. This

⁵ All waste flow data was provided by Jonathan Baer, Director of Building Services.

dual approach to waste reduction will be addressed within this paper with a focus upon waste generated by Dining Services, student waste generated during the move-out period and the improvement of campus recycling practices.

Dining Services

The first target of general waste reduction is food waste. With regards to food waste, the Princeton Dining Hall system is already managed in such a manner as to minimize surplus food. First, Dining Services donates surplus food to several Trenton area food banks. Unfortunately, due to the size and needs of these food banks, this partnership is only able to encompass the surplus of the Butler/Wilson and Forbes facilities. Made-to-order grill stations featured in the residential college Dining Halls also serve to cut down on food waste. At these stations food is prepared based entirely upon student orders, thus minimizing the amount of surplus produced. In terms of absolute efficiency in food waste reduction however, the current system is severely limited by constraints presented by both the facilities and by the mode of food service. In short, Stu Orefice, the head of Dining Services, admits that the existing dining hall facilities feature outmoded technology and inefficiently designed facilities. For example, the existence of Rocky and Mathey or Butler and Wilson as separate dining facilities (even though the paired facilities exist in close proximity with one another and even share a kitchen) serves to display the inefficiencies ingrained into the dining hall system. Furthermore, the self-serve buffet style of food service is in itself inefficient, inducing overconsumption and needless waste. These concerns have not passed unheeded; in the next generation of dining hall renovation, the facilities that are currently paired are scheduled to become combined facilities, while the current arrangement in which pre-prepared food is set out

in trays is largely to be replaced with a system of 'action-stations' where food is to be made on order. To summarize matters, although the dining hall does not currently function with the greatest possible degree of efficiency, this oversight is scheduled to be corrected with the next generation of residential college dining hall. Unfortunately, the same cannot be said regarding the various Dining Services cafeterias that exist outside of the residential dining hall system.

On the Princeton Campus, the residential college dining hall system is supplemented by a number of commercially operated cafés and cafeterias. While the fact that these cafeterias operate on a commercial basis serves to limit the amount of food waste (since these cafeterias do not offer buffet style service, portion sizes are reduced and food waste decreases), the stop-and-go mentality of these cafeteria units in itself serves to increase the total amount of waste attributed to dining services. In many cases, these cafeterias are designed to provide a quick meal or a quick snack, a 'meal-on-the-go' served on disposable service. The disposable nature of these cafeteria operations however, serves only to increase the total amount of waste produced by Princeton University. A reduction in the generation of these consumer disposables presents perhaps the most feasible route toward reducing the overall amount of waste generated by Dining Services. Toward this goal, in the 2003-2004 school year, the group Greening Princeton sponsored a reusable mug initiative in which students who purchase and reuse a Greening Princeton mug are given a discount on the purchase of fountain drinks at Frist. Unfortunately, for a number of reasons, the Greening Princeton project is by most accounts a failed venture. From the start, the Greening Princeton project was saddled with two fundamental disadvantages; it is quite frankly both inconvenient and unfashionable for a Princeton student to carry a

mug around campus. The success of the Greening Princeton project was contingent upon the willingness of students to voluntarily bear an inconvenience (the act of carrying around a mug when it is not in use) in the expectation of future utility. In the case of this project, the approximately \$.25 discount received on the purchase of a Dining Services drink did not provide sufficient utility to induce student participation in the program. In addition to these fundamental shortcomings, the Greening Princeton mug initiative was further disadvantaged by poor advertising and limited opportunities for entry into the program. Information regarding the program was so sparse that oftentimes the few individuals who had heard of the program and desired to participate were unable to find any mugs for sale! The primary advertisement for the Greening Princeton program seemed to be a single small poster and one mug displayed far above the fountain beverages station in Frist. Should students happen to notice this humble advertisement and desire to purchase a mug, they would find that mugs were not available for sale in the Frist cafeteria but in Café Vivian upstairs- therefore adding further inconvenience to entry into the reusable mug program.

The failure of the reusable mug program to achieve any meaningful degree of student participation is in many respects unfortunate. However, while the Greening Princeton program was largely a failure, the original conception of the program remains sound. The provision of reusable beverage containers should reduce the consumption of disposable containers and therefore reduce the amount of waste generated by the University. If this is taken to be true, that students should be encouraged to use reusable beverage containers, the reusable mug issue then becomes a question of how rather than why. How can students be convinced to participate in a program promoting the use of

reusable containers? The answer to this question is itself a question- how can students be convinced that it is in their own best interest to make use of reusable containers? First, superficial as it may seem, it is important to address the issue of fashion. No matter how practical an item may be, the physical attractiveness of a product is also important. Perhaps if Greening Princeton had offered the more widely popular Nalgene bottles rather than mugs, the initial program would have experienced a greater degree of success. Nalgene bottles would also have offered a certain improvement in terms of convenience over a mug. Originally intended as a hiking accessory, Nalgene bottles, and the numerous derivatives they have inspired, are designed for convenience of carry. Students can easily attach a Nalgene to any book bag or knapsack they choose to carry- in comparison, the shape and design of a mug is far more difficult to accommodate. Convenience is an important factor in determining student behavior in that inconvenience generally serves as a strong deterrence to student participation. A final matter of convenience concerns convenience of purchase. Reusable containers should be widely available, both across campus and especially in any facility in which the container can be put to use. Finally, it is important to aggressively market and advertise the reusable container program. For example, reusable Nalgene containers could perhaps be displayed and available for sale at each cashier's station within every campus cafeteria. This would serve a dual purpose, not only would the visibility of the program be increased, but it would also become more convenient for students to purchase a container and thus join the reusable container program. If these conditions are met, the desirability and therefore the rate of success of the reusable container program should increase.

Student Move-out Waste

The generation of student waste on campus is currently a function with bi-annual peaks; there is a peak early in the year when students move-in and a much larger surge at the end of the year during the annual student effort to condense a year into a single vanload. As these efforts are often in vain, the solution of many students is to cut their losses and simply pack everything possible into the nearest dumpster. The move-out peak in waste volume is such that the total volume of waste generated in the third quarter of each fiscal year is approximately half again the volume of waste generated in the first quarter. Clearly, no waste reduction program would be complete if it failed to address the annual problem of student move-out wastes. At the close of the 2003-2004 school year Building Services took the first steps toward redressing this problem. First, with the help of Building Services, the SVC organized a clothing and food drive in which students could deposit unwanted clothing at collection points located in the residential colleges and in the campus center. Similarly, Building Services initiated a carpet reclamation program in which student carpets were removed from the waste flow and given to a carpet recycler. At the end of these new programs, 20-25 large bags of clothing, 17 boxes of food and over 200 carpets were collected- a “modest-success” as Jon Baer termed it. The University would do well however, to look upon these successes as a foundation for further mitigation of unnecessary move-out waste. First, speaking from personal experience, the organization of the clothing drive collection process can be improved. This year, donated clothing was simply piled into small boxes that quickly overflowed. To take the lessons learned this year to heart, increasing the number of collection points would serve not only to decrease the overflow at any individual collection point, but also to improve (from a student’s perspective) the ease of donation.

Better organization at each collection site would serve to ease the donation process for the students and ease the sorting and collection demands placed upon the University. For example, the single box placed at each collection point last year can be replaced by several boxes, each labeled for a particular category of donation (i.e. shirts, shoes, pants, etc.). Furthermore, the scheduling of the donation program can be improved. This year, donations continued to pile up at several collection sites long after the official donation drive had concluded. The donation drive could feasibly be extended at very little cost (indeed, the only costs of the program are space and a negligible labor cost of collecting the donations) and great benefit (benefits include a reduction of waste and goodwill with the community) to the University. Speaking purely in terms of waste however, the collection of student clothing and food represents a relatively small proportion of the total University waste flow. In order to truly impact the net amount of waste generated during the move-out period, the University must expand the scale of its waste reduction efforts.

Basically, the scope and coordination of programs designed to decrease the year-end surge in waste must be improved. One integrated plan to decrease the annual move-out surge in waste production should be created. In many ways, such a plan would simply call for the integration of current waste mitigation policies under the auspices of a central authority. Even as a single united plan is being created however, it is important to test new programs with the intent of addressing sources of waste that had previously escaped consideration. For example, to borrow a lesson from the University of Michigan, a program focused on the collection of student furniture merits further investigation. At the University of Michigan students deposit unwanted furniture (in good condition) in clearly marked common areas (typically a large outdoor area marked off with tape). This

furniture is then donated to local human services agencies. A similar program could easily be initiated at Princeton, and could actually be integrated with the current carpet reclamation program. If such integration occurred, Building Services would save both time and effort; as opposed to individually pulling discarded carpets out of the trash flow, students would themselves deposit unwanted carpets in the collection areas. Such a program would further be facilitated by the fact that the student move-out period roughly coincides with Reunions. Tents set up for Reunions, in addition to providing protection from the rain, would present easy collection points for used furniture. Additionally, programs to remove larger items from the waste flow should be supplemented by efforts to reduce the smaller wastes that actually compose the bulk of the waste flow. To achieve this goal it is important to ensure that there exist sufficient facilities and resources to ease the waste reduction process. It is important to ensure that there are sufficient dumpsters to absorb both recycling waste and general refuse (these dumpsters should be clearly marked, preferably, dumpsters designated for recycling would be of a different color than typical trash dumpsters) in order to ensure that contamination of the recycled waste does not occur. Generally speaking, extra dumpsters should be placed at each trash collection site; these dumpsters should be placed in a central location in order to provide for easy student access.

Recycling Waste

In the sense that both food waste and recyclable waste are entrenched into the typical day-to-day affairs of Princeton University, the incidence of recyclable waste on this campus is similar to that of food waste. Unlike food waste however, a significant reduction in the production of recyclable wastes by the University currently seems to be

highly unlikely. The flow of recyclable wastes at Princeton University primarily stems from two sources, paper and consumer recyclables (e.g. bottles, cans, etc.). In terms of reduction, a reduction in use of both paper and consumer recyclables would be somewhat difficult to mandate from an administrative perspective; the free use of paper has some merit as an educational tool while the consumption of consumer recyclables largely falls in the arena of student consumption.

Realistically speaking, it is almost impossible for an institution of any size to eliminate all unnecessary paper waste; indeed a certain degree of paper waste is necessary, even desirable, for the promotion of efficient University function. Therefore, there is effectively a threshold for the reduction of paper waste at Princeton University. To a certain extent, the Princeton policy of providing free printing services (through the PHAROS clusters) is a part of the reason that unnecessary paper waste exists. It is important to recognize however, that there exist certain arenas in which environmental concerns must play a secondary role in the decision making process. In the instance of paper waste, while it may be true that free printing presents an opportunity for abuse, in the name of furthering education, the potential for abuse is outweighed by the service of free printing as an academic tool. Logistical considerations (troubleshooting, customer service to address consumer complaints, etc.) serve as a further disincentive to a switch to a pay-as-you-print system. That is not to say however, that efforts should not be made to accomplish a source reduction in the flow of paper waste, but that efforts to reduce paper waste should focus where there is the greatest opportunity for reduction. It is also important to note that any policy to reduce paper waste should be supplemented by an effort to increase the effectiveness of paper recycling on campus.

At the moment the greatest potential to achieve a source reduction of paper waste exists in campus printing options outside of the central OIT system. The OIT printer clusters currently feature three models of Xerox printers, the DocuPrint N2125, Phaser 4400 and Phaser 5400⁶. All OIT printers are set on default to create double-sided copies. In comparison, outside of the OIT system, within departments and even within many libraries, many printers are strictly capable of single sided printing. Paper efficiency would obviously be increased if all campus printers followed the OIT example of supplying double-sided printing on default. With regards to efficiency of paper use, however, the far greater problem concerns the theft (or to use a more friendly term, misappropriation) of paper purchased for OIT printers. In 2003, over 6 million pages were printed from OIT printer clusters. However, during that same period of time, it was necessary to purchase 8 million sheets of paper. The only conclusion one can reach is that nearly 2 million sheets of paper were removed from OIT clusters for personal use. Given that the vast majority of personal printers are incapable of double sided printing, one can assume that the use of these appropriated pages did not match the standard of efficiency set in OIT clusters. If efficiency and the reduction of paper waste is a University priority, OIT and Princeton University must find a manner by which to ensure that paper designated for cluster printing remains at the disposal of OIT rather than in the hands of individuals. In addition to these proposed source reductions in paper waste, there exist several other means by which paper waste can be reduced. First, the recommendations for paper conservation set forth in the 2000 PERC Environmental Audit are still valid. Professors should be encouraged to accept double-sided papers and

⁶ Information regarding OIT printing and OIT policy was obtained from Leila Shahbender of OIT Support services.

should themselves encourage double-sided printing. Further, permanent posters should be set up around each printer cluster encouraging paper conservation. However, if any true reduction in the generation of paper waste, or indeed in the generation of all recyclable wastes, is to take place, Princeton University must holistically reevaluate the state of recycling at this university. In the end, the effectiveness of any waste reduction policy will ultimately be determined by the willingness of the student body to alter their habits of consumption.

The Princeton University Design Standards Manual states, “Housing and Building Services are trying to end the practice, in dormitories, of the permanent placement of trash containers (from each dorm room) in hallways.”⁷ The current system of dormitory waste removal is to be replaced with a centrally oriented system, students will either bring their trash to a centrally located trash room, or to a room where trash chutes will funnel their waste to a trash room or rooms.⁸ A similar system of waste collection is planned for Whitman College. As a means of encouraging student recycling, a centrally organized waste collection system has both advantages and disadvantages. Theoretically, a self-service recycling system would increase the propensity of students to recycle by increasing awareness of the campus recycling process. Rather than simply being able to pile trash into several ambiguously labeled bins and placing the bins outside ones door, students must bring their waste themselves to a trash room, where they would then be forced to sort the garbage into the proper category for each chute. In an ideal situation, everything would be properly recycled in the trash room; papers, plastics, bottles and cans would all find their way to the proper receptacle. However, what happens in a

⁷ Princeton University Design Standards, 4.12 Waste Removal and Loading Docks, 1

⁸ Ibid

situation that is less than ideal? What of the students who are unwilling to exert the effort to sort their waste and instead chose to simply dump everything down the chute labeled trash? In effect, it is this dependence upon the assumption that all individuals are socially conscious that creates the primary disadvantage of the self-service recycling system. Within a self-service system, it is difficult to induce uncooperative individuals to cooperate with a recycling program. Conversely, inducement of cooperation under the current system (pre-trash room) can theoretically be accomplished with relative ease. Inducing desired behavior can be as simple a matter as strictly enforcing a system of warnings and fines in order to provide students with a strong financial incentive to recycle. As an added benefit, such a system would be expected to produce a 'double dividend;' not only would participation in a recycling program be expected to increase, failure to participate would result in fees which could then be used to fund further recycling initiatives. Clearly, each system of waste collection presents both advantages and disadvantages for the encouragement of student recycling. Unfortunately, both systems have proven to be ineffective: the first because students seem to lack the initiative to sort their trash, the second because the janitorial staff has expressed a certain degree of discomfort in issuing fines to students. Obviously, something more is necessary to induce student recycling.

As it is with the reduction of recyclable wastes, the success of any recycling initiative depends largely upon student participation. Given the two different methods of waste collection that currently exist on this campus, encouragement of student recycling should be tailored to the needs of each facility. In dormitories equipped with a trash room, the recycling process should be as clear and simple as is possible. To facilitate recycling, the

various classifications of recyclable goods should be clearly differentiated by bin or chute. To further ease the student recycling process, large permanent posters reminding students as to what can and what cannot be recycled should be prominently and permanently displayed in each trash room and in the common areas of each dormitory. Finally, to borrow another idea from the University of Michigan,⁹ each student dorm room should be provided with a 'recycling tote' or some analogous device. The idea behind the recycling tote (the same effect could be accomplished by providing each room with multiple, clearly differentiated garbage bins) is to encourage students to sort recyclable from non-recyclable wastes prior to visiting the trash room, and therefore to further simplify the recycling process. A similar approach toward student recycling would also be effective in dormitories that have not been equipped with a trash room, however, in such dormitories a negative incentive system must replace convenience as the primary encouragement for student recycling. In dormitories equipped with a trash room, students will hopefully recycle simply because it is convenient to do so. The goal is to ease the process of recycling to the point that all but the very laziest of individuals will choose to dedicate that small extra amount of time necessary to recycle rather than simply discard everything. In dormitories without a trash room however, it is currently more convenient to simply disregard the entreaties of the University and consider all garbage containers as simple trash. It is therefore important to provide students with an incentive to recycle. The Building Service fee and fine system (janitors have the right to deliver warnings, after 3 warnings a \$50 fine can be assessed) could be used to provide such an incentive, yet is currently rarely used. In fact, Jon Baer reports that, to the extent of his knowledge, no janitor has ever issued a fine for failure to recycle. It can be

⁹ http://www.recycle.umich.edu/grounds/recycle/residence_hall_recycling.html

expected that if the fee and fine system were more rigorously enforced, student cooperation in the recycling program would greatly increase. Even if the janitorial staff is uncomfortable with the task of levying fines, merely issuing a warning that a fine will soon be forthcoming may be sufficient to induce a greater degree of recycling in the student body. Again, it is important to encourage student recycling by making the process of recycling as painless as possible. Students should still be provided with posters differentiating recyclable from non-recyclable waste. Each room should also be provided with several garbage containers, each clearly marked for a specific type of waste (e.g. paper, plastic, trash, etc.). In the end however, both in those dormitories equipped with trash rooms and in those without, if a true increase in campus recycling is to be accomplished, the student body must embrace recycling. To achieve this goal, the freshman orientation process should perhaps be utilized to introduce students to the proper methods of waste disposal on campus.

Campus Energy Use

It is important to get thinking about energy usage, building siting arrangements and envelope possibilities so that completed designs may significantly exceed current energy code standards for system performance and efficiency.¹⁰

At a glance, the energy usage of Princeton University is fundamentally excellent. On the large scale of energy provision, not only does the Co-Generation Plant ensure a cost-effective fulfillment of Princeton's energy needs, the phenomena of co-generation itself is a remarkably efficient (according to Energy Plant Manager Ted Borer, the CoGen plant achieves approximately 73% efficiency compared to the ~ 34% efficiency of simple cycle

¹⁰ Princeton University Design Standards, 3.3 Energy Guidelines, 1

power plants) method by which to provide power. Furthermore, the accompanying Chilled Water plant represents an energy effective approach to the heating and cooling needs of the University. Finally, as can be seen in the above quote, the Energy Guidelines set forth in the Princeton University Design Standards Manual provide for the consideration of energy efficiency in the ongoing process of University growth and renovation. Along these lines, the room temperature within newly constructed and recently renovated buildings can now be regulated by the residents of each room- a marked shift away from the inefficient centrally regulated system found in older buildings. While fundamentally sound however, the soundness of Princeton's macro-energy policy have not yet been fully integrated on a micro level. The large-scale provision of energy is conducted in an efficient manner, but the use of that energy does not meet the same standards of efficiency. What use is a green architectural design if the interior of the building inefficiently utilizes energy? In a sense, similar to the case of solid waste reduction, the problem of reducing energy usage is compounded by the fact that certain sources of energy waste are ingrained into daily University function. For example, the recirculation of air within Princeton's major laboratories perennially presents a heavy source of energy consumption that is nearly impossible to safely mitigate. As it was with the mitigation of solid waste however, the necessary evils of energy waste are generally accompanied by energy waste that exists merely because it has been overlooked. At Princeton, this source of unnecessary, easily mitigated, energy consumption can largely be traced to the use of inefficient appliances and to the inefficient use of appliances by students, faculty and staff. Any successful attempt to reduce energy usage on campus must be a dual effort to alter behavior and promote the

use of energy efficient appliances. Naturally, a different set of recommendations applies for each goal. Furthermore, as perhaps would be expected, recommendations to change University policy practice differ from recommendations for changes in student appliance usage.

University Appliance Choice

Although the potential energy savings presented by energy-efficient appliances and the efficient use of appliances does not seem to be large in the context of overall University energy expenditure, they are significant nonetheless. Ted Borer uses the example of campus computer usage to illustrate this point. Mr. Borer's example goes something like this- first, assume that there are approximately 10,000 people on this campus during the academic year (students, staff and faculty), and that there exists approximately one desk-top computer for each of these people. The average desktop consumes 130 W of electricity, and therefore, 10,000 computers would consume approximately 1.3 MW. While this number is meaningless at face value, consider that the average campus demand for electricity is 12 MW- in short; approximately 10% of the campus demand for electricity is created by computer usage alone! Consider then the fact that an average monitor consumes 95 W of electricity. Therefore, if only half of the monitors on campus were to be turned off for twelve hours a day, campus demand for power would decrease by 273 kW (refer to Appendix A for all calculations). On average, Princeton University spends approximately \$.06 for each kWh of electricity consumed. Thus, the seemingly simple task of turning off half of the monitors on campus for 12 hours a day effectively represents an annual savings of \$124,830.¹¹ To apply this calculation to the creation of Whitman College and the proposed expansion of the student

¹¹ Ted Borer, *Princeton Energy Use Lecture*, MAE 320

body, the addition of 500 students, or 500 computers, effectively increases the campus energy demand by 65 kW. To follow the model set forth by Mr. Borer, if 250 of these computer monitors were turned off for 12 hours per day, the campus demand for energy would decrease by approximately 12 kW. Even this small reduction in campus energy demand represents an annual savings of \$6241.5. It is important to recognize however that this is only a hypothetical model, many of the assumptions upon which this model depends are unrealistic. Most computer monitors on campus are equipped with various modes of screensaver and standby, each of which represents a different level of energy consumption. The energy savings actually presented by the simple act of turning off computer monitors is therefore likely to be lower than the model suggests. Nonetheless, Mr. Borer's model serves to illustrate the potential for cost and energy savings presented by efficient appliance usage. Ultimately however, the success of such an approach is dependent upon the cooperation of numerous parties. For this reason, the choice of appliances is a matter of some importance.

University operated appliances can be separated into the categories of commercial (or industrial) and domestic (or residential) appliances. The category of industrial appliances primarily encompasses food service appliances found in the various kitchens and dining facilities around campus. Unlike residential appliances however, the energy usage statistics of commercial grade appliances are generally similar; there generally does not exist notable energy savings in the choice of one product over another. For this reason it is the category of household appliances, both student and University operated, that presents the greatest potential for a true reduction in energy consumption.

As it currently stands, the University purchase policy for household appliances (i.e. the refrigerators, televisions and other such appliances that can be found scattered around campus) is haphazard at best. Fragmented is perhaps the best word to describe current appliance purchase policy, as there is yet no central protocol for the purchase of appliances. Decisions concerning appliance choice and appliance purchase are currently made on a case-by-case, department-by-department basis. Regarding new construction or renovation, the choice of appliances is generally an afterthought. To a certain extent, it is nearly impossible to incorporate appliance choice into the early planning stages of construction or renovation. This is true for several reasons. First, there exists a natural time lag between the submission of the design for a new structure and the actual completion of that structure.¹² Due to this lag, the actual outfitting of a particular building is generally not specified due to possible changes in technology during the period between the planning stage and the time when the building is ready to be outfitted. Second, appliances are generally ordered on a last minute basis strictly due to space considerations. Orders for appliances are made at the last minute because most job sites lack the facilities to properly store orders until they are absolutely needed. Finally, appliances are generally not determined during the planning stage strictly as a result of cost considerations. Appliances are purchased from a number of sellers; these sellers include but are not limited to Mrs. G's, H & H Gas, and PC Richard & Son. Any discounts offered by these sellers generally have a strong impact upon the University's choice of both product and supplier. Unfortunately, the lack of a central purchasing policy largely results in the dominance of budgetary considerations.

¹² Information regarding the outfitting of renovated and newly constructed buildings was provided by David Howell, Program Manager for Standards, Office of Design and Construction

Often, the decision of appliance choice becomes strictly a matter of choosing the least expensive product- an unfavorable circumstance for the purchase of energy efficient appliances, as such appliances are generally more expensive than their more inefficient counterparts. The lack of a central appliance purchase policy also creates an interesting study of University appliance choice around campus. For example, in the Environmental Studies Department break room, the refrigerator of choice is a GE GTS10AA, an EnergyStar certified refrigerator while the refrigerator of choice in the Dod Hall kitchenette is a GE GSS20IB, a refrigerator that is not EnergyStar certified. While it is true that the potential energy savings presented by appliance choice is indeed small in comparison to the total University energy expenditure and even in comparison to the potential energy savings presented by student energy expenditure, any reduction in energy demand is significant. Furthermore, University choice in appliances can serve to set a standard for student appliance choice. Not only should the University make an effort to utilize energy efficient appliances, Princeton should publicize the fact that such appliances are in use. Given the fact that the majority of University appliances are provided for the use of students, and are commonly used, any publicity would be sure to find an audience.

The first University appliance that is notable for its inefficient operation also happens to be the most common University appliance on campus- the washing machine. As it currently stands, laundry rooms across campus are primarily stocked with Maytag commercial washers that are somewhat less than ideally efficient. The primary washer to be found in newly renovated dormitories¹³ is the Maytag MAT13MNAAW Commercial

¹³ Older dormitories are stocked with older model machines that are slowly being retired. In order to attain a more accurate comparison of efficiency between EnergyStar and non-EnergyStar appliances the newer

Washer. This washer is a top-loading machine with a capacity of 2.9 cubic feet. Each load that passes through this machine consumes 37 gallons of water. In comparison, the front-loading Maytag Neptune (a small number of Neptune MAH21PNAWN machines can be found around campus), also has a capacity of 2.9 cubic feet yet consumes only 15 gallons of water per load. Furthermore, as an EnergyStar appliance, the Neptune consumes approximately 50% less energy per cycle than a standard washer.¹⁴ To place these numbers into context, assume that the University purchases 10 washers to accommodate the laundry needs of Whitman College.¹⁵ Now assume that each of these machines runs 600 loads of laundry per year (approximately an average of 3 loads a day for the course of the school year). According to the Savings Calculator¹⁶ provided by the EnergyStar website, an EnergyStar commercial washer consumes a maximum of .65 kWh per load while a standard commercial washer consumes approximately 1.57 kWh per load. Now imagine two alternate situations. In the first situation, all 10 of the washers are the standard MAT14MNAAW machines while in the second situation all 10 of the washers are the EnergyStar Neptune MAH21PNAWN machines. Over the course of a year, under these circumstances of operation (refer to Appendix B for calculations), the standard washer would be expected to produce 222,000 gallons of wastewater, compared to the 90,000 gallons produced by the EnergyStar washer. In other words, not only would the University benefit from cutting down water usage by 132,000 gallons, the local watershed would be spared the introduction of 130,000 gallons of graywater discharge. The conservation of 130,000 gallons of water also represents a significant cost

model washers are used for comparison rather than the older model washers. It would be expected that older washers are even less efficient than the new non-EnergyStar appliances.

¹⁴ http://www.energystar.gov/index.cfm?c=clotheswash.pr_clothes_washers

¹⁵ 10 washers for 500 students is approximately the ratio that currently exists in the Residential Colleges.

¹⁶ http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CW_savings_calc.xls

savings in itself. Based upon the price Elizabethtown Water charges to supply the campus with water, each gallon of water costs the University approximately \$.31 (or \$2.31/CCF). Therefore, 132,000 gallons of water saved instantly represents a savings of over \$40,000. As the cost of wastewater disposal can be up to five times the cost of water acquisition¹⁷, meaning that the disposal of 132,000 gallons of graywater could cost up to \$200,000. To speak of energy savings, over the course of a year, the standard washers would be expected to consume 9420 kWh while the EnergyStar machines would consume 3900 kWh. Assuming that the average cost of energy provision is \$.06/kWh, the cost of running the EnergyStar machines is \$331.20 less than the cost of running the standard washers- a small, yet not altogether insignificant savings. Furthermore, when considered in conjunction with dryers, the energy savings presented by EnergyStar washers is even higher. In addition to requiring less electricity to run and producing a smaller amount of wastewater, EnergyStar washers also spin at higher RPM during the spin cycle and thus are able to extract a larger amount of water from the load. This in turn serves to decrease drying time and thus presents further energy savings. The benefits presented by EnergyStar washers should therefore be obvious- an EnergyStar washer requires less input energy and produces less undesired output (graywater). The fact that each washer potentially represents a savings of up to \$24,000 is, as the saying goes, but icing on the cake. While the payoff time required to cover the greater cost of the EnergyStar appliance small in this case, there will arise many cases in which the payback period is far longer. Although cost considerations are indeed important, Princeton University is not a business, seeking only to clear a profit. The same

¹⁷ As reported in the Fall 2003 ENV 201 Class Report; the original estimate that the cost of wastewater disposal can be 5 times the cost of water acquisition was provided by Tom Nyquist.

philosophy should apply to the purchase of all appliances by the University. So long as the savings presented by an Energy Star appliance over the course of the expected lifespan of that appliance meets or exceeds the price premium for energy efficiency, efficient appliances should be purchased over less efficient appliances. The potential to simply ‘break even’ on an investment that benefits the environment should provide more than sufficient cause to undertake that investment. However, although the proper University choice of appliances may be both significant and beneficial, in terms of potential energy savings, individual student appliance choice presents a far greater potential for energy savings to be realized.

Student Appliance Choice

Whereas the University policy toward the purchase of appliances can be described as fragmented, University policy toward student appliance choice is virtually nonexistent. Students are largely free to equip their rooms as they please; the only restrictions placed upon student appliance choice come in the form of small appliances banned by the Housing Department in the name of fire safety. As it is at any University, the appliances that equip student dormitories are transported to Princeton or purchased from one of the vendors near campus. Given the ability of Princeton to draw students from across the globe, one would imagine that the proportion of Princeton students who purchase their dormitory appliances during the move-in period is somewhat greater than the proportion one would find at most other Universities. It is likely however, that the behavior of Princeton students resembles that of students of other Universities (and indeed the University itself) in that cost considerations are likely to have an effect upon the appliance choice of Princeton students.

There once was an age where students could come to university carrying but a suitcase and quite comfortably live out of that suitcase for the entire year. This age has since given way to an era of rental trucks and vans transporting the creature comforts of home to life at college. This age of creature comforts also happens to be the age of student electronics, in which every imaginable gadget and gizmo seems to find its way to campus. It should come to little surprise that in this new age of gadgetry, energy consumption on the Princeton campus has experienced a fairly steady increase over the past dozen years. Consequently, it follows that the use of energy efficient appliances has increased in importance.

Significant as University appliance choice is, the potential for energy savings presented in University appliance choice is by far exceeded by energy savings potential of student appliance choice. The problem arises however in the fact that student appliance choice is far more difficult to influence than University appliance choice. In this regard, a strong and well-publicized University commitment to the use of energy efficient appliances is important. It is far more likely that students would observe a University commitment to energy efficiency and follow suit than take initiative themselves to pursue energy efficient appliances. To this ends the University should display the EnergyStar logo prominently whenever relevant and accompany such displays with small posters describing the significance of that logo. Posters in the dining halls asking students to cut down on food waste could be used as a model for future posters promoting energy efficiency. Realistically however, more drastic measures are necessary in order to truly influence student appliance choice.

Tulane University recently initiated a program that it calls the “Energy Star Showcase Dorm Room.” In this program, students apply to live in a dorm room that is fully equipped with energy efficient appliances.¹⁸ In return the winning students are expected to participate in several publicity events (including tours of their room) throughout the course of the year. In order to fully introduce incoming freshmen to the ideals of energy efficiency, each residential college potentially could have its own Energy Star showcase room. In all likelihood however, one showcase room is far more feasible. To have such a showcase on campus would serve a number of purposes. First, situating the room within a residential college would expose freshman to the existence of energy efficient appliances- an important first step in creating an energy conscious student body. Second, such a showcase would clearly display the intentions of Princeton University to pursue energy efficient modes of growth. Finally, an Energy Star showcase would serve as invaluable publicity for Energy Star and other energy efficient appliances. This idea of outfitting a dorm room with energy efficient appliances could also be instituted on a smaller, yet wider scale- namely, each dormitory could be provided with desk lamps as a source of movable task lighting. A common complaint among students, especially in the older dormitories, is that dormitory lighting is dim. This perceived failing, on the student level, is resolved by purchasing additional lighting. Due to the cost of fluorescent lighting, this additional lighting is typically provided by incandescent bulbs. This problem can be resolved by providing each room with additional furniture in the form of task lighting; each student in each room could be assigned a desk lamp. Such a program could also be expected to recoup the costs of implementation relatively quickly. A 25 W compact fluorescent light (CFL) provides approximately the same amount of illumination

¹⁸ <http://green.tulane.edu/energysmart/EnergySmart.html>

as a 75 W incandescent bulb (refer to Appendix C for calculations). Assume that an average desk lamp is turned on for 12 hours a day for approximately 200 days a year. In our earlier calculations, we have learned that the University purchases electricity at an average cost of approximately \$.06/kWh. Under these conditions, the cost of running the incandescent bulb is \$10.8 while the cost of the CFL is \$3.6. If one further assumes that an acceptable desk lamp can be purchased for \$25 (a sum that should be a comfortable overestimate), the costs of supplying each room with a desk lamp would be entirely recouped in approximately 3.5 years, less if one factors in the longevity of a CFL in comparison to the short lived incandescent bulb.

Should Princeton students happen to take to heart the lesson that energy efficient appliances are desirable over standard appliances, there still exists the issue of purchase. While virtually all of the major retailers in this area carry Energy Star appliances, there still exists a fairly significant hurdle in convincing students to purchase energy efficient appliances when less efficient, less costly choices are readily available. In order to ease this decision it is necessary to ease the process of purchasing an appliance. This goal can be accomplished by a number of techniques. First, the University could choose to subsidize the purchase of energy efficient appliances. The amount of the subsidy would be based upon the value of energy savings to the University over a four-year period, and could be issued in the form of a voucher redeemable at selected local vendors. Another alternative is for the University itself to become a vendor of energy efficient appliances. This could be accomplished with a program similar to the Student Computer Initiative program run by OIT. Under such a program the University would offer selected appliances for sale to incoming students at a discount over typical manufacturer retail

prices. As an added benefit to incoming students, these appliances would be delivered to the student's dormitory during the move-in period, thus eliminating the hassle involved in shopping for appliances. The convenience of this option would likely prove popular with international and out of state students. However, regardless of how it is accomplished, the key convincing students to purchasing energy efficient appliances is to ease the purchase of such appliances. If this can be accomplished then one would expect the campus demand for energy to diminish.

Behavior

Even with the most energy efficient of appliances, appliances that are on when not in use still represent an inefficient allocation of energy resources. Therefore, as important as it is to stress the purchase of efficient appliances, it is equally important to develop the proper habits of appliance use. This generally involves a certain degree of behavioral modification, and quite frankly, it is extremely difficult to induce an individual to change his or her behavior. The key to accomplishing such a goal, as in appliance choice itself, is to make any suggested behavioral alterations as easy upon the effected party as possible. When the goal is to induce the University administration to adopt a policy promoting energy efficient behavior, this involves revealing the cost savings that accompanies such behavior. The special circumstances involving each appliance however are typically more complex than a simple cost analysis. For example, strict adherence to the cause of energy efficiency would dictate that all computer should be turned off when not in use, or at very least placed into standby. In this case the failure of such a strictly efficient approach comes in that OIT requires that computers be turned on in order to properly update security software. Thus, a strictly efficient approach to the

management of University computers would actually compromise the long-term utility of those computers. Therefore, in the case of University owned computers, a compromise has been made- when not in use, the computer itself necessarily stop short of full standby, but the computer monitor is automatically turned off. The point of this example was to illustrate that a strict cost analysis does not always capture all of the variables that effect or restrict behavior with appliances. Not every ineffective behavior can rightly be targeted for termination or alteration; it is first necessary to determine which behaviors are truly ineffective and which merely seem to be.

Conclusion

The purpose of this paper has been to suggest methods to mitigate the effect that the Whitman College expansion will have upon the environmental footprint of Princeton University. That Whitman College will have some impact upon the development of this university is undeniable, it is simply a matter of how Princeton University chooses to adjust to the addition of 500 students to the campus. As previously stated, the suggestions outlined in this paper shall hopefully serve to ease this process. While these suggestions come out of an effort to ease the impact of the Whitman College expansion however, it is important to note that the utility of these suggestions is not limited to Whitman College. These suggestions were developed from a study of the current practices and policies of Princeton University and hopefully will be effective at any stage of University development.

APPENDIX A

	1/1/01 - 12/31/01	1/1/02 - 12/31/02	1/1/03 - 12/31/03
Waste			
Municipal Waste	3024.81	3156.69	3217
Medical Waste	21.86	20.97	23.7
Total Waste	3046.67	3177.66	3240.7
Recyclable Waste			
Mixed Paper	1190.89	943.72	952.06
Bottles/Cans	243.88	233.45	222.65
Scrap Metal	132.78	71.89	55.18
White Goods	0	2.41	0
Food Scraps	572.5	532	638
Anti-Freeze		2.1	1.2
Lead Acid Batteries	7.7	5.35	0.54
Tires	10.28	4.2	4.91
Motor Oil	3.35	3.23	4.56
Household Batteries	0.22	0.35	0.33
Computer Parts	6.09	38.4	26.2
Tree Parts	660	1573	758.25
Leaves	43.75	42.65	41.42
Concrete Asphalt	7209.6	3536	24167
Florescent Lamps	12.09	7.33	8.18
Total Recycled	10093.13	6996.08	26880.48
Total Material	13139.8	10173.74	30121.18
Recycling Percentage	76.81342182	68.7660585	89.24112535

¹⁹

Calculation:

4600 current undergraduate students
500 student increase, Whitman College

using 2003 numbers-

municipal waste: $3217/4600 = .69935$ tons/student x 500 = 349.674 tons x 102 = \$35666.75

mixed paper: $952.06/4600 = .20697$ tons/student x 500 = 103.485 tons

bottles/cans: $222.65/4600 = .04948$ tons/student x 500 = 24.734 tons

food scraps: $638/4600 = .13869$ tons/student x 500 = 69.348 tons x 60 = \$4160.88

¹⁹ Source- Jonathan Baer, Director of Building Services

APPENDIX B

Computer Calculations:

Energy savings when half of monitors turned off 12 hours/day

$$95\text{W} \times 10,000 \times \frac{1}{2} \times \frac{1}{2} = 237\text{kW} \times 8760 \times .06 = \$124,830$$

Increase in energy demand with Whitman College

$$130\text{W} \times 500 = 65000\text{W} = 65 \text{ kW}$$

Whitman College- energy savings half of monitors turned off 12 hours/day

$$95\text{W} \times 500 \times \frac{1}{2} \times \frac{1}{2} = 11.875 \text{ kW} \times 8760 \times .06 = \$6241.5$$

APPENDIX C

Laundry Calculations:

10 standard (Maytag MAT13MNAW) washers
600 loads
37 gallons/load
~1.57 kWh/load
~\$.06/ kWh

$10 \times 600 = 6000$ loads per year $\times 37 = 222,000$ gallons of wastewater
 $= 6000 \times 1.57 = 9420$ kWh/year $\times \$.06 = \565.2

10 EnergyStar (Maytag Neptune MAH21PNAWN) washers
600 loads
15 gallons/load
~.65 kWh/load
~\$.06/ kWh

$10 \times 600 = 6000$ loads/year $\times 15 = 90,000$ gallons of wastewater
 $= 6000 \times .65 = 3900$ kWh/year $\times \$.06 = \234

132,000 gallons in water savings = 17650 CCF $\times \$2.31/\text{CCF} = \40771.5

Appendix D

Lighting Calculations:

75 W incandescent bulb
12 hours/day
200 days/year
~\$.06/kWh

$$75 \text{ W} = .075 \text{ kW} \times 12 \times 200 = 180 \text{ kWh/year} \times \$.06 = \$10.8$$

25 W CFL
12 hours/day
200 days/year
~\$.06/kWh

$$25 \text{ W} = .025 \text{ kW} \times 12 \times 200 = 60 \text{ kWh/year} \times \$.06 = \$3.6$$