Options for a Composting Program at Western Michigan University: A Case Study

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ENVS 410: Appropriate Technology and Sustainability – The Campus as a Living Laboratory with Dr. Harold Glasser
Spring Semester 2007

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Executive Summary

According to *White Paper on Campus Solid Waste*, a report that was done by the Department of Agricultural Economics and the School of Packaging at Michigan State University in 2006, 25% of the waste going to the landfill from the university was organic. In Western Michigan University's cafeterias, students generate at least one pound of waste per person for each meal (Campus Sustainability Assessment). For most universities, organic waste is second only to paper waste leaving the university, establishing a challenge for many universities as they struggle with its management and disposal. WMU's current system of removing these wastes by sending them through kitchen garbage disposals is energy and water inefficient. The system is also reliant on the Kalamazoo Water Reclamation Plant and adds to the water costs of the university.

However, some campuses, such as Penn State University have successfully controlled their organic waste output in a sustainable and practical manner. Penn State's Organic Materials Processing and Education Center (OMPEC) was recently recognized for their program throughout Pennsylvania with the Governor's Award for Environmental Excellence in the Education and Outreach category. Penn State and similar programs at universities around the country could provide examples of how Western Michigan University could implement a composting system that is effective and increases the sustainability of our campus.

I have provided a case study analysis detailing the successes of the existing composting programs at public institutions similar to Western Michigan University. In my study I will discuss the programs in use at the following universities in detail:

- Penn State University
- The University of British Columbia
- The University of Michigan

There will also be a section devoted to short descriptions of these programs:

- Middlebury College
- The University of Michigan's Cultivating Community

As food waste disposal is a cumbersome issue to confront, WMU may wish to implement a smaller student-run pilot program, as many of these universities did as they assessed whether a large scale system would be practical for their institution. A pilot could provide insight into the issue as well as further data on the subject. In addition, it could be beneficial for such an endeavor to work in conjunction with the city of Kalamazoo. Such a partnership could foster stronger bonds between the university and the greater Kalamazoo community through a composting facility.

After evaluating the examples provided by the university programs listed above, I will discuss the limitations and benefits of each example for WMU's campus and provide a detailed recommendation for additional possible solutions to the inefficiency of our food waste disposal system. To complement the solutions I have recommended, a list of potential resources and funding options are included.

Introduction

Food waste refers to the prep wastes of the kitchen as well as the food that remains uneaten by the students eating in the cafeterias. There are 4450 students using Western Michigan University's meal plan for the Spring Semester of 2007(information from Judy Gipper in e-mail correspondence). Assuming these students are consuming three meals a day and generating one pound of waste per person for each meal, about 13,350 pounds of food waste is generated on a daily basis. Most of this waste is removed from campus kitchens by washing it down industrial garbage disposals and into the sewage system. The thousands of gallons of resulting waste water is processed by the Kalamazoo Water Reclamation Plant, which charges 29 cents per cubic yard of water (http://www.kalamazoocity.org/portal/government.php?page_id=166).

According to former Landscaping Services Director, Paul MacNellis, WMU purchases approximately 2000 cubic yards of compost for university green spaces each year. Western Michigan University's Office buildings and landscapes cover over 720 acres of land and compost for campus is bought from an offsite location. 250 cubic yards of "Top Dress", a soil rich (clay loam) composted material is purchased for grass areas and top-dressing thin lawns, another 250 cubic yards of "Planting mix", used for planting shrubs and perennials, from Renewed Earth, and 1500 cubic yards of shredded bark for shrubs and trees. WMU ships off approximately 820 cubic yards of yard waste, such as organic debris, sticks, stumps, spent flowers, and shrub waste to a yard waste recycle/composting station North of Kalamazoo. WMU could be utilizing our abundant resources of food and yard wastes to supplement the soil.

If the university were to implement such a program, their actions would be in accordance with the goals of the *Department of Environmental Quality's Recommendations for Improving and Expanding Recycling in Michigan* from February 22, 2005.

The sections of the report that are relevant include **Recommendation 1**, detailing the need to:

- Capture the environmental and economic benefits of waste reduction, reuse, and recycling;
- Incorporate education of individuals, businesses, and governmental institutions, focusing on the waste management hierarchy by promoting source reduction, reuse, and recycling;
- Develop capacity for recovery of organic residuals

And **Recommendation** 12:

"Whether from farms, food processing plants, or cafeterias, organic residuals make up a large part of the waste stream. Michigan should promote source-separated collection and use of this valuable resource by developing a comprehensive source-separated organic waste management plan."

The objective of this case study is to provide the background information, resources, and incentives to supply a solution to the inefficiencies of the current food waste disposal system at WMU.

Methodology

In order to collect information for this report, documents from the institutions focused on in the examples were utilized for their detail and extensive documentation. Internet research was also a main contributor to the information included, especially the websites for the composting programs that are described. Several interviews and e-mail correspondences were necessary as well, which is where most of the information concerning Western Michigan University was gathered.

As a research based assessment, the scope of this document exists only within the boundaries of a research report. The information compiled into this report is designed to work as a resource for future projects concerning composting on WMU's campus. The task of embarking on a solution for such a large and encompassing issue is difficult and all angles of cost, labor, and practical analysis must be considered in order for such a project to be successful. A goal of this report is to act as a piece of the greater project.

The university programs that are discussed in the following sections will provide significant insight into how a composting program can fit into a university setting. The descriptions of the programs focus on methods or resources that may be especially useful for WMU. There are some aspects of the universities that have these programs that WMU does not, such as an agricultural program or more funding from outside sources. As these things have a significant influence on whether or not large scale composting is feasible for the institution, they are briefly discussed in relation to their programs.

Composting Programs of Other Universities

Penn State University - Organic Materials Processing and Education Center (OMPEC)

Pennsylvania State University has an enrollment of about 34,500 undergraduates and 6,300 graduate students (Bartlett and Chase, 29). Prior to the installment of OMPEC, Penn State sent their organic wastes through the waste water treatment plant, and a portion to the landfill. This system did not adhere to the university's recycling objectives, so when the subject was mentioned by a group of students, the university was open to utilizing their resources for a composting program.

10 Week Pilot

OMPEC was initiated by a group of concerned students and Penn State employees in 1997 and began as a 10 week demonstration project that collected kitchen prep wastes in one of the seven campus dining commons. The small scale of the pilot demonstration served as an opportunity to determine whether collaborative efforts among these concerned parties could function effectively and produce a useable resource. Penn State administrators recognized the value of the demonstration and the projects that resulted from its pilot status and agreed to continue forward with the campus composting initiative. "The initial seed planted by the student group has grown to support the University's environmental strategy and educational mission while fulfilling operating needs" (Davitt, 1).

One-year pilot and Equipment Modification

Following the 10 week pilot, a one year demonstration project operated on a larger scale and collected wastes from three dining commons. During the one year pilot, it was established that operating procedures would need to be modified for the large scale program to eliminate the manual lifting that originally acted as a means of dumping collection bins into one receptacle. A sub-committee met and identified equipment needs such as larger collection containers with wheels and a truck with a roll-off bed with a walking floor and a candy-cane lift for transport. The sub-committee learned that such a piece of equipment did not exist and a design team was implemented to produce a proto-type. The truck bed was created by J&J Body of Somerset, PA, is made out of aluminum and uses sprocket driven mechanical methods to load food waste material from the 90 gallon carts utilized in collection (Matyasovsky, 2). The truck is capable of carrying 5 tons of compost material per load.

Windrow Method

OMPEC uses windrows in compost production. Organic waste is formed into rows of long piles (windrows) and aerated by turning the pile periodically, in the case of OMPEC, by mechanical means. According to the United States Environmental Protection Agency, the ideal pile height is between 4 and 8 feet allowing for a pile large enough to generate sufficient heat and maintain temperatures, yet small enough to allow oxygen to flow to the windrow's core. The ideal pile width is between 14 and 16 feet.

Penn State's Organic Materials Collection Roll-Off depositing food residuals into a windrow. →

Collaboration on the Project

Success of the project has been attributed to university wide cooperation. Staff and students are responsible for sourcing and separating organics in order to divert them to the composting facility. PSU's Office of Physical Plant and the College of Agricultural Sciences have joined forces to collect the material and produce a finished compost product. The initial production needs of the composting process were found within the University's existing facilities and equipment. The program also used existing land space owned by the university (Davitt, 2).

Collaborative efforts between university staff and the College of Agricultural Sciences bring composting and waste management strategies together and by using existing knowledge and resources, the project was established without the duplication of capital equipment or staff. The Office of Physical Plant is responsible for the collection and delivery of food wastes. The College of Agricultural Sciences coordinates compost production.

Staffing for OMPEC primarily consists of a program coordinator and site operator. The coordinator's duties include directing daily activities and facilitating research projects on site as well as any development. The site operator is responsible for all aspects of compost production.

Expansion Since 1997

Expansion of the program since 1997 includes an increase from the eight tons collected during the demonstration phase to over 500 tons in 2001 – 2002.[1] At that time, organics collection consisted of pre-consumer food wastes from seven dining commons, the day care center and the student union, pre and post-consumer wastes from the School of Hotel, Restaurant and Institutional Management's test kitchen and two hotels operated by Penn State. 74% of the food residuals were collected from dining commons patrons (Davitt, 3).

Use of Finished Compost

Before the installation of OMPEC, Penn State bought compost materials for university landscaping from an offsite location. Currently, the primary use of finished compost is in landscape and grounds maintenance. Finished compost is used in ornamental planting beds, potted planters, and turf topdressing and construction site soil restoration. Research projects have also utilized finished compost as a soil conditioner, mulch, soil remediation and in wetlands construction for wastewater remediation. The University maintains over 900 acres of landscape, and at the present rate of production, the demand for finished compost exceeds the supply.

Significance for Western Michigan University

OMPEC's example supplies a method in which WMU could research the best options for the necessary equipment, staffing, and monetary resources in order to

[1] Graph of food residuals and OMPEC feedstock table available in Appendix IV in Davitt report.

embark on a large scale composting project. Penn State's pilot programs provided the background information needed to convince the administration that the program would be beneficial for their waste management system.

Also, the creation of the Organics Materials Roll-off is an example of how WMU could develop a system unique to the university's needs. The utilization of our resources as a research institution could aide in this endeavor, such as creating a class or senior project program dedicated to the design of equipment and specific methods of composting for the project.

Limitations of OMPEC for WMU

OMPEC was possible for Penn State University in part because of their agricultural program. Composting is a subject of expertise in the College of Agricultural Sciences, and the resources, as far as capital equipment in maintaining the windrows used in the system were on hand. The agricultural practices at the university also supplied more of a practical use of the finished compost in crop fields and a large section of property for the location of OMPEC.

WMU does not have an agricultural program, limiting our resources in knowledge of composting practices and equipment that would not have to be purchased specifically for large scale composting. Windrows are not a practical method for WMU as well, because of the lack of property. In addition, after interviewing Paul MacNellis, such a method would not provide enough of an incentive for the university to create a program because of the maintenance requirements.

The University of British Columbia – In-Vessel Composting

The Organics Collection Program at UBC recycles or composts over 70% of their outgoing waste. The program began as a result of the agricultural activities and the need for a disposal method for the animal waste stream. The university began composting food wastes to reach their goals to increase the sustainability of the campus.

In-Vessel Composting: Wright Systems

UBC invested in an in-vessel composting unit from Wright Environmental Management Inc. for large-scale composting activities. In-vessel composting refers to the decomposition of organic waste in a fully enclosed vessel. UBC's unit is capable of processing 5 tons of organic waste daily, producing compost within two weeks (excluding compost maturation time) and has diverted 5000 green bins of organic waste from the landfill in its two years of existence decreasing the number of trips made to the Vancouver Transfer Station, Urban Wood Waste and Richmond BioRecovery by 54% (http://www.recycle.ubc.ca/compost.htm).

UBC's In-Vessel Unit

How In-Vessel Works

The in-vessel unit is constantly processing compost material with a process called continuous loading that is made possible by a moving floor system. A hydraulic ram slowly advances a series of trays the distance of one tray, forcing the last tray in the line, which is holding finished compost, to exit the vessel. The tray which last exited the vessel is cleaned, and re-inserted at the loading end. The vessel is capable of being adjusted for different quantities of compost materials, and is able to accommodate from 600 pounds to 30 tons per day.

The unit processes compost in a 2 week time period by managing oxygen, moisture and temperature. There are temperature probes within the unit's "tunnel", and when the set maximum of any of the three temperature zones in the unit is reached, a supply fan for that zone is triggered. The three temperature zones include the loading zone, the pasteurization zone, and the unloading zone.

The loading zone is set to promote thermophylic, or microbial, composting, and to ensure that the materials remain above 55 degrees C for three consecutive days (EPA 503). The pasteurization zone is kept at 72 degrees C for a minimum of one hour. Finally the unloading zone is maintained at 52-54 degrees C for optimal biodegration. Additionally, to monitor the ideal moisture level of 45-60% in the system, the composting material is broken apart and rendered airborne by spinners inside of the unit and passed through water spraying from ceiling-mounted nozzles.

Capital and Operational Costs

For a commercial scale composting system, Wright's in-vessel unit uses a significantly decreased amount of building materials and land space for its operation and construction.

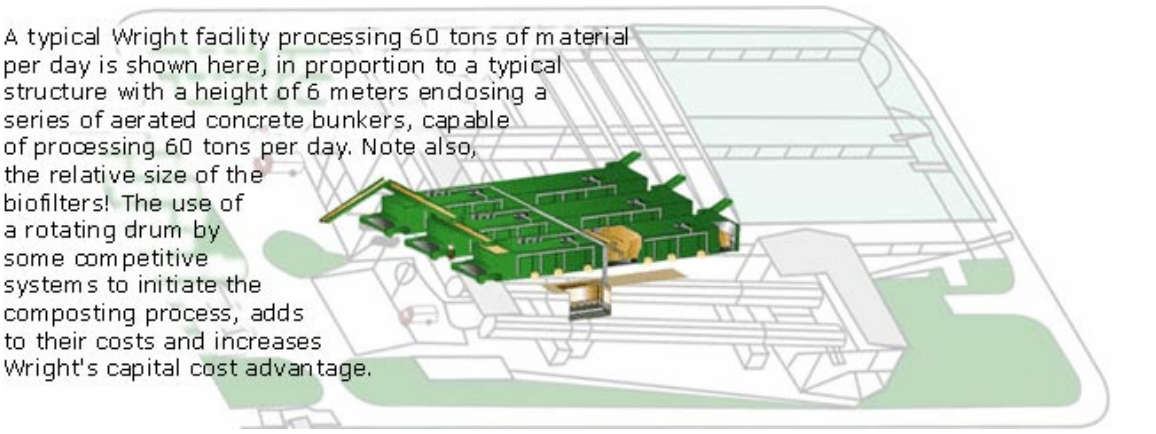


Diagram of scale of in-vessel system in comparison to an alternative system of the same capacity (http://www.wrightenvironmental.com)

The in-vessel system is highly automated, reducing the need for manual labor and personnel to operate the unit. The tunnel itself is designed to last for 20 years according to Wright Environmental Inc. Most of the costs for operation surround the fact that heat is a by-product of the accelerated composting process. Each tunnel's primary exhaust fan runs continuously in order to sustain the unit under negative pressure and keep the temperatures below the set-points in the three temperature zones. The Wright tunnel primary exhaust fan is rated at 5 to 10 HP.

Collecting Wastes

UBC holds that they have a 'closed loop system' where all composted waste returns to the campus as fertilizer in landscaping. UBC Waste Management collects both pre-consumer and post-consumer food residuals in addition to plant wastes from their campus. Pre-consumer food wastes are defined as kitchen scraps including raw fruit and vegetables, while post-consumer waste is defined as cooked fruit and vegetable wastes and meat and dairy products. Other materials collected for the In-Vessel Composter include paper plates, cups, towels and napkins, and yard wastes like leaves and twigs.

Two Receptacles Used in Collecting Organic Waste on UBC's Campus:

1)Green Bins Placed around Campus 2)Sorting Receptacle in Student Union

Significance for Western Michigan University

In-vessel composting supplies an alternative to using a large section of open space owned by WMU, one of the limitations deterring the university from such a program. Additionally, the unit is specially designed for a commercial institution like Western, and Wright Environmental could provide consultation services on the best system for campus waste management needs. The unit's limited necessity for manual operation also decreases the amount of extra staff needed to run the composting system. Operating costs would focus on the collection of the food waste materials.

Limitations of an In-Vessel Unit on WMU's Campus

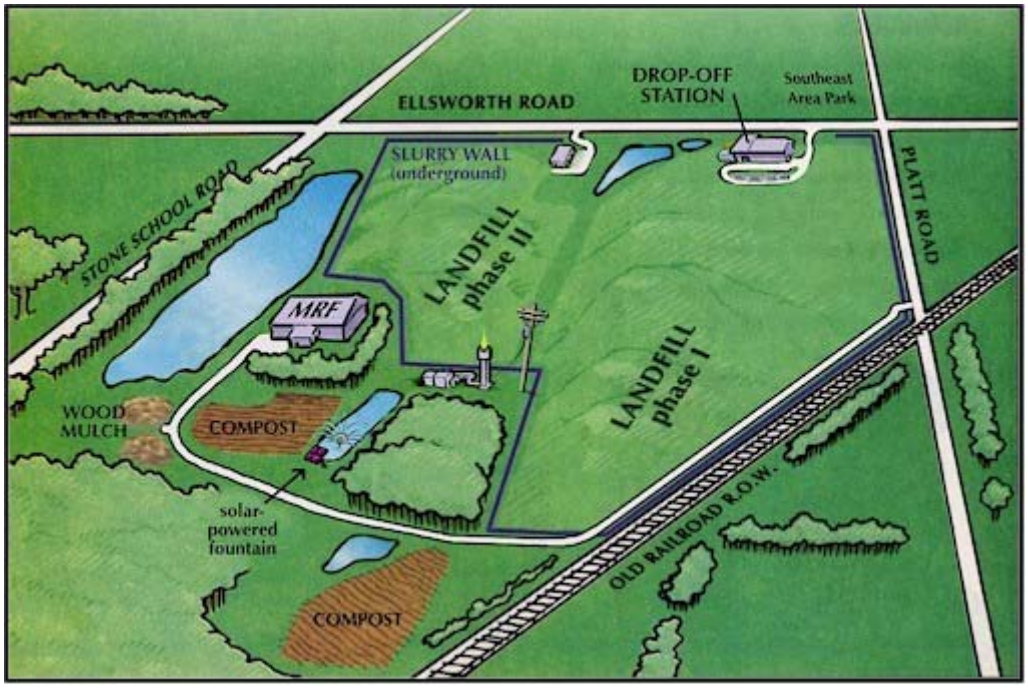
Western Michigan University has been experiencing continuous budget cuts from the state over the last several years. With funding for projects like a composting program exceptionally low, it is not likely that the expensive up-front costs of the unit would be feasible for the university. However there are several funding opportunities available for institutions initiating sustainable development (details in Recommendations and Funding section). It is also possible that there is not a land area that would suit the unit.

The University of Michigan – Working with the City of Ann Arbor

Collaboration between the City of Ann Arbor and the University of Michigan on a compost program for the university has been beneficial for both as they attempt to decrease the waste stream en route to landfills in the area.

Ann Arbor Composting Facility

In March of 1997, the University of Michigan's Waste Management Services (WMS) and the city of Ann Arbor Solid Waste Department received a $19,000 grant from the Washtenaw County Department of Public Works. The grant money was used for an 8 month pilot compost program that developed into the current program. The City was awarded money for the labor to manage the compost site and the University was enabled to purchase equipment and fund the collection of wastes Ann Arbor's 10 acre Material Recovery Facility is responsible for the testing of the finished compost, and sells the product to members of the Ann Arbor community.



Drawing of City of Ann Arbor Material Recovery Facility (from www.ci.ann-arbor.mi.us)

It was cost-effective for the university to collaborate with the city on their composting initiative. According to *The University Record* April 22, 1998 article, "Pilot Program Funds Waste Recycling Program", transportation and landfill space expenses caused the cost of sending refuse to the landfill to be $9.59 per cubic yard when U of M started their pilot program. However, composting waste in the Ann Arbor facility was approximately $4-$6 per cubic yard at that time.

Compost Collection Information

From the installment of the program in August 1997 to June 2006, almost 396 tons of food waste has been composted.

Fiscal Year	Compost (tons)
FY 1998	29.64
FY 1999	22.30
FY 2000	10.26
FY 2001	34.52
FY 2002	47.85
FY 2003	64.96
FY 2004	67.54

FY 2005	66.09
FY 2006	52.70

Content modified: April, 2007 (from http://www.recycle.umich.edu/grounds/recycle/food_composting.html)

Significance for Western Michigan University

The Kalamazoo City compost facility is not located far from WMU. Western could use U of M's example and collaborate with the city in a composting effort. In addition, the city and WMU could apply for a partnership grant in order to start the program. The city may be a great supporter of such a program, as the waste water from WMU's kitchen garbage disposals to the Kalamazoo Water Reclamation Plant would diminish, and the task of processing the food wastes in those waters would be eliminated. Working with the city of Kalamazoo would allow Western to utilize an existing resource, rather than building a site on university property. The partnership would further strengthen the bonds between WMU and the greater Kalamazoo community as well.

Limitations for WMU's Campus Wastes

The costs of transporting food wastes to the Kalamazoo facility may exceed those to treat waste water from using the cafeteria garbage disposals. Further analysis of this method will need to be done in order to determine whether or not it would be lucrative for the university and its monetary limits.

University Programs to Note

Middlebury College: Middlebury College of Vermont has been composting since 1993 when they were awarded a grant by the state. They recycle and compost 75% of their outgoing wastes and received an award from the U.S. Environmental Protection Agency in 1996. Middlebury's program led to $27,000 of net savings for that year. (http://www.middlebury.edu/administration/recycle/topics/compost.htm)

U of M Cultivating Community: Cultivating Community started in 2004 and is comprised of faculty, students, staff, and community members who use vermicomposting, a method of using red worms in composting, for food waste from campus dining halls. Collaboration between the group and projects from two courses resulted in the creation of a student garden at the Botanical Gardens. The vermicomposting unit has also been moved to the Gardens and delivers a portion of the food waste that is collected to feed to the worms. The harvested worm castings are then used to fertilize Cultivating Community's garden plots. (http://www.cultivatingcommunity.com/)

Recommendations and Funding Opportunities

After analyzing other university composting programs, the best courses of action for Western Michigan University in the pursuit of a future program includes the following aspects:

- A student run pilot program with in depth data collection to determine how feasible such a program would be, and how WMU could specialize it to our university
- A partnership with the City of Kalamazoo in utilization of the existing facilities and potential funding resources
- Collaboration of students, staff, faculty and administration to ensure that WMU receives as many benefits of the program as possible and that it is successful

In order to initiate a composting test pilot, an Environmental Studies Major required Senior Seminar on the subject could be implemented for the purpose. The project could also be developed through the Students for a Sustainable Earth (SSE) resident student organization. SSE is the most influential environmental student group on campus, and has been responsible for many of the "green" initiatives on WMU's campus.

Examples of Funding Opportunities

U.S. Environmental Protection Agency Sustainable Development Challenge Grant – www.epa.gov

- **Description**: The Sustainable Development Challenge Grant (SDCG) program funds projects that lessen impacts on the environment, build sustainable futures for communities, boost local economies and foster partnerships among community groups, businesses, and governments. The SDCG program supplies funding amounts from $50,000 – between $50,000 and 100,000.

Contact:

U.S. EPA, Office of the Administrator, Office of Regional Operations and State and Local Relations, 401 M Street, SW, Washington, D.C. 20460, Mail Code 1503.

Michigan Incentives for Energy Efficiency Program Grants - www.dsireusa.org

- **Community Energy Project Grants Description:** The program is solicits for proposals on an annual basis for community demonstration projects that illustrate energy efficiency. The grant is available for public entities and non-profit organizations. Eligible projects include green-building, bioenergy, biofuels, and bioproducts projects. The maximum amount received through the award is $6,000.

Contact:

John Sarver
Michigan Department of Labor and Economic Growth
Energy Office
611 W. Ottawa
P.O. Box 30221
Lansing, MI 48909
Phone: (517) 241-6280
Fax: (517) 241-6229
E-Mail: jhsarve@michigan.gov
Web site: http://www.michigan.gov/cis/

- **The Michigan Public Service Commission energy-efficiency program description:** This grant supports the implementation of energy-efficient and renewable-energy projects. In 2006, over $76 million was awarded to 24 organizations.

Contact:

Robert E. Tuttle Jr.
Michigan Public Service Commission
Energy Grants Section
P.O. Box 30221
Lansing, MI 48909
Phone: (517) 241-9920
Fax: (517) 335-8500
E-Mail: retuttl@michigan.gov
Web site: http://www.michigan.gov/mpsc

The Jessie Smith Noyes Foundation - www.glrppr.org/funding/#336

- **Description:** "The Jessie Smith Noyes Foundation is committed to protecting and restoring the earth's natural systems and promoting a sustainable society by strengthening individuals, institutions, and communities pledged to pursue those goals." The program is available to any state in the U.S. grants funds primarily in the areas of environment and reproductive rights. There is no application deadline, and complete application procedures are available on the website.

Contact:
212-684-6577
noyes@noyes.org
http://www.noyes.org/

Rockefellers Brothers Fund Sustainable Development Program

- **Description:** The Rockefeller Borthers Fund (RBF) sustainable development grant supports environmental stewardship "that is ecologically based, economically sound, socially just, culturally appropriate, and consistent with intergenerational equity." The program encourages sustainable development with environmental conservation in mind. Awards range from $25,000 - $300,000 and a preliminary letter of inquiry is recommended.

Contact:
http://www.rbf.org/programs/sustainprog.html

Best Practice on Campus

WMU Cafeterias: If there is a significant amount of food left over from Friday meals, WMU cafeterias donate the food to the Kalamazoo Gospel Mission. This way the leftovers are not wasted and sent through the sewage or landfill system. Also, the donations benefit a charitable organization and allow WMU to further connect with the Kalamazoo community. Key players in this activity are the WMU kitchen staff, who dedicates their time to transporting the food to KGM.

Green Guide: The Green Guide is a pamphlet that is produced by WMU's Recycling and Waste Reduction Services at Physical Plant. The guide supplies important information on how students can affect the waste they create, including taking smaller portions in cafeterias and buying local vegetables and fruits. The guide is an excellent means for educating the student community, a very important piece of moving toward a more sustainable campus.

Limitations of Analysis

As the creation of a university scale composting program would affect and encompass many different aspects at Western Michigan University, this report acts as a piece of a larger project. Several points of information about the current state of food waste management at WMU were not included. Many of these points revolve around the subject of waste water treatment.

For example, after contacting the Kalamazoo Water Reclamation Plant to inquire about the amount of waste water coming from WMU, it was discovered that billing for WMU's water costs is separated by building. Each building has its own code for billing, and after being transferred through several contacts at the Plant and WMU the author was unable to gather the information before the completion of this report. Additionally, it is difficult to determine how much of the waste water flow is due to food waste disposal, as it is mixed in with sewage water. A detailed analysis of cafeteria water use for each kitchen on campus would have to be done for specific data.

Furthermore, data on the actual costs of any of the recommended programs is not included because the program would be unique for WMU's campus. Precise numbers were not available; rather the cost benefits that other university programs have received were detailed in order to provide examples of what WMU might receive were they to implement a composting system.

Further work for this project includes working closely with Paul MacNellis to determine whether the university would allow a pilot program, talking to Carolyn Noack, the Director of Recycling Services, about the collection program, contacting Greg Rosenboom about the amount of water leaving WMU, and analyzing student and faculty feelings about a composting program – what they would be willing to do to in support.

Short Term Goals

- Approach the Environmental Studies Program about a Senior Seminar in order to start pilot program
- Educate students in cafeterias about food waste – how they can reduce their waste (smaller portions, composting at home etc), and the state of food waste on campus
- Talk to Carolyn Noack – Need to determine the feasibility of adding food waste to the collection program, and analyze the costs

Long Term Goals

- Put together a proposal for the pilot for WMU administrators detailing the amount of monetary, equipment, and staffing resources needed
- Collect data once the pilot is in place – how it could be expanded and what would need to be modified
- Use the data from the pilot to formulate a plan for a large-scale program

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E-Mails:

Paul MacNellis, e-mail message to author, April 17, 2007.

Judy Gipper, Director of Dining Services, e-mail message to author, April 17, 2007.

Appendices

Appendix I. Current Contact List

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Useful Contacts

Greg Rosenboom	387-8591
Carolyn Noack	387-8165
Dining Services Office	387-4844

Appendix III. *Organic Materials Collection Roll-Off* by Al Matyasovsky

Appendix IV. *Alternative Disposal of Organic Residuals and a Means of Fulfilling Needs* by Nadine H Davitt

Appendix V. Campus Sustainability Assessment: Food Waste From Cafeterias (p 3)